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The quality of public finances and economic growth: Proceedings to the annual Workshop on public finances (Brussels, 28 November 2008)

edited by Salvador Barrios, Lucio Pench and Andrea Schaechter

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The quality of public finances and economic growth

Proceedings to the annual Workshop on public finances (Brussels, 28 November 2008)

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Abstract:

What role can better quality of public finances play in supporting Europe's long-term economic growth prospects? This question was at the centre of the 2008 European Commission workshop on public finances. It was largely motivated by the pressures put on European economies and their budgets from ageing populations and increased globalisation. However, the on-going financial crisis has given the issue an even greater prominence. Current fiscal stimulus packages not only include short-term measures, but also aim to have a lasting impact on growth. The latter is one aspect of ensuring a high quality of public finances. The workshop papers presented and analysed a number of policy options, ranging from the role of growth-enhancing public expenditure, in particular public infrastructure, and more generally the provision of public capital, the role of institutions, tax policy and the interaction of short-term counter-cyclical fiscal policy and long-term economic growth.

Key words: Public finances, economic growth, fiscal policy, public spending, revenue systems, taxation, public infrastructure, institutions,

JEL classification: E62, H11, H20, H42, H50, H54, H60

Acknowledgements

This Occasional Paper brings together the papers presented at the Workshop "Quality of public finances and economic growth", organised by the Directorate-General of Economic and Financial Affairs (DG ECFIN) on 28 November 2008. The purpose of the annual workshop is to stimulate discussions among academics and policy makers on topical issues in public finances and their links to fiscal surveillance by the European Union.

All papers are written on a personal basis. The views expressed represent those of the authors and not necessarily those of the organisations that they work for.

The organisation of a workshop with over 140 international participants is always a logistical challenge. We are therefore grateful to all who have helped make the workshop a success, in particular Dominique Prins, Nicole Timmermanns and Dorrie Wilson. We are also indebted to Dorrie Wilson for her secretarial support in putting this Occasional Paper together.

The organisers,

Salvador Barrios
Lucio Pench
Andrea Schaechter Brussels, 20 February 2009

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Introduction[1]

by

Salvador Barrios, Lucio Pench and Andrea Schaechter

Background

Better understanding the link between quality of public finances and long-term economic growth was the main topic of the European Commission's *Public Finances in EMU − 2008* report and the workshop organised by the Directorate-General of Economic and Financial Affairs (DG ECFIN) on 28 November 2008. The annual workshops bring together academics and policy makers to discuss topical issues in public finances as identified in the annual ECFIN publication. This year's workshop took place amidst the financial crisis and two days after President Barroso had presented the Commission's European Economic Recovery Plan. While much of the public and policymakers attention was thus focused on the need for immediate measures for handling the crisis and pulling the economies out of recession, the workshop provided a timely forum to discuss what is needed for public finances to have a lasting impact on growth and strengthen the adjustment capacities of European economies. Both issues had already surfaced before the crisis as Europe's economies were faced with the rising challenges from ageing populations and increased globalisation that put new demands on public finances.

The *Public Finances in EMU – 2008* report developed a conceptual framework on quality of public finances.[2] In particular, quality of public finances was viewed as a concept with many dimensions. It goes beyond low deficits and debt levels, which remain its linchpin, but also comprises all fiscal arrangements and institutions that contribute to an efficient allocation of resources and support achieving macroeconomic goals, in particular long-term economic growth. The impact on growth could run in principle through the composition and efficiency of expenditure, the structure and efficiency of revenue systems and the size of the government. At the same time, fiscal governance, i.e. the set-up of fiscal rules, institutions and procedures, can affect all of the above four dimensions. Such a broad-based multi-dimensional approach reflects the complex nature of the relationships and attempts to avoid the 'omitted variables problem' that occurs when focusing solely, for example, on the level of expenditure items that raise productivity but overlook that such spending may be financed through a high and distortionary tax burden. Also, a multi-dimensional concept of quality of public finance would provide fiscal policymakers with a range of policy options.

Even though a number of empirical regularities have emerged from the literature on the links between quality of public finances and growth, many issues would benefit from further analysis and discussion. One aim of the 2008 workshop was to tackle some of these questions. They included how can the composition of public expenditure help promote long-run growth and which factors impact this link? Moreover, how can tax systems improve the growth potential while accounting for trade-offs to other objectives? And how can the different dimensions of quality of public finances be better embedded into macroeconomic growth analysis?

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[1] The introduction has benefitted from contributions by R. Eisenberg, L. Piana and P. Ritter.

[2] See European Commission, *Public Finances in EMU − 2008*, European Economy No. 4 (http://ec.europa.eu/economy_finance/publications/publication_summary12834_en.htm).

Giving the greater focus on quality of public finances, steps on how to better integrate quality of public finances into surveillance were laid out in the Commission communication that accompanied the 2008 *Public Finance in EMU* report.[3] Even though the role of quality of public finances has been recognised in the EU surveillance tools, the revised Stability and Growth Pact and the Lisbon Strategy for Growth and Jobs, in practice neither instrument has yet systematically focused much on quality issues. This was partly because a common understanding of quality of public finances had not yet been developed and because of shortcomings in Member States' reporting. First steps to remedy these problems, as laid out in the Commission communication, were the presentation of the conceptual framework, proposals to close reporting gaps and develop options for a more regular review of quality of public finances within the existing surveillance tools. Discussing options whether a greater focus of quality of public finances in surveillance is desirable and how it could be achieved was the second main objective of the workshop, which was mostly dealt with in the panel discussion.

The papers and discussions

In their paper **"The composition of government expenditure and economic growth: some new evidence for OECD countries"** *N. Gemmell, R. Kneller and I. Sanz* review existing evidence on the impact of public expenditure on growth for both developing and developed countries, and offer some new results for OECD countries. The authors examine the effect on growth of both total government expenditure and the shares of different categories of spending including the impact of the type of financing of expenditure (through distortionary versus non-distortionary taxation or deficits). Moreover, they control for potential endogenous relationships between spending and growth (i.e., changes in GDP affecting growth) by applying instrument variables. For 17 OECD countries for 1972-2004, they use the pooled mean group methodology to estimate the short and long-term relations between fiscal variables − notably the level and mix of expenditure − and growth.

The results provide robust evidence that reallocating total spending towards infrastructure and education is positive for long-run growth. The estimated magnitudes are similar for both expenditure categories with a 1 percentage point increase in the share of infrastructure or education spending raising the long-run growth rate by about 0.1 percentage points. In contrast, increasing the share of social welfare spending appears to be harmful for growth. However, taking into account the likely negative relationship between social welfare spending and growth over the short run, suggests that switching spending towards social welfare (and away from all others on a pro-rata basis), on average has no long-run growth effect. Defence and housing spending, by contrast, are confirmed to be among the least productive forms of expenditure.

In his discussion of the paper, *X. Debrun* stressed the important methodological improvements the paper made compared to earlier studies on the matter. However, the endogeneity problem had not been fully solved through the use of lagged values of the fiscal instruments since by using annual data the cyclical components of expenditure were still included. To remedy this, he suggested using also other methods (such as LSV and system-GMM) or average data which would dampen the impact of the cycle. The discussant also proposed to account for interactions between expenditure categories, differences between fiscal federalism arrangements and non-linearities. A puzzle in the findings was that the size of overall government spending was found to have a significant negative impact when potential endogeneity was ignored, but turned out to

[3] Communication from the Commission to the Council and the European Parliament, *The Role of Quality of Public Finances in the EU Governance Framework*, (COM2008), 387 final (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52008DC0387:EN:NOT).

be positively linked to growth in the estimate accounting for the contemporaneous cyclical co-movements between growth and spending.

The paper **"Behind public sector efficiency: the role of culture and institutions"** by *M. Casiraghi, R. Giordano and P. Tommasino* aims at empirically assessing the importance of citizens' values for public sector efficiency. In order to control for differences in formal institutions, the authors concentrate the empirical analysis on differences in public sector efficiency within a country (the case of Italy). Specifically, they compute measures of efficiency (calculated by applying data envelope analysis in a one-input/one-output specification) for four spending items (child care, education, health care and civil justice) for 103 Italian provinces and related these measures to proposed indicators of cultural attitudes. The latter are computed based on reported and revealed information concerning generalized morality, interest for politics and network density.

OLS estimates in the paper show that the indicator of interest for politics appears to have a positive impact on public sector efficiency and is strongly significant. In contrast, the indicators of generalised morality and presence of associative networks seem not to be significant or to be significant with the wrong sign. In order to control for endogeneity (i.e., lack of interest in politics being due to bad public services), the interest for politics is instrumented with three sets of variables related to provinces' political history and past political participation. This allows the authors to conclude that historically-determined values and attitudes toward politics still influence the quality of Italian public sector, much more than supposedly "amoral" and "selfish" attitudes.

As the four public services considered are delivered by different levels of government in Italy, the data-set is also exploited to test whether accountability is maximised when the decision-maker authority is set at lower levels of government. Even when controlling for decentralisation, interest for politics remained the most relevant variable explaining public service efficiency, while the government level providing the service do not seem to matter. However, looking at the impact of decentralisation on different quintiles, the authors deduce that decentralised provision would enhance efficiency of public services in high-efficiency provinces while reducing efficiency in low-efficiency provinces.

P. O'Brien focused his discussion of the paper on some possible flaws in the efficiency estimations, in particular the need to correct for contextual factors. Based on the ongoing work on the next OECD survey on Italy, which will include as a special topic education, he highlighted that many variables influence educational attainment, such as the family sociological background. This explains to a great extent the better PISA results achieved by students in the North of Italy relative to the South. He also remarked that it was problematic to relate the efficiency of centrally provided services, such as justice and education, to local cultural attitudes. In the light of both the paper's conclusion and the OECD analysis, the discussant expressed concern that the planned implementation of fiscal federalism in Italy might exacerbate efficiency disparities across regions.

The OECD **"Tax and growth"** study by *A. Johansson, C. Heady, J. Arnold, B. Brys and L. Vartia* sought to provide answers to three questions. First, does the tax structure, as opposed to the level of taxes, matter for per capita growth? Second, to what extent would different tax structures affect investment and total factor productivity (TFP), the main driver of growth over the last decades? And third, would the industry or firm structure matter for the impact of taxes?

In response to these three questions, the study delivers the following key results. There is a clear ranking of taxes in terms of their negative impact on growth. Property taxes (particularly recurrent taxes on residential property) were found to have the least negative impact in growth,

followed by consumption taxes. Personal income taxes (including social contributions) would have a stronger negative impact, and corporate taxes the strongest. These results were obtained by controlling for the overall tax-to-GDP ratio and looking at the tax mix in individual countries over time, following changes in tax law. Therefore, the results would only apply to small changes in the tax structure.

As regards the impact of tax structures on investment and TFP, including differences in firm/industry structures, Heady highlighted the following results. Corporate taxes would reduce investment and productivity, which seemed to be particularly relevant in highly profitable and risky industries. Conversely, R&D tax incentives appeared to increase productivity at the industry level. It would therefore not be possible to discriminate between a tax system with high corporate taxes but high R&D allowances and one with low corporate rates and small R&D allowances. At the firm level, young and small – unless rapidly growing – firms seemed to be less affected by the corporate tax rate. High top marginal personal income tax rates would reduce productivity growth, especially in industries characterised by high entry rates of new firms; high social security contributions would reduce productivity growth especially in labour-intensive industries.

The following policy implications were drawn. In general terms, the tax structure should be shifted towards consumption and property taxation. While cutting corporate tax rates was fostering growth, one should be careful to lowering it much below the top personal income tax rate as this would encourage tax arbitrage. The literature further showed that a broadening of the base of consumption taxation was preferable to an increase in the statutory rate. Moreover, multiple consumption tax rates were ineffective to promote employment and their equity objectives were best achieved by other means.

Politically, these insights might be hard to implement. A move from income to consumption taxation would generally be perceived as regressive, thus raising the issue of a trade-off between long-term economic growth and equity. However, residential property taxation might not be regressive, if large allowances were granted. As for cutting corporate tax rates, it was pointed out that the tax incidence would ultimately fall on workers. Finally, in taxation the devil was in the detail, so a careful design was equally important.

Commenting on the comprehensive paper, *G. Nicodème* stressed the necessity of recognising changes in tax systems as structural reforms. To this end, he referred to studies suggesting that the effects of the tax reform on growth (in the case of corporate tax coordination) could be similar in magnitude to the 2004 EU enlargement, the full implementation of the Services Directive, the liberalisation of network industries or the completion of the Single Market. In that respect, it would be beneficial to build up a comprehensive database of tax reforms. However, despite clear conclusions in the literature on tax structures, for example concerning the desirability of reduced corporate rates for small firms or the lack of empirical support for multi-rate consumption taxes, the problem of political implementation remained severe and indeed, the devil was in the detail. Finally, attention should be paid to taxation issues from an international perspective, especially to tax coordination, profit-shifting by multinationals and repercussions on trade.

The paper **"Growth and public infrastructure"** by *G. Myles and N. Hashimzade* extends the multi-country Barro model of productive public expenditure. In the case of infrastructural externalities between countries the provision of infrastructure would be inefficiently low if countries did not co-ordinate. This would give a role to a supra-national body, such as the EU to coordinate the efficient level of provision thereby increasing the growth rate. Another conclusion of the paper was that capital flows between countries would act to equalise growth rates. This could help explain why there has been limited empirical evidence for tax rates

causing cross-country differences in economic growth rates. However, the conclusions should not be read as implying that taxation does not affect growth: if production required public infrastructure, then growth would be affected by the total provision of the public good. The capital flows would act to distribute the benefit of this across countries.

The discussant, *S. Kessing* offered comments related to four key areas. First, as regards the nature of infrastructure goods and spillovers the model assumes infrastructure to be a smooth externality, while in fact it is often discrete in nature (e.g. either there is a bridge or there is no bridge) implying a reduction of the inefficiency in provision. Second, concerning tax and infrastructure competition the model should rather assume a repeated game than a one-shot strategic interaction, in particular given the long time-horizon considered. A third concern with the model was its restriction to a single policy instrument: Member States may finance infrastructure by other means than taxation of capital, in particular by relying on less mobile tax bases such as labour. And finally, the discussant proposed to capture also asymmetries other than the size of the initial endowment.

In their paper, **"Macro policy and industry growth: the effect of counter-cyclical fiscal policy"** *P. Aghion and E. Kharroubi* argue that the literature up to date has neglected the effects of macroeconomic stabilisation policy on long-run growth. Instead, it had focused on the relation between the trend component or structures of macroeconomic policy and growth. The paper aims to address this gap.

To assess the impact of counter-cyclicality the authors set op the following specification. Growth data are drawn from industry-level value added series for a panel of industrialised countries. Growth at the industry level would be too small to have an effect on overall growth, which would help to identify causality in terms of stabilisation policy influencing overall growth and not vice-versa. In a first step, an indicator of "fiscal policy counter-cyclicality" is estimated by regressing the fiscal balance on the output gap. In a second step, growth (in labour productivity or in value added) at the industry level is regressed against this indicator times financial dependence of that industry in the US. The authors find a strong positive effect of this interaction term on industry growth. In a refinement, it appears that stabilisation policy carried out through the expenditure side of the budget had larger effects than revenue policy.

In discussing the paper, *R. Beetsma* (University of Amsterdam) said that, with an ingenious approach, the authors had generated strong results. He thought, however, that the paper could have been more tightly integrated with existing literature. Given the focus on industry-level data, more empirical implications might be investigated, for example whether stronger counter-cyclical fiscal policy would indeed stabilise output and whether more stable output would cause higher growth. Moreover, it should be discussed in more detail why discretionary policy might have a stronger effect than automatic stabilisers, in view of the substantial scepticism about the stabilising effect of discretionary fiscal policy. While the estimated coefficients seemed robust, their magnitude seemed rather large. Thus, it might be likely that they picked up other effects, for instance monetary policy, the size of government or the countries openness, if export sectors would be more dependent on external finance. A more thorough discussion of the regression results would be desirable. He suggested investigating further the aggregate effect of counter-cyclical policy for a given level of financial development and whether this would lead to more stable growth.

The paper **"Public and private inputs in aggregate production and growth: a cross-country efficiency approach"** by *A. Afonso and M. St. Aubyn* analyses the role of public capital, private inputs (including both physical and human capital) and governance (represented by a composite indicator covering various aspects of governance) on GDP per capita growth using a production possibility frontier approach. Total factor productivity is modelled as a composite effect of

efficiency (measured by an efficiency score) and by changes in the possibility production frontier. The analysis is undertaken for the years 1970, 1980, 1990, 2000 and a cross-section of OECD countries. Two methods are used: a Malmquist productivity index and a (non-parametric) stochastic frontier analysis. Results using both methods tend to coincide regarding the position of each country with respect to the production possibility frontier. Private physical and human capital emerge as the most important determinants of GDP per worker growth while public capital contribution was usually estimated as positive but, depending on the specification used, this variable did not always display a statistically significant coefficient. Governance, on the other hand, tends to foster countries' economic performance by allowing them to operate closer to the production possibility frontier.

M. Larch welcomed this paper as it applied innovative methods to tackle a key question: the efficiency of public finances. The production frontier approach used was also considered to be relevant given that OECD countries have relatively similar technological capability. While Larch found the results interesting as they were broadly in line with expectations, some countries, such as Italy and Portugal, were found to operate at the frontier of production possibilities, which did not match the evidence provided by more traditional approaches using growth accounting techniques. Therefore, Larch suggested trying to explain why efficiency did not appear to matter much compared to capital accumulation, especially in the light of results obtained with the growth accounting approach. Moreover, the paper left unresolved the role played efficiency regarding the higher contribution of private capital compared to public capital.

The policy panel discussion

The **panel discussion** stood under the heading **"Greater focus on the quality of public finances: a building block in EMU's road forward?"** The Chair, *L. Pench,(DG ECFIN)* asked the panellists *X. Debrun* (IMF), *C. Heady* (OECD), *L. Schuknecht* (ECB) whether a greater focus on quality of public finances was warranted in surveillance and how this could be achieved. While the importance of QPF has been acknowledged in EU surveillance, namely the reformed Stability and Growth Pact and the Lisbon Strategy for Growth and Jobs, in practice QPF has often not gotten the attention from policy makers that it deserved. That was one reason why, the Commission's EMU@10 report had put better QPF at the top of the domestic policy agenda for improving the functioning of the monetary union.

X. Debrun pointed out that in the IMF's surveillance process the issue of QPF was very present in policy discussions but the details were not always fully reflected in IMF reports. In particular, the discussions on QPF considered microeconomic conditions to ensure that policy measures were suited to country-specific situations with regard to the long-run impact. Fiscal frameworks, such as fiscal rules, were also an important aspect in QPF. Experience has shown that such rules should be simple and not too flexible. Flexibility should rather be on the side of those assessing when deviations from rules are appropriate. International institutions may have a useful role to play in this assessment by providing an independent outside perspective.

According to *C. Heady*, the workshop had shown that QPF, in particular the micro structures of policy measures, matter for economic growth. As regards, the tax side of such measures, they were, however, rarely monitored and assessed by national surveillance bodies, such as national audit offices. But they were discussed in multilateral surveillance by the OECD which also accounted for the country-specific environments. The OECD has usually compared country-figures with OECD averages. Averages, however, did not necessarily correspond to benchmarks but they could help signal important questions while taking into account country-specific circumstances. Such multilateral surveillance discussions have been explicitly framed around

objectives other than growth and particularly taken the trade-off between growth and equity into account. Usually, relatively rich countries have a preference for equity over efficiency.

The third panellist, *L. Schuknecht*, put forward three recipes for successfully ensuring a greater role of QPF. First, be patient on the speed of developing analytical tools, such as efficiency measures for public expenditure, and accept that policymakers attention at the current juncture lies on crisis resolution policies. Second, don't loose the overall picture by looking at too many details of QPF. And third, don't be captured by interest groups that want academics to find results in support of their own interests, such as the need for higher spending in certain areas. He then linked the long-term QPF issues with the discussions on the role for discretionary fiscal policy in face of the current financial crisis. In his view, the slogan of a "timely, temporary and targeted" fiscal stimulus was meant to add a qualitative angle to the discussion. However, even well-meant discretionary spending would typically be captured by interest groups, such as the car industry. Moreover, experience has shown that such measures have been difficult to reverse. More generally, the policy measures should respond to the roots of the crisis, which in Schuknecht's view were not a Keynesian liquidity trap and lack of aggregate demand but the need for balance sheet repair, which would require deleveraging of the financial and corporate sector. With falling house prices, households could be tempted to deleverage as well and this might entail further falls in consumption and investment. As regards, qualitative aspects of the fiscal policy responses, he felt that they had not sufficiently been included in the on-going debate of the crisis responses even though they were very important in the current juncture. However, more public investment would not be the answer as it did not tackle the root of the problem. As an example of balance-sheet-repair friendly policies that could be envisaged, he quoted support for mortgage payments for the unemployed, as envisaged by the Spanish government.

A workshop participant inquired about the role of QPF for the objectives of equity and stabilisation, which were not covered by the workshop given its focus on the link to economic growth. *Debrun* stressed that in IMF surveillance and programme design, social objectives were considered and mentioned the recent IMF-supported programme to Hungary as an example, in which pensioners were explicitly protected. However, he stressed the risk of special interest groups taking advantage of such considerations, with the Troubled Assets Relief Program, which developed from an initial three page proposal to a 300-page document as it was passed by the US Congress, being a prime example. He received support on this point by *Heady*, who also emphasised the risk of special-interest measures becoming entrenched. More generally, there was a trade-off between temporary and targeted measures. The latter were intrinsically difficult to reverse. In this respect, *Schuknecht* reiterated his concern that equity was often misused as an argument by politicians catering to special-interest groups. If, at the current juncture, it was decided to support the economy with a discretionary fiscal stimulus, even if that was not the appropriate response in his view, it should be done in an effective way, including by avoiding to create moral hazard that would lead to the re-emergence of the current problems in the future.

Following up on this discussion, a workshop participant asked how a greater focus of policymakers on longer term issues, such as QPF, could be achieved. *Heady* stressed the role for independent fiscal bodies in providing input and assessing the budget. However, there was no case for an independent fiscal policy making-agency (similar to an independent central bank), since decisions on taxation were an expression of sovereignty. *Debrun* also reiterated the important role that independent fiscal institutions could play, a view that had been challenged in the past by policy makers but was becoming more and more popular. *Schuknecht* put for consideration a greater role of an independent DG ECFIN for greater fiscal coordination in Europe.

Conclusions

The workshop confirmed the critical role that better quality of public finances can play for long-term growth but also its complexity and many facets. Nevertheless, a few policy conclusions can be drawn from the workshop. First, the composition of public expenditure matters for long-run economic growth. In particular, switching expenditure towards infrastructure and education can be growth enhancing. Second, the structure of tax systems impacts growth prospects. While taxes can be ranked according to the least negative impact on growth (namely, property taxes, consumption taxes, personal income taxes and corporate taxes), the design of tax systems clearly poses trade-offs to other than growth objectives. Third, how efficient public spending is and what quality of public services is being demanded by citizens is influenced also by cultural factors. This implies that changes in quality may be implemented only slowly. Fourth, the role that counter-cyclical fiscal policy can play for economic growth remains debated. And fifth, stronger fiscal governance, including through national fiscal rules, medium-term budgetary frameworks and fiscal institutions, are viewed to be a key pillar for better quality of public finances.

THE QUALITY OF PUBLIC FINANCES AND ECONOMIC GROWTH

(Speakers in bold)

A Workshop organised by the European Commission
Directorate-General for Economic and Financial Affairs (DG ECFIN)
Brussels, 28 November 2008

9.00-9.10 **WELCOME ADDRESS BY MARCO BUTI, DIRECTOR GENERAL, DG ECFIN**

9.10-10.25 **SESSION 1 – THE COMPOSITION OF PUBLIC EXPENDITURE AND GROWTH –-** CHAIR: PETER PART (MINISTRY OF FINANCE, AUSTRIA)

- Norman Gemmell (University of Nottingham School of Economics), **Richard Kneller** (University of Nottingham School of Economics), and **Ismael Sanz** (Universidad Complutense, Madrid), "The Composition of Government Expenditure and Economic Growth: Some New Evidence for OECD Countries"

  Discussant: Xavier Debrun (IMF)

- Marco Casiraghi (Boston University), **Raffaela Giordano** (Banca d'Italia) and Pietro Tommasino (Banca d'Italia), "Behind Public Sector Efficiency: The Role of Culture and Institutions"

  Discussant: Paul O'Brien (OECD)

10.45-12.00 **SESSION 2 – TAXATION, PUBLIC INVESTMENT AND GROWTH –-** CHAIR: LUCIO PENCH (EUROPEAN COMMISSION, DG ECFIN)

- Asa Johansson (OECD), **Christopher Heady** (OECD), Jens Matthias Arnold (OECD), Bert Brys (OECD) and Laura Vartia (OECD) "Tax and Economic Growth"
  Discussant: Gaetan Nicodème (European Commission, DG TAXUD)

- **Gareth Myles** (University of Exeter) and Nigar Hashimzade (University of Reading), "Growth and Public Infrastructure"

  Discussant: Sebastian Kessing (European Commission, DG ECFIN)

13.30-14.45 **SESSION 3 – THE MACROECONOMIC IMPLICATIONS OF QUALITY OF PUBLIC FINANCES –** CHAIR: ISTVAN SZEKELY (DIRECTOR, DG ECFIN)

- Philippe Aghion, (Harvard University) and **Enisse Kharroubi** (Banque de France), "Macro Policy and Industry Growth: The Effect of Counter-Cyclical Fiscal Policy"

  Discussant: Roel Beetsma (University of Amsterdam)

- António Afonso, (ECB and ISEG/UTL-Technical University of Lisbon) and **Miguel St. Aubyn**, (ISEG/UTL-Technical University of Lisbon), "Public and Private Inputs in Aggregate Production and Growth: A Cross-Country Efficiency Approach"

  Discussant: Martin Larch (European Commission, BEPA)

15.00-16.00 **POLICY PANEL DISCUSSION: "GREATER FOCUS ON THE QUALITY OF PUBLIC FINANCES: A BUILDING BLOCK IN EMU'S ROAD FORWARD?" –-** MODERATOR: LUCIO PENCH (EUROPEAN COMMISSION, DG ECFIN)

Participants: Christopher Heady (OECD), Xavier Debrun (IMF), Ludger Schuknecht (ECB)

The Composition of government expenditure and economic growth: some evidence from OECD countries

by

Norman Gemmell[1,2], Richard Kneller[2] and Ismael Sanz[3]

January 2009

Abstract:

This paper reviews existing evidence on the impact of public expenditure on growth for both developing and developed countries, and offers some new results for OECD countries. We examine the growth impacts of both *total* government expenditure and of changing the *shares* of different categories of spending, taking account of the method of financing expenditure changes. We also allow for potential endogenous relationships between spending and growth. Our results provide robust evidence that reallocating total spending towards infrastructure and education has been positive for long-run growth. Increasing the share of social welfare spending appears to be harmful for growth when potential endogeneity is ignored. However, recognizing the likely negative relationship between social welfare spending and growth over the short-run, suggests that switching spending towards social welfare (and away from all others on a pro-rata basis), on average has no long-run growth effect.

[1] New Zealand Treasury; [2] University of Nottingham, UK; [3] Ismael Sanz: Department of Applied Economics I, Universidad Rey Juan Carlos and GRIPICO, Spain

1 Introduction

In this paper we are concerned with the effect of the composition of government expenditure on economic growth. In the early public policy endogenous growth models of Barro (1990) and Barro and Sala-i-Martin (1992) this effect could be predicted by whether the particular expenditure function of interest could be best described as 'productive' or 'non-productive'. Expenditures that enter the firm's production function ('productive' expenditures) affect the growth rate, whereas expenditures that affect household's utility (non-productive expenditures) affected growth only if financed by distortionary taxes. This debate was nuanced by Turnovsky (2004) who shows the conditions under which these effects are transitory or permanent.

In later models the simplicity of this categorisation was removed and the mix of productive expenditures was also shown to be important for growth. Devarajan Swaroop and Zou (1996) demonstrate using a simple extension to the Barro model that different types of productive expenditure will have varying impacts on growth if they have different rates of return, or because public spending types have varying degrees of productive and unproductive elements. The best examples of this are usually made with reference to aspects of expenditures on health, education or public investment, which may be simultaneously viewed as helping to foster productivity improvements (they encourage economic growth), but also to affect social welfare (be neutral for growth), or even to encourage rent seeking (harm growth). Empirically, this raises the possibility that the growth effects of government spending will vary in size, and lengths of time, across expenditure categories, but also between countries and according to the priors of the researcher in organising the data into productive or non-productive types for estimation. It is these empirical questions that we focus on here. Secondly, as the review by Nijkamp and Poot (2004) show few provide a complete and systematic treatment of the question of the mix of expenditures; Devarajan et al. (1996), and Miller and Russek (1997) are exceptions. Most instead focus on sub-sets of expenditure categories, such as defence, education and transport and communication expenditures, producing a mixed set of findings. Thirdly, since the mid-1990s a number of papers, using more reliable methodologies, have argued that there is more robust evidence of long-run impacts of fiscal policy on GDP growth. In this paper we apply estimators that can account for this feature of the data as well as heterogeneity in the short-run adjustment parameters across countries.

We consider these questions for OECD countries using the longest and most timely data available. Updating recent Government Financial Statistics (GFS) data on government expenditure composition, we extend previous datasets available for OECD countries from the early 1970s up to 2004. This is not a straightforward exercise in view of numerous changes in data definitions. Nevertheless we find strong support for some traditional views on public expenditure-growth links, such as that infrastructure and education spending boost long-run growth. However, our results question the view that health and social welfare spending are respectively growth-enhancing and growth-retarding. Controlling for endogeneity these effects do not find support in the data. When we consider the length of time it takes for each of the different expenditure functions to reach close to their maximum impact we find evidence that in some cases, in particular for education and transport and communication expenditures, that this can be around a decade in length. Interestingly there is some evidence that the negative effects of some expenditure functions affect growth more quickly.

The remainder of this paper is structured as follows. Section 2 briefly describes the links between public expenditure composition and growth hypothesised by recent theory, and summarises current evidence for developed and developing countries. Section 3 then discusses our testing methodologies and dataset; while section 4 reports results for a sample of 17 OECD countries over 1972-2004. Some conclusions are drawn in section 5.

2 Public spending, taxes and growth

2.1 Theory

As is well known, in the neoclassical growth model, if the incentives to save or to invest in new capital are affected by fiscal policy, this alters the equilibrium capital-output ratio, and therefore the level of the output path, but not its slope. Growth is affected only for a transitional period as the economy moves onto its new output path. The 1990s, however, saw the development of a number of endogenous growth models, such as of Barro (1990), Barro and Sala-i-Martin (1992), Futagami et al. (1993), and Deverajan et al. (1996) that overturned the transitory nature of fiscal policy in these earlier models.[1] A novel feature of these new models was that fiscal policy can determine both the level of the output path and the steady-state (long-run) growth rate.[2] Key predictions of these models include that some 'productive' public expenditures affect the productivity of the private sector while other 'unproductive' expenditures only raise citizens' welfare and that some taxes, levied to fund public expenditures, distort investment decisions.

The categorising of public expenditures into 'productive' and 'unproductive' and taxes into 'distortionary' and 'non-distortionary' (with respect to investment decisions) allows the predicted growth effects from such models to be summarised as in Table 1. This shows that the growth impacts of fiscal policy depend both on the composition of public expenditures (expenditures that affect social welfare or private sector investment or productivity) and the forms of taxation used to finance them (whether taxes discourage investment, including human capital investment). Positive, negative or zero effects are each possible depending on the tax/expenditure combinations used. When the above models are extended to allow for the growth effects of deficits/surpluses, outcomes can be positive, negative or ambiguous depending on what the deficit is financing. For example, increasing productive spending using deficit financing may help or harm growth depending on the relative sizes of the (predicted) positive spending effects and negative effects of increased budget deficits (reduced surpluses).

Table 1: Growth Effects of Taxes, Public Expenditures and Budget Deficits/Surpluses

Financed by:		Public Spending: Productive	Public Spending: Unproductive	Budget Surpluses
Taxes:	**Distortionary**	*positive/negative* (at *low/high* gov. size)	*negative*	*ambiguous*
	Non-distortionary	*positive*	*zero*	*positive*
Budget Deficits		*ambiguous*	*negative*	-

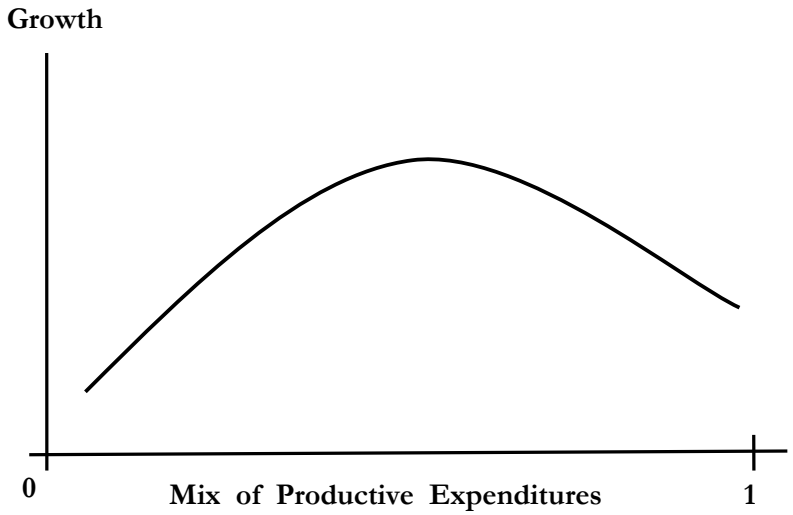
Following these early models and the simple predictions set out in Table 1 the main thrust of this literature concentrated on studying the impact that different types of taxation have on

1 Futagami et al. (1993) use the same model as Barro (1990), but assume that public services are derived from the stock of public capital instead of the flow of public expenditure.

2 Not all endogenous growth models predict long-run growth effects from fiscal policy. The 'semi-endogenous', R&D-based model of Jones (1995), for example, yields endogenous growth via R&D activities, but the long-run growth rate depends only on the exogenous rate of population growth. Recent endogenous growth models in which fiscal policy continues to have long-run effects include Kaas (2003), Kalyvitis (2003), Zagler and Durnecker (2003), Park and Philippopoulos (2003) and Ho and Wang (2005).

growth (for example, Stokey and Rebelo, 1995; and Mendoza et al., 1997). On the expenditure side developments were fewer. Key here was the model with multiple productive expenditures by Devarajan et al. (1996). As summarised in Figure 1 the growth effects of expenditures depend upon a combination of the *relative* productivities of these expenditures and their initial *relative* budget shares. This suggested that changes to the mix of expenditures could be as important for growth as changes to the level of expenditure.

Figure 1: Growth Effects of Changes in the Mix of Productive Government Expenditures



Of the other extensions to the literature: some models have altered the long-run versus transitional predictions of fiscal variables, while others have explored interactions between public spending types. For example, Eicher and Turnovsky (1999), Howitt (2000) Dalgaard and Kreiner (2003) have constructed endogenous growth models in which the growth impacts of taxes or public expenditures can be 'transitory' rather than permanent, and convergence to equilibrium following policy shocks may be rapid or slow.[3] Turnovsky (2004), on the other hand, develops a neoclassical model in which growth effects are transitional but very long-lasting. Turnovsky's simulations suggest that effects on growth rates from changes in tax rates on wage income, capital and consumption could be measured in decades not years. Thus various neoclassical and endogenous growth models now predict fiscal-growth effects over prolonged periods of time.

Turnovsky (2000) examines the effect of endogenous labour supply in the context of a neoclassical growth model, where all spending is financed out of distortionary taxes. He shows that introducing endogenous labor supply amplifies negative growth effects from unproductive government (consumption) spending and produces ambiguous growth effects from productive expenditures.4 Alternatively Adam and Bevan (2001) develop a model which explicitly examines the impact of budget deficits on growth. Allowing expenditures to be financed by taxes, grants and three forms of deficit finance – domestic and international borrowing, and seigniorage – they show that the growth impacts of deficits are ambiguous and depend on both the mix of current deficit-financing and outstanding debt stocks.

In a series of recent papers, Agénor (2005a-d) and Agénor and Neanidis (2006) have examined various extensions of the Barro/Devarajan framework which explicitly model (i) infrastructure, education and/or health spending as inputs into private production; and (ii) interactions between these spending types, for example, by allowing the supply of health services or infrastructure

3 See also Peretto (2003, 2004).

4 Previously Mendoza et al. (1997) had shown that consumption taxes become 'distortionary', and adversely affect growth, where labour supply is endogenous.

spending to enter into the productions function for education. Semmler et al. (2007) develop an endogenous growth model to consider the growth impacts of these three types of spending, in which the tax rate is assumed to be chosen optimally. They solve the model numerically and calibrate it to explore the impact of shifts between public investment in infrastructure assets that directly influence market production and public investment devoted to the production of human capital accumulation (education and health). Blankenau and Simpson (2003) focus specifically on the relationship between public education expenditures and growth. They show that the relationship need not be monotonic when account is taken of tax-financing methods (analogously to Barro) and the specification of the technology of human capital production (e.g. how public and private inputs into human capital formation, and the input of human capital from preceding generations, are combined).

2.2 Existing empirical evidence on public expenditure and growth

While there have been a number of previous reviews of the empirical literature, including Agell et al., (1997), Tanzi and Zee (1997), Myles (2000), these are primarily pre-2000 and did not focus specifically on public expenditure or review studies in light of the various methodological weaknesses highlighted in the subsequent literature. In particular it is now recognised that tests of the growth effects of public expenditure decompositions (and other fiscal variables) must accommodate the total government budget (expenditures, revenues, deficits). Of the available literature reviews Gemmell (2004) is therefore an exception. Recent evidence on the growth effects of public expenditures for developed and developing countries are summarised in Tables 2 and 3 respectively (see pp.28-30).

Table 2 shows that, for developed countries (DCs), though some non-robustness remains in the evidence, this largely applies to studies before 2000, or where the government budget constraint (GBC) is ignored in regression specifications. (Theory predicts that total public expenditure includes elements with positive, negative and no growth effects; regressions need to accommodate this). Where decompositions have been examined for DCs, education, health and/or transport and communication (T&C) spending show some evidence of positive growth effects. Even the meta-analysis of Nijkamp and Poot (2004), which covers many studies almost all of which ignore the GBC, finds evidence of strong growth effects for education and infrastructure spending.[5]

The more recent empirical literature on fiscal expenditures has tended to concentrate on developing countries (LDCs), perhaps in part to challenge the Devarajan et al. (1996) result that in LDCs capital (current) spending has a negative (positive) growth effect. These studies, summarised in Table 3, find strong positive growth effects from public capital spending. See, for example, Aschauer (2000), Dessus and Herrera (2000), Milbourne et al. (2003), Ramirez and Nazmi (2003), Haque (2004), Bose et al. (2005), Gupta et al. (2005), Adam and Bevan (2005) and M'Amanja and Morrissey (2005).[6] Haque (2004) in particular demonstrates that the Devarajan et al. result can be replicated using panel data which fails to correct for non-stationarity in the variables, while with this correction capital (current) spending is found to impact positively (negatively) on growth.

A number of the results for developing countries mirror those found for developed countries. Focusing on sectoral classifications, Bose et al. (2005), Haque and Kim (2003), and Adam and

[5] They do not find strong evidence for fiscal variables in general however, which is again not surprising given the mixture of positive and negative effects expected for many fiscal aggregates, depending on composition and financing methods.

[6] A recent paper which does support Devarajan *et al.* (1996) is Ghosh and Gregoriou (2006) but, unlike Devarajan *et al*., they do not control for tax effects. Ghosh and Gregoriou (2008) draw the opposite conclusion however for OECD countries, based on regression analysis which does incorporate the government budget constraint.

Bevan (2005) show that sectors usually regarded as 'productive' (T&C, education, health, etc.) have significant positive long-run growth effects in LDCs. These are supported by a number of studies on particular types of expenditures: for *infrastructure* (Albala-Bertrand and Mamatzakis, 2001; Milbourne et al.., 2003; Fedderke, *et al.,* 2006); *education* (Milbourne *et al.,* 2003; Ramirez and Nazmi, 2003; Bose et al. (2005); and *health* spending or health indices (Bhargava, 2001; Ramirez and Nazmi, 2003; Bloom, 2004).

In addition to these largely regression-based studies of individual, or groups of, developing countries, Biletska and Rajaram (2007) have examined the possible growth impacts of fiscal policies based on 12 country case-studies.[7] They argue that in most of the twelve countries, but especially in high aid-dependent countries, insufficient public expenditure allocation towards infrastructure, education and/or health, or inefficient use of spending in those areas, has been a critical constraint on their growth rates.

3 Methodology and data

3.1 Government budget constraint

The empirical methodology that we apply to the question of the composition of public expenditures and economic growth in OECD countries is drawn directly from Devarajan et al. (1996). The estimating equation (equation (1) below) regresses the growth of GDP in country *i* at time *t* against the level of total government expenditure, *E*, in GDP and the share in total government expenditure of one element of the total, e_1, where this expenditure category is rotated across the different expenditure categories. We include each of the expenditure categories in turn in order to save on degrees of freedom in our panel regression model (see below), and a set of conditioning variables. This affects the interpretation of the parameter on the included expenditure category, as we discuss below.

Because of the government budget constraint, the estimating equation needs to recognise that expenditures, *E*, must be financed by total tax revenues, *R*, or the budget surplus/deficit, *D* (Kneller et al. 1999). Thus, if g_{it} is the growth of GDP in country *i* at time *t*, we have:

$$g_{it} = \ldots \gamma_1\left(\frac{E}{GDP}\right)_{it} + \gamma_2\left(\frac{e_1}{E}\right)_{it} + \gamma_3\left(\frac{R}{GDP}\right)_{it} + \gamma_4\left(\frac{D}{GDP}\right)_{it} + \ldots \qquad (1)$$

However, since $D_{it} = R_{it} - E_{it}$, the three variables would be perfectly collinear in a regression. Hence, (1) must be rewritten, and estimated, as:

$$g_{it} = \ldots (\gamma_1 - \gamma_4)\left(\frac{E}{GDP}\right)_{it} + \gamma_2\left(\frac{e_1}{E}\right)_{it} + (\gamma_3 + \gamma_4)\left(\frac{R}{GDP}\right)_{it} + \ldots \qquad (2)$$

This demonstrates the correct interpretation of the growth effects of expenditure and tax variables (as ratios of GDP). The estimated parameters on these variables now capture the effect of increases in total expenditure, or decreases in tax revenues, financed by changes in the budget deficit (the omitted category). This depends on the signs and relative sizes of γ_1, γ_3 and γ_4. In comparison the interpretation of the coefficient on the individual expenditure component of

7 See also the summary in World Bank (2007).

interest, γ_2, remains unaffected: it measures the effect on growth of a change in the share of spending on each category holding total expenditure, tax revenues - and hence deficits - constant (provided these two variables are included in the regression). Implicitly therefore, increases in the included expenditure share are financed by pro rata reductions in the other, excluded expenditure shares.

3.2 Allowing for heterogeneous fiscal-growth effects

We follow Gemmell et al. (2007) in adopting the form in equation (2) above, and using the pooled mean group (PMG) methodology of Pesaran, et al. (1999). This allows for heterogeneity in the short-run adjustment parameters across countries while imposing long-run homogeneity.[8] Acceptance of this latter restriction implies that the results from the PMG estimator are more efficient than those from the alternative, mean group (MG) estimator which also permits long-run heterogeneity (Pesaran, et al., 1999). Gemmell et al. (2007) demonstrate that while the conclusions about the long-run effects of fiscal variables are little affected by the use of the PMG compared to those found from a dynamic fixed effects model (which imposes both short- and long-run homogeneity) it does have an effect on the estimated speed at which changes in fiscal variables impact on growth. In the current context the PMG specification has the additional advantage of controlling for non-stationarity in the variables, a factor shown by Haque (2004) to be important for the results derived by Devarajan et al. (1996).

The estimated regression for the PMG model is of the following 'error correcting' form:

$$\Delta g_{it} = \phi_i (g_{i,t-1} - \beta F_{i,t-1}) + \sum_{k=1}^{K} \alpha_{ik} \Delta g_{i,t-k} + \sum_{m=0}^{M} \lambda_{im} \Delta F_{i,t-m} + \varepsilon_{it} \qquad (3)$$

where F is a vector of fiscal (including the level and mix of expenditures) and control variables; φ,β,α and λ are parameters to be estimated and ε_{it} is a classical error term. The test for the long run effect of expenditures is made on the parameter vector, β (the long run parameters adjusted for lagged growth). The long run effect of fiscal variables across countries is measured as the (unweighted) average of the estimates from the $i = 1...n$ individual country regressions. [9]

The disadvantage of the PMG estimator is that, unless the available time series is very long, a degrees of freedom problem is soon reached. For the dataset available here this requires some restrictions on lag lengths and/or the set of right-hand-side (RHS) variables. For this reason we restrict the RHS variables to include each expenditure category (share) separately in turn, two control variables (the investment rate and employment growth) and up to two lags. Though this lag length is relatively short, the inclusion of the lagged dependent variable ensures that short-run adjustment can take place over many periods; see Gemmell et al. (2007).

3.3 The updated dataset

In this paper we use an extension of the Bleaney et al. (2001) dataset, as described in detail in Gemmell et al. (2007). This uses GFS fiscal data for 17 OECD countries, available from the early 1970s to 1995, to construct measures of total expenditure and individual expenditure shares, distortionary and non-distortionary taxes, and budget surpluses/deficits. [10] The dataset

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[8] Gemmell et al. (2007) estimate that short-run adjustment towards long-run equilibrium can be quite different across OECD countries, potentially affecting the estimated size of the long-run parameters.

[9] Results reported below were estimated using Pesaran's GAUSS programme, available from his website: http://www.econ.cam.ac.uk/faculty/pesaran/jasa.exe .

[10] In general the 'non-distortionary' taxes in this context are consumption taxes. The term 'less distortionary' may be more appropriate in this case since these taxes can distort investment

has been updated to 2003 or 2004. This is not straightforward, however, because of changes in the GFS methodology, which moved from a cash accounting, to an accruals accounting, basis for fiscal data from the late 1990s onwards. Using the expenditure growth rates obtained from the accruals-based data to grow our cash-based data forward, and comparing overlap years, this exercise provides around 30-32 annual time-series observations each for most of the 17 countries in the sample.

Data on GDP growth and the two control variables – the investment/GDP ratio and employment growth – were obtained for the same period from *OECD Economic Outlook*. An important difference from previous studies of taxes/public spending and growth is that our investment control variable is private non-residential investment (PNRI) instead of total investment (gross fixed capital formation). Since all regressions include various public expenditure variables, the use of PNRI avoids the possibility of 'double counting' much public investment which otherwise would affect both the investment and public expenditure data.[11]

4 Empirical results

4.1 Testing for total public expenditure effects

Before testing for the growth effects of the share of particular expenditure categories it is worth examining the impact of the implicit financing category in the government budget constraint methodology because it changes the interpretation that we make on the parameters. As the parameter estimates on the shares of individual spending categories in total expenditure are unaffected by this we omit them from the regression for the moment. Table 2 shows three regressions in which total spending is included, financed by the three alternative fiscal variables: deficits, non-distortionary taxes and distortionary and 'other' taxes.[12]

Table 4 reveals that increasing total public spending, financed by non-distortionary taxes (regression ***1***) has a mildly positive effect on growth, whereas financing the same spending increase by a reduced budget surplus and/or by increases in distortionary taxes results in a negative impact on growth. These results emphasise that whatever type of spending is examined, conclusions regarding its impact on growth are likely to depend on the assumed form of financing – the form of taxes, or budget deficits.

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decisions via labour supply effects in models such as Mendoza et al (1997). The method of aggregating the GFS functional classification into these sub-aggregates is described in Bleaney et al. (2001) and summarised in Appendix Table A1.1.

11 Using total investment rather than its private component, as a control variable, would also bias results because public investment would appear within the 'control'.

12 'Other' taxes refers to the GFS categories 'taxes on international. trade and transactions', 'other taxes' and 'non-tax revenues'. It is unclear how distortionary these might be.

Table 4: Testing Expenditure Levels and Implicit Financing

Regression No.	***1***	***2***	***3***
Financed by:	*Non-distort. taxes*	*Budget Surplus*	*Distort. & other tax*
Budget surplus	0.120 (2.11)**	-	-0.109 (-3.73)***
Distortionary and other taxes	-0.214 (-3.80)***	-0.112 (-3.79)***	-
Non-distortionary taxes	-	0.153 (2.75)***	0.256 (4.43)***
TOTAL Expenditure	**0.061 (1.31)**	**-0.050 (-2.61)*****	**-0.158 (-6.79)*****
Investment ratio	0.049 (1.46)	0.022 (0.67)	0.038 (1.20)
Employment growth	0.181 (3.50)***	0.230 (4.44)***	0.216 (4.27)***

Note: t-statistics in parentheses below parameters. Dependent variable: economic growth rate in real terms (%)

4.2 Public expenditure composition and growth

Table 5 shows the results from repeating regressions of the form in regression ***2*** in Table 4, but adding the shares of each GFS spending category: transport and communications (T&C), education, health, etc. in total expenditure (excluding interest payments). To save space the table shows only the parameters on total public expenditure and the spending decompositions of interest. Due to a lack of degrees of freedom, it is not possible to include all the detailed categories in one regression. The parameter on each expenditure share in regressions ***4*** – ***12*** should therefore be interpreted as the impact on long-run growth of switching spending into the included expenditure category and away from all other expenditure categories (on a pro rata basis), holding total spending constant (as a share of GDP). A significant positive (negative) parameter therefore indicates that the category in question has a greater (smaller) impact on growth than the average of all other categories.

Notice first that all regressions reveal significantly negative *total* spending growth effects, since all spending increases are funded from an increased budget deficit (reduced budget surplus) as in regression ***2*** in Table 4. Regressions ***4-12*** are arranged in decreasing order of the estimated expenditure share parameter size. It is important to remember that these parameter estimates represent *the combined impact* of one additional unit of a particular type of spending (say, education), financed by reductions in other spending categories that may also have positive, negative or zero growth effects.

Table 5: Testing Expenditure Composition: Functional Categories

Regression:	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***
Share of:	T&C	Education	Health	Defence	Econ. services	Hous-ing	Gen. pub. services	Social welfare	Recrea-tion
Expenditure SHARE	**0.118 (4.29)*****	**0.102 (2.71)*****	**0.053 (2.00)****	**0.032 (1.74)***	**0.032 (1.21)**	**-0.007 (0.16)**	**-0.033 (0.94)**	**-0.037 (3.37)*****	**-0.490 (1.98)****
TOTAL Expenditure	-0.077 (3.54)***	-0.043 (2.32)**	-0.038 (1.65)*	-0.052 (2.50)**	-0.050 (2.32)**	-0.051 (2.31)**	-0.045 (2.26)**	-0.064 (3.03)***	-0.055 (2.49)**

Included variables = total expenditure; distortionary and 'other' taxes; non-distortionary taxes; investment ratio; employment growth. *Excluded variable* = Budget surplus. *,**,*** Significant at the 10,5 and 1%, respectively. Dependent variable: economic growth rate in real terms (%)

It is clear from the table that the largest and most robustly estimated positive growth effects are associated with T&C, education and health spending shares. There is weaker evidence that defence spending impacts more positively than average on growth. The parameters can be

interpreted as follows. For T&C, for example, a 1 percentage point increase in the T&C share of total spending (e.g. from 10% to 11%) generates, on average, 0.12 of a percentage point increase in the long-run growth rate. The effect from the same change in education expenditure is very close to this at 0.10 of a percentage point increase in the long-run growth rate, while the effect from health is half of that at 0.05.

These results closely match a number of findings within the current literature. Nijkamp and Poot (2004) for example, identify the positive impact of education, and especially public educational investment, on economic growth as amongst the most robustness findings of the growth literature. The orderings of the coefficients are also very similar to those found by Devarajan et al. (1996) for developing countries - albeit for a narrower range of expenditure functions – though, like Bose et al. (2005), they find that education spending has the strongest growth effects. Our results are also consistent with the calibrations of Semmler et al. (2007), who conclude that public investment should be directed primarily towards public infrastructure and then to education and health because the former facilitates market production directly, whereas the latter two expenditure categories have to first permeate the economic system before affecting the availability of public resources and thus growth.

In contrast to these three expenditure types, the other expenditure categories have growth impacts that are either insignificant different from the 'average' or are negative. Economic Services parameters are positive but relatively small and less precisely estimated, while that on Housing is effectively zero. Shifts of total expenditure towards general public services, social welfare and recreation spending shares in comparison reveal negative growth effects, although only the latter two are statistically significant.

4.3 Testing alternative classifications of public expenditure

Available data limits our ability to examine expenditure decompositions based on 'economic' categories: consumption, investment etc. This is available from the GFS source up to around 1998 or 1999.[13] More recent OECD-sourced data is available for this decomposition but for *general* government. We combine both datasets to examine this aspect; results are reported in Table 6. The results labelled 'OECD shares' are obtained by using expenditure shares calculated from the OECD data, but applied to the GFS data on total expenditure levels. 'IMF shares' refer to results obtained using the shorter time-series of GFS data. In both sources, data are unavailable for Luxemburg and Turkey, so the sample is reduced to 15 countries.

Table 6: Testing Expenditure Composition: Economic Categories

Regression:	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Source:	*IMF shares*	*OECD shares*	*IMF shares*	*OECD shares*	*IMF shares*	*OECD shares*	*IMF shares*	*OECD shares*
Share of:	Consumption		Net Investment		Current Transfers		Capital Transfers	
Expenditure SHARE	**-0.083 (-3.04)*****	**-0.123 (-3.45)*****	**0.198 (3.11)*****	**0.059 (1.36)**	**0.008 (0.41)**	**-0.014 (-1.56)**	**-0.058 (-0.32)**	**0.016 (1.46)**
TOTAL Expenditure	-0.070 (-3.65)***	-0.104 (-3.78)***	-0.047 (-1.65)*	-0.028 (-1.36)	-0.045 (-2.51)**	-0.038 (-2.30)**	-0.038 (-2.30)**	-0.050 (-2.75)***

Included variables = total expenditure; distortionary and 'other' taxes; non-distortionary taxes; investment ratio; employment. *Excluded variable* = budget surplus. Regressions based on 15 countries: excluding Luxemburg and Turkey.
*, **, *** Significant at the 10, 5 and 1%, respectively.
Dependent variable: economic growth rate in real terms (%)

Results from either source suggest quite strong negative growth effects from consumption spending and positive growth effects from (net) investment spending. For current and capital transfers, results are ambiguous depending on data sources. The OECD-based results suggest

[13] The GFS provides data for the economic composition of central government expenditures, using an accrual basis, for the period 1998-2004. However, this information does not allow a separation of public investment from capital transfers.

mildly negative (positive) impacts from current (capital) transfers, while GFS data yields small, statistically insignificant effects in both cases.

Table 7 considers productive and other expenditures along with the traditional 'public finance' spending breakdown into 'public goods' (defence, general public services, T&C, recreational services); merit goods (health, education, housing); 'transfers' (social welfare, economic services – mainly subsidies); and 'residual' spending (mainly interest payments). These results support the view that increases in 'productive', public and merit goods expenditures are good for long-run growth on average (small positive effects) while shifts towards transfer and residual spending appear to involve, albeit small, growth sacrifices.

Table 7: Testing Expenditure Composition: Public and Merit Goods and Transfers

Regression:	***21***	***22***	***23***	***24***	***25***
Share of:	Product & Other	Public goods	Merit Goods	Transfers	Residual [a]
Expenditure SHARE	0.093 (5.27)***	**0.078 (4.14)*** **	**0.046 (2.22)** **	**-0.015 (-1.31)**	**-0.026 (-1.69)***
TOTAL Expenditure	-0.046 (-2.85)***	-0.051 (-3.02)***	-0.047 (-2.16)**	-0.061 (-2.95)***	-0.060 (-2.36)**

[a] mainly interest payments. *, **,*** Significant at the 10, 5 and 1%, respectively.
Dependent variable: economic growth rate in real terms (%)

4.4 Testing for endogeneity

We cannot discount the possibility that the evidence in the previous sub-sections arises from simultaneous relationships between growth and fiscal variables. That is, instead of, or as well as, direct impacts of fiscal variables on GDP growth, changes in GDP growth may be inducing changes in these fiscal variables. The arguments that faster growth induces changes in *total* government expenditure or taxation are well known. Economic downturns reduce taxable capacity and generate demands for additional public expenditure such as unemployment benefits and social insurance payments. Though these may be at the expense of other types of expenditure, this is often insufficient to prevent total spending from rising in downturns. Short-run contractions of less cyclically-dependent expenditures, such as public investment, are typically more difficult to achieve when social expenditures increase (see Sanz and Velázquez, 2003, 2004).

The effect on expenditure components is more ambiguous. As already noted, social welfare expenditures might be expected to rise in response to an economic downturn implying a negative correlation with growth. On the other hand, the share of more 'productive' expenditures would be expected to rise when faster growth generates additional revenues, and demands for welfare-related expenditures (such as social insurance) weaken. This would have contrasting effects on the share of these different components of expenditure in total expenditure and for total expenditure as a ratio to GDP. Over the longer-term, it is sometimes argued that some public expenditures, such as education and health, display income-elastic qualities so that faster income growth induces a greater consumer demand for such services, which are often delivered via public spending.[14]

These arguments suggest the possibility that our previous evidence of positive growth impacts of T&C, education, health etc., and negative growth effects of social welfare spending, might be due to these reverse causation arguments. Or they may simply be the outcome of contemporaneous co-movement of our expenditure and growth variables. Endogenous responses may also account for our previous evidence of negative growth effects from (deficit-financed) total public expenditure, if economic downturns induce additional total spending in association with worsening deficits.

[14] Gemmell et al. (2007) also discuss why parameter estimates for tax revenues and deficits in growth regressions might be expected to be biased due to endogeneity. Below we control for possible endogeneity of all fiscal variables.

To account for these endogeneity problems we adopt an instrumental variable approach, testing for endogeneity bias on each of the different fiscal categories as well as private non-residential investment.[15] We use lagged values of the fiscal and investment variables as instruments, as listed in Appendix Table A3 and summarised in Table 8. A valid instrument must satisfy two requirements: (a) be correlated with the included endogenous variable; and (b) be orthogonal to the error process in the growth regression. Tests for both are reported in Table 8.

Our test for the correlation between the instruments and endogenous variables contains a number of parts. Firstly, we use the F-statistic and the partial R^2 between the excluded instruments and the endogenous regressors of the first-stage. However, these measures will not reveal the weakness of a particular instrument if the rest of the instruments are highly correlated with the endogenous variables (Staiger and Stock, 1997). The Shea partial R^2 (Shea, 1997) overcomes this by taking into account the cross-correlations among the instruments. Table 8 shows that the first stage Shea partial R^2 are all satisfactorily high (Appendix Table A3 reports similarly robust results for other variables)

Baum et al. (2003) suggest as a rule of thumb that if the standard R^2 is large whereas the Shea partial R^2 measure is small, we may conclude that some of the instruments lack sufficient relevance to explain the endogenous regressors.[16] The partial R^2s are reported in the table in parenthesis below the Shea partial R^2s. A comparison of the two suggests that the differences are generally small. As a further check, we also report the Anderson test of under-identification. This tests the hypothesis that the excluded instruments are uncorrelated with the endogenous variables. The test is safely rejected in all cases, indicating that the excluded instruments are relevant in explaining the endogenous variables.

A high Shea partial R^2 and rejection of the Anderson test does not guarantee that weak instrument problems are not present however (Hall et al., 1996). Stock and Yogo (2005) instead propose a test based on the F-statistic form of the Cragg-Donald statistic for the presence of weak instruments that overcomes this problem. The Stock-Yogo test essentially tests whether the bias in IV parameter estimates due to weak instruments exceeds the bias in the equivalent OLS regression. Using either of the Stock-Yogo definitions of a weak instrument we can reject the null hypothesis that our instruments are weak. [17] Finally, to complete the second part we use the Sargan test of the null hypothesis that the instruments are orthogonal to the error process in the growth regression. The Sargan test results do not reject the hypothesis that the instruments are valid.

4.5 Instrumental variable (IV) results

Comparing the results from the instrumental variable approach in Table 8, with those in Table 5, is interesting. Several of the expenditure categories do appear to co-vary with rates of economic growth. Point estimates can be pushed in either direction compared to those in Table 5, with the strength of this effect differing across expenditure categories, so that the ranking of point estimates is also altered.

Some key outcomes are as follows. Firstly, IV parameter estimates confirm strong positive growth effect from transport and communication and education. The strong growth effects for education support previous findings in the literature by Bose et al. (2005) and of Nijkamp and Poot (2004). Secondly, health spending, the other expenditure category found previously to

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15 An extensive empirical literature has questioned whether investment variables in growth regressions suffer from similar endogeneity problems.

16 The distribution of Shea's partial R^2 statistic has not been derived.

17 Stock and Yogo (2005) class an instrument as weak, or 'performing poorly', using two alternative definitions. The **first is that "a group of instruments is weak if the bias of the IV estimator, relative to the bias of** the OLS, could exceed a certain threshold *b*" (we use *b = 5%*). The second is that the instruments are weak "if the conventional α-level Wald test based on IV statistics has an actual size that could exceed a certain threshold *r*" (we use *r = 10%*).

have a positive and significant association with economic growth, is now smaller and no longer statistically significant when we control for possible endogeneity. (IV results suggest a reduction in the size of the estimated coefficient, rather than an increase in its standard error).

Thirdly, perhaps the most striking changes that occurs in Table 8 relative to Table 5 are those for social security, defence and housing expenditures. According to the IV results, the previous significantly negative social welfare expenditure is now effectively zero (i.e. it's growth effect is 'average'). As the endogeneity arguments discussed above suggested therefore, the apparent growth retarding effects of social welfare spending found previously would seem to be a consequence of a negative cyclical co-movement with growth, rather than evidence of adverse impacts.

Table 8: Testing Expenditure Composition: Functional Categories (IV)

Regression:	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***
Share of:	T&C	Educat-ion	Econ services	Health	Social welfare	Recreat-ion	Gen. public services	De-fence	Hou-sing
Expenditure SHARE	**0.156 (3.09)****	**0.111 (2.11)***	**0.062 (1.57)**	**0.023 (1.10)**	**0.012 (0.91)**	**-0.056 (0.21)**	**-0.067 (2.04)***	**-0.200 (3.25)****	**-0.555 (5.97)****
TOTAL Expenditure	0.408 (9.05)**	0.304 (8.01)**	0.381 (9.77)**	0.400 (10.69)**	0.338 (7.88)**	0.302 (6.54)**	0.485 (13.27)**	0.291 (6.45)**	0.314 (8.03)**
Correlated with the included endogenous variables									
Shea partial R^2s (standard R^2s below):									
Expenditure Share	0.87 (0.89)	0.87 (0.93)	0.71 (0.85)	0.92 (0.94)	0.85 (0.96)	0.81 (0.90)	0.67 (0.73)	0.91 (0.97)	0.57 (0.61)
Total Expenditure	0.51 (0.93)	0.52 (0.93)	0.52 (0.93)	0.51 (0.92)	0.51 (0.93)	0.51 (0.93)	0.52 (0.93)	0.52 (0.93)	0.52 (0.93)
Anderson test $\chi^2(6)$	336.4	348.5	346.6	377.8	382.9	339.3	3335.5	348.5	344.0
Stock-Yogo F-test	47.2	49.6	49.2	47.5	47.1	47.8	47.0	49.6	48.7
Orthogonal to the error process									
Sargan test $\chi^2(5)$	5.85	4.04	4.78	5.29	5.89	7.28	7.33	6.40	6.73
Instrument set: Lags 2and 3 for: total expenditure, each relevant expenditure share, distort. and non-distort. tax, and investment.									

Note: Dependent variable: economic growth rate in real terms (%)

Defence and housing expenditures in contrast, are estimated to have large negative effects on growth in Table 8. (In Table 5 the effect of defence expenditure was positive and significant at the 10 per cent level). Since these expenditures are largely of an investment nature, and therefore tend to be facilitated in economic booms, it would seem that the previous estimated effects picked up this contemporaneous positive correlation with growth. The IV results suggest however, that switching spending into these categories tends to be harmful for subsequent growth. This may reflect a tendency for public investments in defence and housing to be among the least productive forms of public investment. Negative growth effects from defence spending have previously been found by Lim (1983), Cappelen et al. (1984) and Lindgren (1984). Of the other expenditure functions, there is some evidence that economic services are modestly growth-enhancing while general public services are modestly growth-retarding. This result confirms the claim of Biletska and Rajaram (2007), who analyse fiscal policy in six high growth countries in the last twenty years and find that most of those countries significantly reduced the share of public administration in total expenditure.

The instrumental variable approach also has a noticeable effect on the previous conclusions drawn about total expenditure (for a given form of financing). The IV results no longer point to a small negative growth outcome from increases in the size of total expenditure financed by increased deficits, but instead suggest a positive effect. Again, this would appear to support the endogeneity hypotheses described above, that deficit-financed spending increases when growth is lower (and vice versa) largely reflect the contemporaneous cyclical co-movement in those variables. There is however a stronger case that deficit-financed spending increases (for a constant spending mix) affect growth positively with a lag.

4.6 Quantifying spending effects on growth

In this section we use the results from Table 8 to provide a quantitative assessment of the contribution of the different fiscal expenditures to growth in OECD countries over time. Given the large number of fiscal variables included in the regressions we concentrate our analysis on those significant variables in Table 8, namely, T&C and education as examples of expenditure categories that raise growth, and general public services, defense and housing as expenditure categories that lower economic growth.[18]

In Table 9 we report the implied growth consequences of changes in each expenditure share, relative to each country's observed growth rate for the 1990-2002 period. For example, the results imply that the reduction in transport and communication expenditure in Austria over the 1990 to 2004 period lowered growth by 0.216 percentage points relative to what growth would have been were the expenditure mix been left at its 1990 value. In comparison reductions in the defense budget were associated with an increase in growth of 0.276 percentage points. It is important to note when interpreting the results from this table, that since each spending type (as a share of total spending) was entered in regressions one at a time, the estimated growth impacts *cannot be added together to identify an overall growth impact*. Rather, they measure the effect on growth had, say, T&C spending been allowed to increase as observed, whilst all other spending shares were reduced *pro rata*.

A general summary of the results from Table 9 would be that most of the implied changes in growth are relatively small. Only 15 of the cells (18 per cent) in Table 9 have values for which the estimated growth impact is greater than 0.3 percentage points, and only 6 cells (7 per cent) for which the growth impact is greater than 0.5 percentage points. These large growth effects are in general spread across the different expenditure categories. They are highest for education expenditure, where the trend towards increased expenditures on education in New Zealand, Norway and Turkey had particularly pro-growth outcomes, and are fewest for transport and communication expenditures, where the reductions in expenditure on this category had a strong negative effect on growth in Finland.

The counterpart to this is of course that most of the changes in fiscal expenditures since 1990 have had only modest growth impacts. This suggests that, though our regression results identify a robust, positive effect on growth from changes in T&C and education expenditure shares, the estimated effect historically in most OECD countries has been small – typically around ±0.1% p.a. or less. Of course, the estimated growth effects of increasing these spending categories *relative to GDP* would be larger, since our estimated growth effect of increases in total expenditure/GDP is positive.

Averaging across countries we calculate that increased education expenditures in the OECD and lower defense and housing expenditures, funded by a pro rata decrease in all other expenditure categories, have increased growth in OECD countries over the period since 1990, whereas lower relative expenditures on transport and communication and increased spending on general public services have lowered growth. On average lower relative transport and communication

[18] The results in Figure 1 are obtained using both the long-run and short-run parameters (the latter are not shown in Table 8).

expenditures have lowered growth by 0.07 percentage points, while increased education expenditure have been associated with a 0.09 percentage point increase in growth.

These averages depend of course on the mix between positive and negative effects across countries. Using the calculated change in growth in absolute terms and calculating the average we get a somewhat different picture. In absolute terms the greatest changes in growth that have occurred have been a consequence of defense (0.216) and general public services (0.192) percentage points. To provide a different perspective on the data in Table 9 we also display the estimated changes in growth for transport and communication and education expenditures in Figure 2.

Table 9: Net Growth Effects of Fiscal Changes (in % points p.a.), 1990-2004

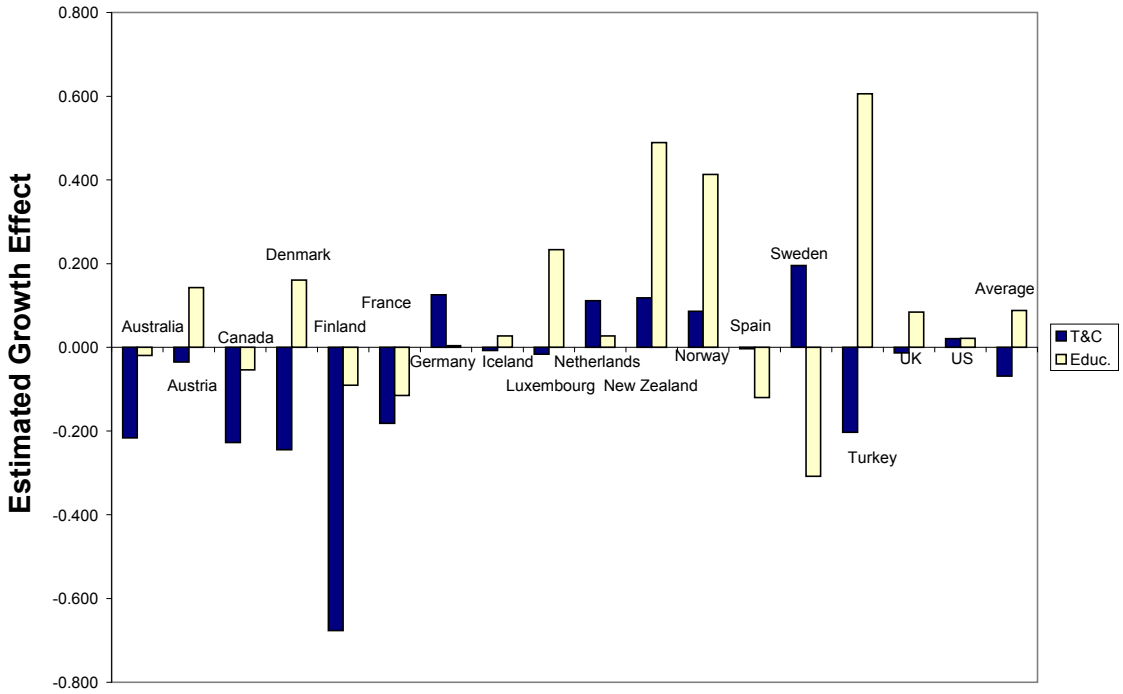
	T&C	Educ	GPS	Def	Hous
Australia	-0.216	-0.019	0.201	0.276	0.032
Austria	-0.035	0.142	-0.219	-0.050	0.273
Canada	-0.228	-0.054	-0.072	0.075	0.025
Denmark	-0.245	0.160	0.044	0.295	-0.017
Finland	-0.677	-0.090	-0.859	-0.017	-0.535
France	-0.181	-0.115	-0.040	-0.333	0.039
Germany	0.126	0.004	0.095	-0.100	-0.004
Iceland	-0.007	0.027	0.082	0.377	0.059
Luxembourg	-0.016	0.234	-0.269	-0.117	-0.448
Netherlands	0.112	0.027	-0.060	-0.507	0.079
New Zealand	0.118	0.489	-0.020	0.079	0.366
Norway	0.086	0.413	0.043	0.106	0.068
Spain	-0.003	-0.119	0.003	0.280	0.146
Sweden	0.196	-0.308	-0.266	0.150	-0.253
Turkey	-0.203	0.606	0.127	-0.322	0.232
UK	-0.014	0.084	0.024	0.099	-0.077
US	0.021	0.022	-0.848	0.494	0.162

Note: * Based on regressions from Table 8 and observed changes in fiscal policy 1990-2004

The World Bank (2007) report on fiscal policies in twelve developing countries claims that addressing growth constraints need not necessarily imply increases in government spending. That report concludes that tilting the composition of government spending towards productive activities such as infrastructure, education and health, without increasing the size of the public sector and the financing needs could yield growth gains. Our evidence supports this conclusion for developed countries: on average across the OECD, current government spending composition is not growth-maximising, such that changing the structure towards transport and communication and education and away from general public services, defense and housing could increase economic growth.[19] It is of course not necessarily optimal for spending to switch towards those growth-enhancing categories where government spending also has to help deliver on current social objectives.

[19] Nevertheless, growth constraints in developed countries might be found at higher levels of education whereas World Bank (2007) argues that developing countries should prioritise primary education levels.

Figure 2: Growth Effects of Changes in Expenditure Shares (in % pts p.a.), 1990-2004*



Note: * Based on results in Table 8.

4.7 Short-run dynamics

The final question that we consider is the length of time that the various expenditure categories are likely to affect growth. Theory provides little guidance on how long it might be expected to take for fiscal changes to impact fully on economic growth rates, though periods from several years to several decades have been proposed based on alternative views of the likely speed of convergence towards a new steady state following a fiscal shock. For policy makers it is clearly important to be able to identify how quickly the long-run fiscal-growth effects feed through. For example, does the bulk, or all, of the growth impact of an increase in a particular form of productive expenditures occur quickly or only after several years? Does growth respond much more quickly in some countries than others?

Because the dynamics in the PMG regressions are allowed to differ across countries, it is possible in principle to answer these questions for each country and fiscal variable. However, the merit of the PMG approach is primarily in delivering more reliable, homogeneous *long-run effects*, by relaxing the homogeneity assumption for the short-run. With relatively short time-series for each country, the individually-estimated short-run effects are not typically estimated with much precision and should therefore be interpreted cautiously. Nevertheless, for the sample as a whole they might be expected to give some indication of the likely time lags involved in adjusting towards a new long-run equilibrium following a fiscal shock.

The trajectory followed by each country is determined by the estimated lag structure on each fiscal variable for that country together with its error-correction parameter, ϕ_i, in equation (3). Since this is an asymptotic process, (except where ϕ_i = -1) one way to summarise these trajectories is to consider the number of years taken to reach a given percentage of the long-run

equilibrium, following a fiscal shock.[20] Table 10 therefore reports the number of years taken (0, 1-2, 3-4 etc.) for each fiscal-growth effect to reach 90% of its long-run value.[21]

Table 10 Short-Run Dynamic Adjustments*

No. of years to achieve 90% of long-run effect	T&C	Educa-tion	Econom. services	Health	Social welfare	Recrea-tion	Gen public services	Defence	Housing
1 – 4	2	3	4	0	2	1	2	4	6
5 – 7	6	7	3	4	5	5	3	7	8
8 – 10	1	2	4	4	4	2	4	3	3
10+	8	5	6	9	6	9	8	3	0
Average	12.1	8.5	14.4	15.3	11.7	9.9	10.8	7.6	5.4

* using regressions from Table 8.

The table reveals that the adjustment process is relatively slow in most cases. Interestingly, the positive growth effects (those on the left-hand-side of the table), in general take longer on average to reach 90% of their long-run values than the negative effects on the right-hand-side of the table. For example, for transport and communication expenditures it takes on average 12.1 years for 90% of the estimated long-run effect (of 0.156) to be achieved, whereas for Housing the 90% of the negative effect (of -0.555) is achieved within 5.4 years on average. The table also suggests that this is not a consequence of a few outlier countries. There are 6 countries for which Housing has 90% of its effect within 4 years, compared to just 2 for transport and communication expenditures and 3 for education. Similarly, for 8 countries transport and communication expenditures take more than 10 years to reach 90% of their long-run value, and 5 for education, whereas there are no countries for housing and only 3 for defense that take this long.

Perhaps unexpectedly some of the slowest rates of adjustment are found for those expenditure categories that were estimated to have neutral long-run growth impacts. For example, on average it takes 15 years for health expenditures to reach 90% of their long-run value, and close to 12 years for social security expenditures.

While we caution against making too much of the precise estimates for each country, there is some consistency across different expenditure categories in those countries that take the longest, and those that are quickest, in reaching 90% of their homogenous long-run effect. The countries that are quickest include Austria, Spain, Finland, Norway and the US, whereas France, Germany, New Zealand and the UK are consistently amongst the slowest. Explanations behind this consistent set of ordering are beyond the scope of this paper, although suggest further research might be of value.

5 Conclusions

This paper has reviewed existing evidence on the impact of public expenditure on growth for both developing and developed countries, and offered some new results for OECD countries. Our assessment of previous evidence is colored by the fact that we regard much of that literature as methodologically weak. This is mainly because many regression analyses have been unclear about what elements of the government budget are omitted from their analyses or interpretation

[20] Half-lives (the more usual indicator of adjustment speeds in such cases) are not very helpful in this case because of the relatively rapid adjustment observed, as shown below.

[21] In those cases where countries oscillate towards the long-run equilibrium, we choose the number of years until the relevant fiscal-growth effect *remains* within 90% of its long-run value. Results are not sensitive to the particular percentages chosen.

of parameters is difficult because of what is explicitly or implicitly omitted. Endogeneity concerns also remain regarding the reliability of numerous previous estimates.

Nevertheless, the recent literature is beginning to produce a, perhaps surprising, degree of consistency, at least in the finding that infrastructure and educational spending by governments tend to be growth-enhancing. This appears to apply to both developed and developing country evidence. Clearly however, the method of financing any spending increase matters, whether this involves higher taxes (with differing distortionary characteristics), higher deficits, or reductions in alternative spending categories.

Our examination of the impact of public expenditure on economic growth for OECD countries has sought to deal explicitly with the financing aspects and with potential endogeneity concerns. Using longer time-series data than has been examined hitherto has also allowed us to apply more flexible (pooled mean group) methods that can accommodate heterogeneous, short-run responses across countries. We examined the growth impacts of changes in total government expenditure, alongside changes in the shares of spending devoted to various categories.

Our initial PMG results suggested only small (but possibly negative) effects on growth from increases in total expenditure financed by increased deficits and holding the shares of all spending categories at their currently observed levels. However, there was strong support for positive growth effects from switching a given dollar of spending towards transport and communication, and education spending, with support for smaller, but still positive, effects for health and defense spending. Social welfare appeared to be the main spending category likely to generate positive growth effects if resources were switched *away* from this category.[22]

However, there are a number of legitimate endogeneity concerns with these public expenditure-growth regressions. Principal among these is the possibility that lower growth may induce an increase in total public spending – because economic downturns encourage increased short-term spending on such things as social welfare. At the same time longer-term spending, often of an investment nature, is difficult to reign back. This also suggests that changes in growth are likely to have differential impacts on different spending types. In particular, slower growth might be expected to generate higher social welfare spending, and perhaps other welfare-related spending such as health and housing.

The use of lag structures in our PMG regressions might be expected to help mitigate these endogeneity problems but nevertheless it is possible that observed contemporaneous co-movement in our expenditure and growth variables reflect these endogenous aspects. When we deal with this by using the second and third lags of relevant variables (which a battery of endogeneity tests support), we find some interesting similarities and differences with our previous results.

The previously strong positive growth effects for T&C and education spending continue to receive robust support. Health and defense spending effects (previously significantly positive, though small) weaken, with defense spending in particular now appearing to have adverse growth impacts. One inference that may be drawn from this is that the beneficial growth spillovers sometimes claimed for defense spending may be exaggerated.[23] In our analysis, a switch into defense spending involves pro-rata reductions in other spending categories including T&C and education.

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22 Shifting the composition of government spending towards productive spending and away from utility-enhancing expenditures may be difficult because of the presence of vested interests or because the benefits of this policy option are often not immediately visible. Nevertheless, World Bank (2007) claims that these difficulties could be eased by making the likely growth and distributional trade-offs that arise from alternative choices explicit. In this way when goals other than growth are pursued through public spending, citizens would be aware of the growth losses implied.

23 The arguments in favour of 'productive' defence spending often presume that this involves substantial capital spending when in fact the main type of spending is often wage payments.

Perhaps the main change from our initial regressions is that increasing the share of social welfare spending now appears to be neutral, not adverse, for growth. This provides some support for the view that the previous evidence reflected the endogenous negative co-movement of social spending and growth, typically observed over cycles, but there is no robust evidence of long-run adverse effects from social welfare spending. As with all our results, this conclusion is, of course, conditional on the form of expenditure financing. It is obtained here under the assumption that total spending remains unchanged and increased social welfare spending replaces other spending categories on a pro-rata basis.

We also provide some quantitative assessment of the regression results from the paper. These involve assessing how long the various forms of expenditure take to reach close to their maximum impact on growth, and how the observed changes in fiscal policy in the OECD countries over the period 1990-2004 have added to, or subtracted from, growth. The results from the former exercise suggest that the effects of expenditure take between 5 and 15 years to have close to their full impact on growth. Interestingly there seems to be some difference between those expenditure categories found to have positive versus negative effects, with the positive effects taking on average longer to come through. There is also some consistency in the speed of transmission across countries, although we caution on making too much of those results until further research has been conducted. The results from the second exercise suggest the various fiscal policy changes observed across OECD countries have had a rather small impact on growth. We found that where relevant fiscal changes persist, their effects on growth are generally compensating so that the *net* effect is typically small.

Table 2: Summary of Recent Results for Developed Countries

Study	Dataset	Dependent Variable	Method	Growth Effect *(?)*[*]			Comments
				positive	*negative*	*none*	
DEVELOPED COUNTRIES							
Devarajan et al. (1996)	21 OECD 1970-90	GDP per cap growth	panel	capital exp; T&C; health *(?)*	current exp; defence *(?)*; education *(?)*		controls for total tax/GDP; poor regression fits
De la Fuente (1997)	21 OECD 1965-85	GDP growth	panel		gov exp (tax-financed)		
		GDP levels			gov exp (tax-financed)		
		Priv. Invest.			consumption exp		
Miller and Russek (1997)	16 OECD 1975-84	GDP per cap growth	panel	education	gov exp (tax-financed) health *(?);* soc sec *(?);* econ affairs *(?)*	gov exp (debt-financed) defence *(?)* T&C *(?)*	Generally non-robust results for DCs; debt-financing of exp decompositions.
Kneller et al. (1999) and Bleaney et al. (2001)	21 OECD 1970-95	GDP per cap growth	dynamic panel	productive exp health 'other productive'	distortionary taxes budget deficits	non-productive exp social security exp	explicit inclusion of gov bud contraint
Blanchard and Perotti (2002)	US (1960-91 and 1947-91; quarterly)	GDP levels Invest. levels	VAR	gov exp defence and non-def.	 gov exp		tax levels also +ve. tax levels also –ve.
Perotti (2002)	5 OECD (1960-2000; quarterly)	GDP levels	VAR	gov exp ('small') gov exp (pre-1980)		gov exp (post-1980) *(?)*	gov exp also affects price level (+ve)
Nijkamp and Poot (2004)	93 studies, 1983-88 123 meta obs.	GDP or GDP per cap growth	meta analysis techniques (various)	("strong") education infrastructure	("weak") fiscal vars. overall		Almost all 1st or 2nd generation studies
Schuknecht and Tanzi (2005)	22 DCs 19602-2002	GDP growth, employment, social indicators	Descript stats comparing pre- and post fiscal reform	total exp. decreases assoc with increased trend growth and employment		no or little impact on social indicators	gov exp reducing countries mainly cut transfers and interest payments

Note: * (?) indicates that there is some doubt over the estimated effect (usually relatively large standard errors).

Table 3: Summary of Recent Results for Developing Countries

Study	Dataset	Dependent Variable	Method	Growth Effect *(?)* *			Comments
				positive	*negative*	*none*	
DEVELOPING COUNTRIES							
Devarajan et al. (1996)	43 LDCs 1970-90	GDP per cap growth	panel	current exp	capital exp;T&C; defence *(?)*, health *(?)*, educ *(?)*		controls for total tax/GDP
Miller and Russek (1997)	23 LDCs 1975-84	GDP per cap growth	panel	gov exp (tax-financed); T&C *(?)*	gov exp (debt-financed) educ; health; soc sec.; econ affairs		
Aschauer (2000)	46 LDCs 1970-90	GDP per cap growth	cross-section	gov capital exp 'effective' gov cap	gov debt		gov debt used to control for (future) tax burden; effective gov capital measured from quality indices (e.g. faulty phone lines).
Dessus and Herrera (2000)	28 LDCs 1981-91	GDP	annual panel	gov invest	'excessive' gov invest (relative to private inv)		only tests for effects from investment; production function approach; 'excessive' where $MPK_G < MPK_P$
Albala-Bertrand and Mamatzakis (2001)	Chile 1960-95	GDP and Investment	VAR	public infrastructure			Production function with public infrastructure as input; public infrastructure 'causes' output and private investment.
Bhergava et al. (2001)	92 DCs and LDCs	GDP growth	panel	health index (many LDCs)	(some DCs)		Impact of health indicators on growth (adult survival rates = life expectancy)
Haque and Kim (2003)	15 LDCs 1970-87	GDP growth	dynamic panel (IV) and causality tests	T&C			Examines only T&C; T&C Granger-causes growth; no reverse causality
Bose et al. (2003)	30 LDCs 1970-90	GDP growth	dynamic panel (IV)	capital exp, defence educ, educ invest, T&C, T&C invest		14 other exp categories	**excluding** GBC
				capital exp; educ exp; educ invest; 'other' exp		current exp	**including** GBC explicitly; passes endogeneity tests; separate data on total exp and investment component
Milbourne et al. (2003)	74 DCs and LDCs	GDP per cap	cross-section	gov inv (long-run, OLS); gov invest, educ, T&C (short-run, OLS and IV)	gov consumption (OLS and IV)	gov inv (*?*) (long-run, IV)	tests for transitional impact as in Solow model; no GBC control

Study	Dataset	Dependent Variable	Method	Growth Effect *(?)* *			Comments
				positive	*negative*	*none*	
Ramirez and Nazmi (2003)	9 Latin Am. 1983-93	GDP per cap growth; Pte inv/GDP	annual panel	gov inv; educ exp health exp [also affects pte invest]	gov consumption [gov invest and defense exp affect pte invest]		no GBC control [human capital also affects private investment positively]
Bloom (2004)	104 DCs and LDCs	GDP growth	panel	health index			Estimates productions function with human capital affected by health, schooling and work experience
Haque (2004)	33 LDCs 1970-89	GDP per cap growth	cross section and panel	capital exp (in c-s, and panel; non-stationarity corrected)	current exp (in c-s, and panel; non-stationarity corrected)		includes GBC explicitly; Replicates Devarajan et al (1996) result using panel regression **when no correction for non-stationarity**
Adam and Bevan (2005)	40-45 LDCs and NICs 1970-99	GDP per cap growth	dynamic panel	total exp + net lending; productive exp *(?);* interest exp deficits (<1.5% of GDP)	total rev + grants; total tax rev; non-tax rev; deficits (>1.5% of GDP)	grants	all exp financed by 'residual exp'; allows non-linearities in deficit; growth-max deficit = 1.5% of GDP; methods of financing deficits and debt levels important
Gupta et al. (2005)	39 LDCs 1990s	GDP per cap growth (and changes in)	annual panel	gov cap exp non-wage G&S exp (esp for pre-stabilization cases)	wage G&S exp deficits	weaker effect for post-stabilization cases	only countries with IMF-supported adjustment programs; includes GBC; impact of deficits worse if domestic financing than international
M'Amanja and Morrissey (2005)	Kenya 1964-2002	Real GDP	time-series (ADL) and causality tests	gov invest exp	gov current exp on educ, health, econ serv.	other current exp	includes GBC; causality from gov invest to growth
Akitoby et al. (2006)	51 LDCs 1970-2002	**Gov exp**	time-series (ECMs)	income affects gov exp (long-run) in 70% of countries; highest for gov capital exp. Short-run income increases raise gov exp which not reduced in downturns (ratchet effect)			Focuses on Wagner's Law; finds (more than proportional) long-run increases in gov exp in assoc with incomes.
Fedderke et al. (2006)	South Africa 1875 - 2001	GDP per cap	time-series	infrastructure inv leads growth (especially roads)			direct and indirect (via private sector MPK) effect of gov infrastructure exp; evidence of bi-directional causality.
Segura-Ubiergo et al. (2006)	26 transition economies 1992-2001	GDP growth	panel ECM		gov borrowing (especially 'monetized deficits')		Focuses on 'fiscal adjustment' (deficit reductions). Positive growth effects till macro stab. achieved, then less clear.

Note: * (?) indicates that there is some doubt over the estimated effect (usually relatively large standard errors).

Appendix: The updated OECD dataset

The dataset used in this paper builds on that used by Bleaney et al. (BGK, 2001), who used GFS fiscal data, covering consolidated central government functions only, based on the 1986 GFS Manual classification of fiscal variables. Like much National Accounting at that stage, these variables were measured based on a 'cash', as opposed to 'accruals', accounting method. We refer to this below as the "old" classification. The 2001 GFS Manual introduced a "new" classification system (mainly involving the reclassifying of other expenditures into general public services, and separating environmental protection from housing; see Wickens, 2002). In line with new National Accounting practice, the "new" GFS is based on accruals accounting and so is not directly comparable with the original BGK dataset. In addition GFS data for central government on a cash basis has not generally been updated beyond about 1999 or 2000 for most countries in our sample. The most recent data available (typically up-dated to 2003 or 2004), based on the new classification, is available for central and general (central plus local) government but has only been back-dated to 1990.

Annual differences between fiscal variables measured on cash or accrual bases can be quite substantial. For example, the financial year in which corporation tax (cash) payments are made in many OECD countries can be different by up to 2-3 years from the (accrual) accounting period to which the tax liability relates. As a result, up-dating our dataset beyond around 2000 requires a careful splicing of 'old' and 'new' data streams and is likely to involve a number of inaccuracies of unknown magnitude.

The currently available data is summarized in Table A1 below. In general, we use (i) the latest GFS data on a cash basis for central government to up-date BGK (typically to 1999 or 2000) and then (ii) the annual rate of change in 'new' fiscal variables for central government to up-date the series to the latest possible year (typically 2003 or 2004). In some cases, where overlaps in the series suggest that the new and old GFSY do not correspond well, we supplement this with OECD sourced data which is based on a similar definition to the new GFS. Though in principle we would prefer to use a dataset capturing all levels of government, the unavailability of data on this basis prior to 1990 or 1995 would leave us with insufficient time-series observations. The up-dated dataset includes 16 of the previous 17 countries used by BGK plus one new country, New Zealand (shown in bold in Table A2 below).27 In most cases results are reported for a sample of 17 countries, from the early 1970s to 2003 or 2004.

[27] BGK included data for Belgium for which some series end in 1990. To keep the country time-series approximately the same for all countries, we omit Belgium from this sample. The other 'additional countries' shown in Table A2 also have an insufficient time-series dimension to be included in regressions.

Table A1 Summary of Data Sources and Coverage

Source	Classification System	Cash or Accrual?	Government: Central or General?	Approx. Period Coverage
Fiscal Variables:				
IMF GFS	Old	Cash	Central	1970-98
IMF GFS	New	Cash	Central	1990-1998/9
IMF GFS	New	Accrual	Central	1998-2003/4
IMF GFS	New	Accrual	General	1998-2003/4
OECD	New	Accrual	General and Central	1990/95–2003/04
GDP:				
OECD: Economic Outlook		Real GDP growth		1970-2004
Private Investment:				
OECD: Economic Outlook		Private non-residential fixed cap. formation		1970-2004

Table A2 Sample Countries

Original Sample	Original Sample	Additional Countries
Australia	**Luxembourg**	Belgium
Austria	**Netherlands**	Ireland
Canada	**Norway**	Italy
Denmark	**Spain**	Japan
Finland	**Sweden**	Mexico
France	**Turkey**	**New Zealand**
Germany	**UK**	Portugal
Iceland	**US**	

Appendix Table A3 Testing Expenditure Composition: Functional Categories (IV)

Regression:	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***
Share of:	T&C	Educ.	Econ serv	Health	Social welfare	Recreat.	Gen pub serv	Defence	Housing
Expenditure SHARE	**0.156 (3.09)****	**0.111 (2.11)***	**0.062 (1.57)**	**0.023 (1.10)**	**0.012 (0.91)**	**-0.056 (0.21)**	**-0.067 (2.04)***	**-0.200 (3.25)****	**-0.555 (5.97)****
TOTAL Expenditure	0.408 (9.05)**	0.304 (8.01)**	0.381 (9.77)**	0.400 (10.69)**	0.338 (7.88)**	0.302 (6.54)**	0.485 (13.27)**	0.291 (6.45)**	0.314 (8.03)**
Non-distortionary	-1.169 (11.21)**	-0.831 (8.57)**	-0.960 (9.74)**	-1.114 (12.74)**	-0.917 (9.21)**	-0.837 (7.78)**	-1.063 (12.85)**	-0.839 (7.62)**	-0.471 (5.23)**
Distortionary	-0.245 (4.12)**	-0.094 (2.17)*	-0.193 (3.97)**	-0.223 (4.68)**	-0.136 (2.69)**	-0.109 (2.11)*	-0.338 (6.93)**	-0.118 (2.52)*	-0.527 (8.65)**
Investment	0.560 (7.84)**	0.300 (6.20)**	0.315 (5.41)**	0.519 (8.78)**	0.299 (5.73)**	0.285 (5.11)**	0.456 (8.23)**	0.192 (3.00)**	0.140 (3.25)**
Employment growth	0.400 (7.26)**	0.445 (7.62)**	0.471 (9.06)**	0.319 (6.38)**	0.382 (6.84)**	0.454 (8.67)**	0.316 (6.51)**	0.407 (6.53)**	0.470 (10.85)**
Constant	-1.834 (2.22)*	-2.153 (3.84)**	-1.119 (1.85)	-1.108 (1.44)	-0.823 (1.32)	-0.661 (1.10)	-0.901 (1.39)	1.992 (3.12)**	6.449 (7.88)**
Correlated with the included endogenous variables Shea partial R^2s:									
Expenditure share	0.87 (0.89)	0.87 (0.93)	0.71 (0.85)	0.92 (0.94)	0.85 (0.96)	0.81 (0.90)	0.67 (0.73)	0.91 (0.97)	0.57 (0.61)
Non-dist tax	0.66 (0.97)	0.71 (0.97)	0.66 (0.97)	0.66 (0.97)	0.68 (0.97)	0.65 (0.97)	0.68 (0.97)	0.69 (0.97)	0.67 (0.97)
Distort. tax	0.53 (0.95)	0.54 (0.94)	0.56 (0.94)	0.53 (0.94)	0.53 (0.95)	0.54 (0.94)	0.54 (0.95)	0.54 (0.94)	0.54 (0.94)
Total expend	0.51 (0.93)	0.52 (0.93)	0.52 (0.93)	0.51 (0.92)	0.51 (0.93)	0.51 (0.93)	0.52 (0.93)	0.52 (0.93)	0.52 (0.93)
Investment	0.78 (0.80)	0.78 (0.80)	0.75 (0.81)	0.77 (0.80)	0.76 (0.80)	0.78 (0.80)	0.77 (0.80)	0.76 (0.80)	0.75 (0.80)
Anderson test $\chi^2(6)$	336.44	348.48	346.57	377.79	382.92	339.32	3335.52	348.48	344.02
Stock-Yogo F-test	47.20	49.60	49.22	47.49	47.09	47.78	47.04	49.60	48.71
Orthogonal to the error process									
Sargan test $\chi^2(5)$	5.85	4.04	4.78	5.29	5.89	7.28	7.33	6.40	6.73
Instrument set: Lags 2and 3 for: total expenditure, each relevant expenditure share, distort. and non-distort. tax, and investment									

Dependent variable: economic growth rate in real terms (%)

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Behind public sector efficiency: the role of culture and institutions*

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Abstract:

Despite the common institutional framework, public sector efficiency varies significantly over the Italian territory. In this paper we compute objective measures of efficiency in the provision of several public services for the 103 Italian provinces. We then study the determinants of efficiency. In particular, we investigate the importance of a widespread civic culture and of decentralized service provision. While the former has a strong positive effect on efficiency, the latter appears to be efficiency-enhancing only in areas where efficiency is already at satisfactory levels.

JEL Codes: C14, H50, H77, Z13.

Keywords: Public spending, efficiency, culture, institutions.

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1 Introduction

The capability of a country's public sector to provide high-quality goods and services in a cost-effective way is crucial to foster long-term growth. It's up to politicians and bureaucrats to set rules and practices which increase efficiency and reduce slack, delivering the highest possible value for money to taxpayers.

However, the literature on political economy and public choice stresses that one cannot take for granted that public decision-makers will always use public resources in the most appropriate way. The relationship between citizens and politicians is to some extent similar to a principal-agent relationship, which creates risks of opportunistic behaviour and moral hazard.[1]

As we cannot have untarnished faith on the honesty and competence of public decision-makers, there is the need of well-designed formal rules for the political and administrative system: electoral rules, term limits, checks and balances, etc.

However, citizens' willingness to invest time and effort monitoring public affairs is also necessary, if policy-makers are to be held accountable for what they do, and deterred form wasting public resources. This in turn requires a shared set of values which go beyond narrow self-interest and, in particular, a widespread concern for public affairs. Indeed, there is a well-known free-riding problem inherent in the political sphere: the impact of a single individual on outcomes is negligible, while mobilizing in elections and in other political activities, distracting time and resources from the care of one's private affairs can be quite costly.

The first and foremost goal of this paper is to empirically assess the importance of citizens' values for public sector efficiency (PSE).

To this aim, we first propose and compute measures of efficiency for several public services (namely child care, education, health care, and civil justice), for the 103 Italian provinces. Concentrating on within-country differences, we can control for differences in formal institutions, and limit omitted variable bias. We document that, despite 150 years have elapsed since the political and administrative unification of the country, huge differences in PSE still remain across Italy's regions and provinces.

Then, we relate our measures of PSE to the prevailing attitudes toward politics. The task of eliciting people's values and preferences is notoriously problematic. While polls are a precious instrument, there is the risk of misreporting. On the other side, observable behaviour (e.g. voting, participating to protests or rallies), is often an imperfect proxy for the underliyng preferences. In our empirical analysis, we rely on well-established indicators of cultural attitudes (including survey answers).

Apart from the aforementioned measurement problems, there is the problem that preferences concerning political engagement can be legitimately seen as endogenous. This is a common

1 The literature on the agency relationship between citizens and politicians is thoroughly surveyed and expanded by Besley (2006). Of course, focusing on this relationship we do not mean to downplay the other conflicts that shape political life, in particular that between groups of citizens with conflicting goals and values. However, in a context in which efficiency is the main dependent variable, the latter problem seems less pressing: even if people disagree about the size and the composition of public sector activities, they should all agree on the fact that public resources should not be wasted.

concern with any attempt to use preferences to explain political or economic outcomes (Guiso et al. 2006). We would ideally like to capture the effects of the truly exogenous component of values and preferences, which is really part of the society's cultural heritage.

For example, Guiso et al. (2006) refer to culture as to "those customary beliefs and values that ethnic, religious and social groups transmit fairly unchanged from generations to generations". While Italy is still quite homogenenous ethnically and religiously, Italian regions are deeply different with respect to their century-long political history, and there is a vast literature arguing that its ancient vicissitudes still partly shape the political life of contemporary Italy (among which there is the seminal contribution of Robert Putnam, 1993).

So our empirical strategy is to address endogeneity of political preferences (as well as measurement error) instrumenting them with three sets of instruments: measures of political and social participation in early XX century in Italy (from Nuzzo, 2006), features of formal political institutions in place in the XIV century (from de Blasio and Nuzzo, 2006) and in the XVII century-XIX century period (from Tabellini, 2005).
Due to the institutional caracteristics of the Italian public sector, our data-set can also shed some light on a second determinant of PSE besides political culture, namely the degree of centralization in public sector provision. We are interested to test the idea, which is present in the literature on fiscal federalism, that accountability is maximized when the decision-maker authority is set at lower levels of government. Decentralized government might be efficiency-enhancing for several reasons (Treisman, 2002, Oates, 2005, Rodden, 2006). One reason (originally advanced by Buchanan and Brennan, 1980) is that competition among jurisdictions limits the possibility of Leviathan-style local governments to extract resources from the polity. Local politicians have also more incentives to behave, given that their objective function is likely to be more sensitive to citizens' satisfaction in a given district (Seabright, 1996). Another reason is that in a decentralized framework citizens can assess more easily how resources are used: as Thomas Jefferson himself once said, \distance, by rendering detection impossible to their constituents, will invite the public agents to corruption, plunder and waste" (quoted by Treisman, 2002). Finally, decentralization might also improve government performance indirectly, by increasing political participation (Inman and Rubinfeld, 1997).

As the four public services which we study are delivered by different levels of government (Central Government provides education and administrates justice, Regions provide health care, Municipalities provide child day care), we can relate our service-specific measures of public sector efficiency to the degree of decentralization in service provision and to our measures of political preferences. Using quantile regression techniques,[2] we discover that decentralized provision has ambiguous effects. It reduces PSE in those provinces in which efficiency is low, but it enhances efficiency in those provinces in which it is high. This result is of great policy relevance. As decentralization might enhance the already existing differences between regions, forms of "two-speed decentralization", where only the most efficient regions are allowed to provide certain services, seem advisable.[3]

Our paper relates to a growing literature assessing the importance of culture for government performance. The seminal papers on this issue are Knack and Keefer (1997) and La Porta et al. (1997).[4] Both studies use a cross section of about 40 countries, and take indicators of trust and civicness from the World Value Survey. However, drawing inferences from cross-country data

2 Koenker and Hallok (2001) provide a very readable introduction to the literature on this tecnique and a comprehensive set of references.

3 A similar arrangement is in place in Spain, and has been proposed in Italy as well.

4 See also La Porta et al. (1999).

is problematic, due to the high number of possibly relevant variables. Moreover, as pointed out by Guiso et al. (2006), these early contributions did not control for the endogeneity of trust. Our paper is more closely related to Knack (2002), which uses data from US states (and controls for possible endogeneity). We differ from him because we use objective efficiency indicators, instead of perceived quality, as our dependent variable. We believe this is appropriate given that expectations concerning government performance might be unreliable: individuals in areas in which short-sighted selfishness and distrust are widespread, and governments consistently under-perform, will probably expect less from their politicians and public officials. Objective measures analogous to ours have been recently computed for a cross-section of countries by international organizations, such as the OECD (Hakkinen and Joumard, 2007, Sutherland et al, 2007), the IMF (Verhoeven et al. 2007) and the European Commission (European Commssion, 2008).[5]

To our knowledge, the only other paper which uses an objective efficiency measure as a dependent variable is Borge et al. (2008). The authors build an aggregate index of public sector efficiency for almost 400 Norwegian provinces, for the years 2001-2005, encompassing six service sectors (elderly care, primary and lower secondary education, day care, welfare benefits, child custody and primary heath care). The index is a simple ratio of a performance indicator (expressed in relation to the sample mean) and the amount of available fiscal resources. They relate this index to local government revenues and to local political characteristics such as party fragmentation, left-wing majority, voter turnout, top-down vs bottom-up budgetary procedures. They find in particular that a more cohesive government and a stronger democratic participation increase efficiency.

Another stream of literature studies the much broader issue of the impact of cultural traits on economic growth (Tabellini, 2005, 2008, de Blasio and Nuzzo, 2006). In contrast with this literature, we try to keep distinct generally pro-social values (what Tabellini calls "generalized morality") from values inherent to the political sphere. We stick to the idea, well-established in political science at least since Almond an Verba (1963), that political values (and more generally political culture), should be distinguished by morals. For example, it may well be possible that the recent decades witnessed an increase in the willingness to participate in pro-social activities (e.g. volunteering) together with a growing disillusion and detachment from politics (Inglehart, 1977).[6] Of course, pro-social values can have a positive influence on public service efficiency independently of their effect on political engagement (for example rising the likelihood of having honest politicians, so reducing the need for checks and balances).

Needless to say, we are deeply indebted with the work of Putnam (1993). As it is well known, one of the ideas in his seminal book is that a dense network of associations is often a pre-condition of effective collective action (see also Verba et al. 1995). While we control for the presence of social networks, our work also highlights the limits of an encompassing measure of "social capital", where moral and political values, beliefs, networks are merged together.[7]

The rest of the paper is structured as follows: in the second chapter we compute our sector-specific measures of public sector efficiency for several public services; in the third chapter we present our baseline econometric exercise, and in chapter four we report the results; chapter 5 concludes.

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5 See also OECD (2008) and Afonso et al. (2005). Within-country studies are also frequent. Afonso and Scaglioni (2005) provide efficiency measures for Italian regions.

6 In the same vein, people in a community might have a high degree of interpersonal trust, but a high degree of mistrust with respect to political institutions.

7 Critiques to the soundness of Putnam's approach come from the political science (Jackman and Miller, 1996) as well as from the economics (Durlauf, 2002) camp.

2 Public sector efficiency in the Italian provinces

2.1 Defining (in)efficiency

There are several well-established definitions of (in)efficiency of a production unit (be it an industrial plant, a firm, a public administration) in the microeconomic literature.[8] In this paper we use concepts of technical efficiency, all of which basically boil down to a comparison between actual and potential performance. More formally, suppose that several production units produce a certain output y with a certain input x, where T is the set of all technically possible input-output combinations.

Define:

$$L(y) = \{x|(x,y) \in T\}$$

$$P(x) = \{y|(x,y) \in T\}$$

$$F(x) = Max\{y|y \in P(x)\}$$

Then a natural measure of inefficiency for a production unit i, which produces y_i units of output with x_i units of input, is:

$$Ineff_i^{OUT} = Max\{\theta|y_i\theta \in P(x_i)\} = F(x_i)/y_i.$$

Basically, it defines inefficiency as the ratio between potential (given technology and inputs) and actual performance. In turn, the inverse of $Ineff_i^{OUT}$ can be taken as a measure of efficiency:

$$Eff_i^{OUT} = \frac{1}{Ineff_i^{OUT}}.$$

Another widely used measure is provided by:

$$Eff_i^{INP} = Min\{\theta|x_i\theta \in L(y_i)\}.$$

It measures how much less input unit i could use to produce the level of output it actually produces.[9] $Ineff_i^{OUT}$ and Eff_i^{INP} are also referred to, respectively, as output-oriented and input-oriented Debreu-Farrell indices, while Eff_i^{OUT} is known as the Shephard index.[10]

In the rest of the paper, unless otherwise stated, we focus on Eff_i^{OUT} as our preferred definition of efficiency. However, our results do not change with different definitions of efficiency.

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8 Fried et al. (2008) is a comprehensive and up-tp-date survey of the field of efficiency measurement. 9In the presence of constant return to scale the two scores coincide.

9 In the presence of constant return to scale the two scores coincide.

10 As IneffiOUT takes values between 1 and +∞, EffiOUT takes values in (0,1). When we use efficiency as the dependent variable in our econometric exercises, we actually use deviations of IneffiOUT from its sample mean.

2.2 Estimating the frontier

Whatever the definition of efficiency adopted, the main problem encountered in measuring efficiency is how to find out the potential production frontier. As the latter is unknown, in practice efficient performances are defined as un-dominated performances, i.e. performances located on the \best practice frontier". To construct this frontier from the observed input-output pairs $(x_i y_i)$, two approaches have been used in the literature: the parametric and the non parametric approach. The advantage of the non-parametric approach is of course that it does not require the specification of a functional form, so that it avoids the risk of confusing the effects of misspecification of the functional form with those of inefficiency. The basic idea underlying non parametric methods is quite simple. Given our sample of production units $(x_i y_i)$, we use it to deduce the production possibility set T. Once we have such approximation of T -let us call it T'- we also have approximations of the sets L(x), P(x) and F(x) defined in equation 1:

$$L'(y) = \{x|(x,y) \in T'\}$$
$$P'(x) = \{y|(x,y) \in T'\}$$
$$F'(x) = Max\{y|y \in P'(x)\}.$$

So non-parametric methods differ in how they build T'. Our baseline measure of the efficiency of public spending in the Italian provinces is constructed applying a commonly used non-parametric method, called Data Envelopment Analysis (DEA).[11] In the DEA approach, T' is identified as the intersection of all the production sets which satisfy the following list of assumptions: (1) convexity; (2) free disposability; (3) all the $(x_i y_i)$ belong to the set; (4) to produce a strictly positive amount of output a strictly positive amount of input is needed In practice, the various efficiency indexes in a DEA setting are computed solving linear programming problems.[12]

An important assumption involves returns to scale. In our baseline calculation, we do not restrict returns to scale in any way. We also provide PSE estimates in which constant returns to scale are assumed. Moreover, to further check the robustness of our results, we also use the deterministic frontier methodology, a parametric tecnique. In particular, we follow most of the literature by assuming a log-linear relationship:

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11 Another non-parametric approach that can be used to assess productive efficiency is the FDH (Free Disposal Hull) technique. The main difference between the two methodologies is that in the FDH assumption 1 (convexity) is dropped. The DEA efficiency frontier always encompasses the FDH frontier, so that some units which are efficient according to FDH method are instead inefficient according the DEA technique (see Tanassoulis et al. 2008 for further details).

12 In the case of 1 input, 1 output and N productive units, EffiINP equals:

$$Eff_i^{INP} = Min\left\{\theta \text{ subject to}: \sum_{j=1}^{N} x_j\lambda_j \leq \theta x_i; \sum_{j=1}^{N} y_j\lambda_j \geq y_i; \lambda_j \geq 0 \forall j; \sum_{j=1}^{N} \lambda_j = 1\right\}.$$

IneffiOUT is instead computed as:

$$Ineff_i^{OUT} = Max\left\{\theta \text{ subject to}: \sum_{j=1}^{N} x_j\lambda_j \leq x_i; \sum_{j=1}^{N} y_j\lambda_j \geq \theta y_i; \lambda_j \geq 0 \forall j; \sum_{j=1}^{N} \lambda_j = 1\right\}.$$

In both expressions the last constraint implies variable returns to scale (non-increasing returns to scale if it holds with <). Dropping this constraint amounts to assume a production function with constant returns to scale.

$$lny_i = \alpha_0 + \alpha_1 lnx_i + u_i, \quad u_i \leq 0.$$

Estimation is performed with a two-step procedure: first, an OLS estimation is run; second, the fitted residuals are augmented by the minimum constant which makes all of them less or equal than zero. It turns out that such procedure gives consistent estimates of the parameters α_0 and α_1 (Greene, 2008). Then the frontier is given by the function:

$$lny = \hat{\alpha}_0 + \hat{\alpha}_1 lnx.$$

2.3 Input and output measures for the Italian public sector

In assessing the efficiency of public sector in the 103 Italian provinces we focus on four spending categories. Two of them are provided by the central government (judiciary and education); the remaining two (health and child care) are provided by local governments. Not for all categories we use spending as a measure for input. While for child care and health care public expenditure can be reasonably apportioned to individual provinces (in the case of child care we have even budgetary data for each municipality), for justice and education we prefer to measure inputs in terms of number of public employees (judges and teachers, respectively), as in these sectors most of the spending is accounted for by compensation of employees, on which accurate information at provincial level is available. Depending on the sector we consider averages over a given period of time (if it is sensible to assume that it takes time for public intervention to influence outcomes) or the most recent year for which data are available (when we have more straightforward output measures).

In what follows we provide information about how we measure inputs and outputs for each of the four spending categories and our data sources.

Health: We use as input per capita public health expenditure adjusted for the age structure of the population. We take averages over the years 1985-2007. Our computation is based on official statistics for expenditure and for population, and on coefficients provided by the Ministry of Health to compute the equivalent population (intuitively, these coefficients correct for the fact that health expenditure is concentrated on particular age-groups, so that regions with a higher share of elderly individuals tend to have higher per capita spending). All the data refer to the 20 Italian regions. Given the lack of province-level data, we assume here that our input measure does not vary across provinces within the same region. Our health performance indicator is the change in life expectancy between the years 1981-1983 and 2003-2005 (as customary, we use averages to reduce the influence of temporary and exceptional events, such as particularly rigid winters, on mortality rates). We take variations in life expectancy instead of levels to at least partially control for environmental factors which influence outcomes independently of public health care. Data for each province from 1992 onward are available from Istat (the National statistical office); for the previous years, we use data from Lipsi and Caselli (2002), who compute mortality tables for the Italian provinces in the years 1971-73, 1981-83, 1991-93.

Education: Our input measure is the number of teachers per pupil in the primary and first three years of secondary school (school year 2005-06). These data are published for each province by the Ministry of Education. Using teachers instead of spending, for which we do not have province-level data, does not affect our results. In fact, about 97% of education expenditure in Italy is due to compensation of employees. As a measure of output, we use 6th and 9th grade students' performance in tests carried out by INValSI (the public institute in charge of

evaluating the Italian educational system) during the school year 2005-06. Performance is measured by the average score (i.e., percentage of correct answers to a multiple choice questionnaire) obtained in the Italian, Math and Science tests. In contrast to evaluation exercises carried out by international institutions (e.g., OCSE-PISA, TIMSS, PIRLS), whose sample of pupils cannot be used for our purposes as it is not representative at the province level, INValSI evaluations encompass a much larger number of schools. Actually, for the 6th grade almost all the schools have been tested, while for the 9th grade we refer to a representative sample.[13]

Civil justice: We take as input the number of judges per 1,000 new trials in 2006. This number has to be considered with caution for two main reasons. First, lower-level court districts in Italy do not perfectly overlap with provinces (there are 103 provinces and 165 *tribunali*[14]), so we restrict ourselves to the judges working in the main court *(tribunale)* of the province (it is typically located in the main city, even if it often has other subsidiaries inside the province, which we consider as well). Second, in many districts it is not clear how many judges work in the civil sector, and how many in the criminal sector. We use estimates of this ratio, computed using the available data.[15] Finally, our measure for output in the civil justice sector is the average length of trials in 2006, as estimated by Istat.

Child care: Our input is expenditure for child day-care and other infant services by municipalities in 2006 (again, we only consider the capital of the province). Our output is given by number of available seats in day care in 2006. Data come from the Ministry of Internal Affairs *(Certificati di conto consuntivo dei comuni)*.

2.4 The map of public sector efficiency in Italy

In Table 1 we report regional averages of public sector performance indicators for each of the four spending items. In the last column we also report overall regional public sector performance, obtained as a simple average of the performances in each spending area. The indicators show notable differences across Italian regions. In all service categories regions in the South exhibit the lowest performance. Overall, public sector output in the South (whether measured in terms of health conditions, education, functioning of the judicial system, or provision of child care services) is 77 per cent of the Italian average. The gap is higher for the service supplied by municipalities (child care), for which the performances obtained by southern regions do not reach 50 per cent of the average.

13 Although on average the results reported by INValSI do not differ substantially from those shown by other international tests, the outcomes in the South, particularly those obtained by primary schools, have to be taken with caution, as they appear to many observers too favourable with respect to other evaluation exercises.

14 Lower-level court districts (circondari di tribunali) are in turn grouped into 29 higher-level districts (distretti di corte d'appello).

15 We are grateful to our colleague C. Giorgiantonio for providing us with these figures, based on data from the Consiglio Superiore della Magistratura website.

Table 1. Public sector performance indicators

Region (1)	Health (2)	Education (3)	Judicial system (4)	Day care (5)	Total
Valle d'Aosta	1,04	1,06	1,35	1,27	1,18
Piemonte	1,01	1,06	1,95	1,06	1,27
Liguria	1,00	1,01	1,04	1,16	1,05
Lombardia	1,18	1,04	1,43	0,71	1,09
Trentino Alto Adige	1,21	0,98	1,52	1,72	1,36
Veneto	1,20	1,04	1,10	0,65	0,99
Friuli Venezia Giulia	1,09	1,11	1,39	1,23	1,20
Emilia Romagna	0,98	1,05	1,03	2,35	1,35
Toscana	0,95	1,04	1,05	1,86	1,23
Umbria	0,91	1,02	0,97	1,17	1,02
Marche	0,98	1,05	0,97	0,79	0,95
Lazio	0,93	1,01	0,97	1,07	1,00
Abruzzo	0,88	1,03	0,95	0,63	0,87
Molise	0,84	0,98	0,93	0,24	0,75
Campania	0,94	0,96	0,95	0,21	0,77
Puglia	1,06	0,95	0,66	0,20	0,72
Basilicata	0,85	0,94	0,62	0,71	0,78
Calabria	0,87	0,93	0,77	0,13	0,68
Sicilia	0,91	0,95	0,83	0,48	0,79
Sardegna	0,95	0,95	0,74	0,72	0,84
ITALIA	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**
North-west	1,06	1,04	1,44	1,05	1,15
North-east	1,12	1,04	1,26	1,49	1,23
Centre	0,94	1,03	0,99	1,22	1,05
South	0,91	0,96	0,81	0,42	0,77

(1) Regional values are obtained as simple averages of provincial values. - (2) Change in life expectancy. - (3) Invalsi score obtained by 6th and 9th grade students. - (4) Inverse of average length of trials. - (5) Number of available seats in day care per capita.

The same picture emerges if we look at PSE. In Table 2 we report our baseline measures of efficiency. Again, for brevity, we show regional averages even if data show also significant variation across provinces within the same region. Again, overall public sector efficiency in the South is below the Italian average. The North is the geographical area showing the highest public sector efficiency. Geographical differences in efficiency are more pronounced in the sector that is delivered by municipal authorities: the standard deviation-to-mean ratio ranges between 0.55 (child care) and 0.08 (education). Interestingly, however, the dispersion in judicial efficiency scores is quite high as well (0.45), mainly due to the high efficiency of courts in the North-west (particularly, in Piemonte). Overall, the correlation between efficiency in different public services is not strong (Table 3), which seems promising for our empirical analysis.

Table 2. Public sector efficiency indicators (Output-oriented, DEA)

Region (1)	Health	Education	Judicial system	Day care	Total
Valle d'Aosta	0,77	0,92	0,30		0,66
Piemonte	0,76	0,91	0,43	0,51	0,65
Liguria	0,74	0,87	0,23	0,39	0,56
Lombardia	0,87	0,89	0,32	0,28	0,59
Trentino Alto Adige	0,89	0,84	0,34	0,41	0,62
Veneto	0,88	0,89	0,24	0,35	0,59
Friuli Venezia Giulia	0,82	0,95	0,31	0,38	0,61
Emilia Romagna	0,72	0,92	0,23	0,75	0,66
Toscana	0,72	0,90	0,23	0,62	0,62
Umbria	0,69	0,88	0,25	0,48	0,57
Marche	0,74	0,91	0,21	0,41	0,57
Lazio	0,69	0,87	0,22	0,38	0,54
Abruzzo	0,66	0,89	0,21	0,28	0,51
Molise	0,62	0,84	0,21	0,19	0,46
Campania	0,70	0,83	0,21	0,20	0,49
Puglia	0,78	0,82	0,15	0,11	0,47
Basilicata	0,69	0,81	0,14	0,42	0,51
Calabria	0,68	0,81	0,17	0,20	0,46
Sicilia	0,67	0,82	0,18	0,28	0,49
Sardegna	0,70	0,82	0,16	0,30	0,50
ITALIA	**0,74**	**0,87**	**0,24**	**0,37**	**0,56**
North-west	0,79	0,90	0,32	0,30	0,62
North-east	0,83	0,90	0,28	0,47	0,62
Centre	0,71	0,89	0,23	0,47	0,57
South	0,69	0,83	0,18	0,25	0,49

(1) Regional values are obtained as simple averages of provincial values.

Table 3. Correlations across sector-specific efficiency measures (1)

	Health care	Education	Judicial system	Day care
Health care	1.00	0.19	0.33	-0.11
Education		1.00	0.26	0.32
Judicial system			1.00	0.01
Day care				1.00

(1) Measures refer to output efficiency (DEA).

Finally, we compare our baseline measure of total public sector efficiency with other indices, obtained by using different definitions of efficiency and frontier estimation methodologies (Table 4). The results just described for the baseline measure seem extremely robust. In particular, the correlation coefficient between the output-oriented DEA-based efficiency measures and the values obtained by estimating the frontier by means of the parametric approach is 0.86 (Table 5).

Table 4. Total PSE scores (1)

Region (2)	Output efficiency		Input efficiency		Linear efficiency		Deterministic efficiency	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Valle d'Aosta	**0.66**	**1**	0.50	6	0.50	2	**0.78**	**1**
Piemonte	0.65	3	0.54	2	**0.53**	**1**	0.71	**2**
Liguria	0.56	11	0.45	10	0.43	10	0.63	10
Lombardia	0.59	7	0.50	6	0.50	2	0.67	3
Trentino Alto Adige	0.62	4	0.41	15	0.40	16	0.67	3
Veneto	0.59	7	0.51	4	0.50	2	0.67	3
Friuli Venezia Giulia	0.61	6	0.49	9	0.48	7	0.66	7
Emilia Romagna	**0.66**	**1**	**0.56**	**1**	0.49	5	0.67	3
Toscana	0.62	4	0.53	3	0.48	7	0.66	7
Umbria	0.57	9	0.50	6	0.47	9	0.63	10
Marche	0.57	9	0.51	4	0.49	5	0.64	9
Lazio	0.54	12	0.43	11	0.41	14	0.60	12
Abruzzo	0.51	13	0.43	11	0.42	11	0.59	14
Molise	**0.46**	19	0.39	18	**0.39**	18	**0.56**	20
Campania	0.49	16	0.40	17	0.40	16	0.58	17
Puglia	0.47	18	0.42	14	0.42	11	0.57	18
Basilicata	0.51	13	0.43	11	0.42	11	0.60	12
Calabria	**0.46**	19	**0.39**	18	**0.39**	18	0.57	18
Sicilia	0.49	16	0.41	15	0.41	14	0.58	16
Sardegna	0.50	15	**0.39**	18	**0.39**	18	0.59	14
ITALIA	0.56		0.46		0.45		0.63	
North-west	**0.62**		**0.50**		**0.49**		**0.69**	
North-east	0.61		0.49		0.47		0.67	
Centre	0.57		0.49		0.46		0.63	
South	0.49		0.41		0.40		0.58	

(1) Scores refer to overall public sector performance. - (2) Regional values are obtained as simple averages of provincial values.

Table 5. Correlations across measures (1)

	Output-oriented DEA	Input-oriented DEA	Linear efficiency	Deterministic efficiency
Output-oriented DEA	1.00	0.63	0.81	0.86
Input-oriented DEA		1.00	0.79	0.50
Linear efficiency			1.00	0.84
Deterministic efficiency				1.00

(1) Measures refer to overall public sector performance.

3 The determinants of public sector efficiency

What determines the efficiency of a public service? Our hypothesis is that a constant oversight of the citizens and users is crucial in keeping politicians and bureaucrats accountable. However, political participation has the nature of a public good: all citizens benefit from it in a non-rival, nonexcludable way. This is true even for the most basic form of political participation, i.e. the act of voting: as highlighted by the literature on the so-called voting paradox, for narrowly self-interested citizens the costs of going to vote are likely to out-weigh the expected benefits. This is even more true for other more resource-consuming forms of political participation. Widespread altruistic values and a feeling of civic duty are required to provide the needed politicians' oversight. In addition, the institutional set-up influences the degree of politicians' accountability. Decentralized government makes it easier to obtain information on the conduct of public officers and to assess responsibility for inadequate performance and waste of public

money. Decentralization can also have an indirect effect on accountability, by increasing the willingness to participate.

In what follows we first provide a very simple and sketchy conceptual framework in which these ideas are put down a little bit more formally. Then we go from theory to data, describing our cultural variables.

3.1 A simple conceptual framework

To fix ideas we propose a straightforward extension of the retrospective voting model of Barro (1973) and Ferejohn (1987). In this model, the only relevant dimension of political conflict is the agency relationship between citizens and the political decision maker. In particular, there is no conflict of interests among citizens (who are assumed to behave in a coordinated manner), and there are no differences in competence or talent between politicians (so the problem is one of moral hazard).

In a certain province *p* a politician is in charge of providing a service *s*. He can either provide the service in an efficient way, by exerting an effort which costs him C in utility terms, or he can shirk, and provide the service inefficiently, but at no cost for him. However, shirking may have a cost for him in the election day, when he runs against an opponent. Suppose that a fraction *q* of citizens knows that he has shirked. In line with the literature on retrospective voting (Barro 1973, Ferejohn, 1986) we assume that these guys will punish him and vote for his opponent. The uninformed guys will instead randomize between the two candidates. If there are no relevant differences between candidates, this voting rule is quite natural. The incumbent utility is increasing in the fraction of votes that he receives in that province, in particular, it will be equal to:

$$U\left(q+\frac{1-q}{2}\right)-C$$

if he exerts effort in providing the public good, and to

$$U\left(\frac{1-q}{2}\right)$$

if he shirks, where *U(.)* is an increasing concave function. So he will behave if and only if $q > q^*$, where q^* is defined as the unique value of *q* for which:[16]

$$U\left(q+\frac{1-q}{2}\right)-C=U\left(\frac{1-q}{2}\right)$$

Ex ante, citizens can decide whether to acquire information about the actions of the politician. In particular, suppose that they can see whether the politician shirks or not at a cost c_s. If the politician does not shirk, and the public service is provided efficiently, each citizen will get a higher level of utility (say, u^h) than if the politician shirks (say u^l). However, from a purely self-interested point of view, of course, no citizen will find it optimal to acquire information, because he understands that the impact of his vote at the electoral stage will be negligible. As it

16 We stick to the assumption that U(1) C > U(0), so that q* is between 0 and 1.

is customary in the literature on voting, we assume that the overall utility of citizens does not only depend on the efficiency of the public service, but he also has a feeling of duty, so that he gets utility from the very act of getting informed about politics. In particular, the utility of citizen *i* is set equal to:

$$u - X_i(c_s - v_i),$$

where $u = u^h$ if the politician behaves and $u = u^l$ if the politician shirks, *vi* represents the psychic gains that individual *i* gets from participating in politics, *Xi* is an indicator that is equal to 1 if the citizen acquires information and zero otherwise. Moreover, we assume that in the province p *vi* is distributed in the population according to a uniform distribution with support [0; v_p] (so provinces with a higher v_p have a higher degree of civicness). Then it turns out that the fraction of people that acquire information about service *s* in province *p* is equal to $min[0,1\ c_s=v_p]$, and this in turn implies that service *s* will be provided efficiently in province *p* if and only if:

$$1 - \frac{c_s}{v_p} > q^*.$$

In words, service *s* in province *p* will be provided efficiently if c_s is sufficiently low (which we argue that it is more likely to happen if the service is provided by the local government), and/or if v_p is sufficiently high (i.e. if the province is sufficiently imbued of civic values).

One can easily extend the basic framework to take into account another element that is considered relevant to determine PSE levels, namely the quality of politicians (Besley, 2006). While in our basic framework all politicians are purely self-interested, one could introduce a fraction of "good-spirited" politicians who always behave honestly, irrespectively of incentives. Let us set the fraction of "good" politicians equal to π_p, and let self-interested politicians differ with respect to their level of C (which is continuously distributed according to a cumulative distribution function *Fc* (.)), and assume that the quality of the politicians is unobservable, so that an adverse selection component is added to the moral hazard one. In such a framework, the incentives of self-interested politicians change, because behaving honestly has now the further benefit of improving one's reputation in the face of the well-informed guys. In particular, in equilibrium the informed citizens understand that the probability that the incumbent is good, given he exerts effort, is:

$$\frac{\pi_p}{\pi_p + (1 - \pi_p)F_C(C^*)} > \pi_p$$

(while it is obviously 0 otherwise), where C* is the level of C such that

$$U\left(q + \frac{1-q}{2}\right) - C = U\left(\frac{1-q}{2}\right)$$

and the probability of a high effort is $ir_p + (1\ ir_p)Fc(C^*)$, which is decreasing in ^- and increasing in ir_p.[17]

17 Here we do the standard assumption that the informed voters confront the incumbent reputation with the reputation of an outsider chosen at random from the population, and reelect the first as long as his reputation is better.

3.2 Measuring preferences for participation

Measuring political participation and its cultural underpinnings is by no means straighforward. We try to capture the values that favour pro-social behaviour in a polity with two distinct proxies. First, we use survey data on morality taken from the 2004 Bank of Italy Survey on Household Income and Wealth (SHIW). The 2004 wave of the survey concerns a representative sample of the Italian population, consisting of 20,581 individuals (8,012 households). Details about the interviews and data collection procedures are in Banca d'Italia (2006). In a special section it was asked to a subgroup of the sample (about half of respondents) to what extent they deem the following three behaviours acceptable:

a) not paying for one's ticket on public transport;
b) keeping money obtained by accident when it would be possible to return it to the rightful owner (for example, if you found a wallet with the owner's name and address, or if you were given too much change at the supermarket check-out);
c) not leaving one's name for the owner of a car you accidentally scraped while parking;

From the answers to these three questions (legitimacy was reported in a 1 to 10 scale) we get an index of reported "generalized morality". However, one thing is answering survey questions, quite another is actual behaviour. To get around this problem, we also used data on actual altruistic behaviour; in particular, following Guiso et al. (2004), we use the amount of blood donations. Putting together reported and \revealed" altruistic values, we construct an index of generalized morality *(morality)*.

However, pro-social attitudes and values do not automatically translate into political participation. So our next step is to try to capture attitudes toward political engagement. We again exploit the fact that in the 2004 Bank of Italy's survey people were explicitly asked \How interested are you in politics". Four possible answers (Very, fairly, not very, not at all) were possible. Again, to bridge the gap between reported and actual preferences, we also used the amount of newspapers sold in the province (taken from Cartocci, 2007) and turnout for referenda from 1946 to 1989 (again we follow here Guiso et al. 2004). Referendum turnout is a more accurate measure of participative attitudes than election turnout, because patronage motivations are absent (we do not consider post-1989 referenda because, given the existence of a minimum turnout threshold, in recent years abstention has been used by those contrary to the referendum objective as a means to make it fail).

Putting the three together we come up with an index of \interest in politics" *(intpol)*.

As Verba et al. (1995) point out, the willingness to engage in policy is not enough. People willing to participate also need channels in order to be heard by power, and in particular the availability of associations. So we also include in our regression the number of not-for profit associations in the province *(network)*.[18]

3.3 The empirical model

In our theoretical framework, political culture (in particular, the concern of citizens for public affairs) has an impact on efficiency (due to the pressure it puts on politicians). In our empirical analysis we try to capture this link estimating the following equation:

18 Figures are from Nuzzo (2006). We consider both cooperative sociali and associazioni riconosciute.

$$Eff_{s,p} = \beta_0 + \beta_1 morality_p + \beta_2 intpol_p + \beta_3 network_p + \beta_4 pop_p + \epsilon_{s,p},$$

where $Eff_{S,p}$ represents our efficiency measure, for service *s* in province *p; $morality_p$, $intpol_p$, $resources_p$* are respectively our morality, interest in politics, and resources indicators for province *p:* To control for the size of the province, which might be important if there are economies of scale in service provision, we introduce population *(pop_p)* as an additional regressor. We estimate this equation separately for our four sectors.

4 Results

4.1 OLS estimation

In Table 6 we report estimation results. OLS estimates confirm our expectations: the coefficient of our indicator of "interest for politics" appears with the positive sign and is strongly significant in all regressions.

Table 6: OLS estimation by sector - dependent variable: output efficiency (DEA) score (t-statistics in parentheses)

	Health		Education		Judicial system		Day care	
Constant	0.558	***	0.700	***	0.049		-0.601	
	(5.19)		(10.44)		(0.12)		(-1.23)	
Morality	0.003	**	0.002	**	0.002		-0.001	
	(2.29)		(2.56)		(0.33)		(-0.10)	
Intpol	0.005	***	0.002	*	0.017	***	0.011	*
	(3.36)		(1.86)		(3.07)		(1.76)	
Net	-0.003	***	0.001		-0.006		0.024	***
	(-2.78)		(1.21)		(-1.49)		(4.62)	
Pop	0.001		0.000		-0.001		0.002	
	(1.47)		(-0.59)		(-0.22)		(0.62)	
R^2	0.23		0.21		0.11		0.33	
Observations	103		103		103		88	

Instead, generalized morality and the presence of associative networks are often non significant or significant with the wrong sign. It is confirmed that to get an efficient public sector one needs effective and strong political pressure much more than a generic concern for others. As remarked by Putnam, "citizen in the civic community are not required to be altruists", and altruism is neither sufficient nor necessary to participate in politics. To put it bluntly, institutional performance is more a matter of politics than of morals. Inefficient public action in the less developed areas of Italy might have more to do with political apathy and discouragement, with a sense of political ineffectiveness, than to the often quoted "amoral familism" (Banfield, 1958).

4.2 Instrumental variables estimation

While it is plausible that preferences shape political and economic outcomes, one cannot take for granted that preferences themselfs are exogenous. Concerning our subject matter, there are

many reasons why current PSE may influence current interest for politics. Low quality government may indeed breed in some citizens discouragement and apathy with respect to politics, instead of pressures for change.

Ideally, we would like to capture the effects of the truly exogenous components of political values. To this aim, we resort to instrument variables estimation. Given the results form the OLS analysis, we use two parsimonious specifications. In the first one, only our *intpol* variable is taken as explanatory variable. In the second one, we use a composite index of *intpol, morality, networks,* which we label *social capital.*

We instrument our cultural variables with three different sets of variables:

(i) Features of formal political institutions in place in the XIV century (de Blasio and Nuzzo, 2006). The idea here is that while in the medieval *repubbliche* civic liberties and political engagement were flourishing, in the rest of Italian provinces institutional arrangements were characterized by weaker democracies and a less developed political life. In particular, de Blasio and Nuzzo (2006) distinguish other four kinds of government, namely, the dictatorial *signorie,* the absolutist kingdom of the church, the southern *Regno delle due sicilie,* and a residual group of provinces governed by foreign powers.

(ii) Features of formal political institutions in place in the period XVII century - XIX century taken from Tabellini (2005). He builds an index capturing the constraints imposed on the executive authority by the existing constitutional check and balances in pre-unitary Italian States.

The assumption underlying both sets of instruments is that ancient political history still shapes citizens'attitudes toward politics (without having a direct impact on today's PSE, which seems quite plausible).

We also experiment a third set of instruments, namely indices of political and social participation in early XX century, given rispectively by electoral turnout in the last pre-fascism election and by the fraction of people participating in pro-social associations (both are taken from Nuzzo, 2006).

The results for the four service categories are summarized in Tables 7 a-d. The first stage regressions are quite encouraging: most instruments are significant, and together explain a good portion of today's values.

Table 7a: Instrumental variable (2SLS) estimation: Health
(t-statistics in parentheses)

Sets of instruments	1: Political history I				2: Political history II				3: Past political participation			
	Two stages least squares											
Intpol	0.009	***			0.014	***			0.011	***		
	(4.65)				(4,90)				(5,70)			
Soc cap			0.009	***			0.022	***			0.02	***
			(4.98)				(3,95)				(4,60)	
	First stage for political participation											
Repubbliche	1.075		3.506	**								
	(0,51)		(2,18)									
Pontificio	-6.007	**	-1.026									
	(-2,26)		(-0,50)									
DueSicilie	-13.868	***	-8.841	***								
	(-7,12)		(-5,90)									
Periferiche	-0.616		3.698	*								
	(-0,21)		(1,68)									
Limits to executive					4.117	***	2.536	***				
					(6.70)		(4,94)					
Election									0.468	***	0.273	***
									(7.88)		(5,33)	
Associations									0.006		0.01	
									(0.68)		(1,5)	
R^2	0.42		0.43		0.31		0.19		0.46		0.32	
Observations	103		103		103				103			

Variations in the first and in the third set of instruments explain about 40-50 per cent of the variation in *intpol.*

Table 7b: Instrumental variable (2SLS) estimation: Education
(t-statistics in parentheses)

Sets of instruments	1: Political history I				2: Political history II				3: Past political participation			
	Two stages least squares											
Intpol	0.005	***			0.004	**			0.005	***		
	(4.48)				(3.01				(4.17)			
Soc cap			0.006	***			0.006	**			0.007	***
			(4,29)				(3,08)				(4.07)	
	First stage for political participation											
Repubbliche	1.075		3.506	**								
	(0,51)		(2,18)									
Pontificio	-6.007	**	-1.026									
	(-2,26)		(-0,50)									
DueSicilie	-13.868	***	-8.841	***								
	(-7,12)		(-5,90)									
Periferiche	-0.616		3.698	*								
	(-0,21)		(1,68)									
Limits to executive					4.117	***	2.536	***				
					(6.70		(4,94)					
Election									0.468	***	0.273	***
									(7.88)		(5,33)	
Associations									0.006		0.	
									(0.68)		0	
R^2	0.42		0.43		0.31		0.19		0.46		0.32	
Observations	103	103	103		103		103		103		103	

The second stage regressions confirm that political values matter in explaining political outcomes. The component of *intpol* explained by political history has a strongly significant, positive effect on PSE. In all four service categories, the size of the coefficients is larger than that obtained by running an OLS regression, suggesting that maybe instruments partly solve a measurement error problem affecting our independent variables.

Table 7c: Instrumental variable (2SLS) estimation: Judicial system
(t-statistics in parentheses)

Sets of instruments	1: Political history I				2: Political history II				3: Past political participation			
	Two stages least squares											
Intpol	0.027	***			0.024	***			0.025	***		
	(3.85)				(2,94)				(3.81)			
Soc cap			0.028	***			0.038	***			0.041	***
			(3,11)				(2,66)				(3,61)	
	First stage for political participation											
Repubbliche	1.075		3.506	**								
	(0,51)		(2,18)									
Pontificio	-6.007	**	-1.026									
	(-2,26)		(-0,50)									
DueSicilie	-13.868	***	-8.841	***								
	(-7,12)		(-5,90)									
Periferiche	-0.616		3.698	*								
	(-0,21)		(1,68)									
Limits to executive					4.117	***	2.536	***				
					(6.70)		(4,94)					
Election									0.468	***	0.273	***
									(7.88)		(5,33)	
Associations									0.006		0.0	
									(0.68)		11	
R^2	0.42		0.43		0.31		0.19		0.46		0.32	
Observations	103				103				103			

Table 7d: Instrumental variable (2SLS) estimation: Day care
(t-statistics in parentheses)

Sets of instruments	1: Political history I				2: Political history II				3: Past political participation			
	Two stages least squares											
Intpol	0,039	***			0,004				0,030	***		
	(4.38)				(0.31				(3.32)			
Soc cap			0,060	***			0,006				0,044	***
			(5,29)				(0.31				(3,45)	
	First stage for political participation											
Repubbliche	0,716		3,254	**								
	(0,33)		(2,06)									
Pontificio	-5,808	**	-0,878									
	(-2,23)		(-0,42)									
DueSicilie	-14,684	***	-9,344	***								
	(-7,28)		(-5,84)									
Periferiche	-1,808		1,222									
	(-0,53)		(0,45)									
Limits to executive					3,655	***	2,228	***				
					(5.51)		(4,08)					
Election									0,447	***	0,268	***
									(7.23)		(5,11)	
Associations									0,006		0,013	
									(0.51)		(1,45)	
R^2	0,46		0,43		0,26		0,16		0,43		0,32	
Observations	88		88		88		88		88		88	

5 The impact of decentralization

The impact of decentralization on policy-making is of course multifaceted (see for example Treisman, 2002; Rodden, 2006; Lockwood, 2006). On the one hand, it is often emphasized that

local politicians are more easily monitored, so that (using the framework put forward in the previous chapter) c_s is lower if service s is provided by a lower level of government. On the other hand, there might be diseconomies of scale in providing services in a decentralized manner: C could be higher if the service is provided locally. This last point has an obvious impact on incentives: as C is higher for the decentralized providers (let us assume that for each politician the cost of effort is increased by a quantity AC > 0 equal for all of them), q* and C* are higher as well, so that the probability that self-interested politicians will behave in an honest way tends to be lower. Finally, the benefits from decentralization are likely to depend on the quality of the local pool of politicians. All in all, we have that decentralization is beneficial if and only if:

$$(\pi_p - \pi_{mean})(1 - F_C(C^{*dec})) + (1 - \pi_{mean})(F_C(C^{*dec}) - F_C(C^{*cen})) > 0.$$

which can be true or false depending on the parameters, and on the specific characteristics of the province considered. In particular, the first term is positive in areas in which the public spirit is higher than the average, and negative otherwise. The second term is positive if and only if $C^{*dec} > C^{*cen}$ [19], i.e. if the increase in the benefits stemming from honest behaviour due to a stricter citizens'oversight is higher than the increase in the cost of effort, due to diseconomies of scale. To sum up, whether on average decentralized service provision enhances efficiency remains an empirical question.

Moreover, it is not even certain on a priori grounds whether the net benefits of decentralization increase with the degree of civicness. Indeed, while this is true for $(ir_p\ ir_{mean})(1\ FC(C^{*dec}))$, it can be easily shown that $FC(C^{*dec})\ FC(C^{*dec})$ decreases as v_p rises (intuitively, the decrease in c_s due to decentralization is less important in those provinces in which there is a high level of v_p: in these provinces, people monitors politicians' behaviour in any case).

Our data-set allows us to study the impact of decentralization on PSE. Indeed, while some public services in our sample are provided by the Central government, other are provided by Local governments (Regions and Municipalities). Therefore, one way to assess the impact of decentralization is to pool the observations for all sectors together in a single regression, and control for decentralization. Formally, we estimate the following specification:

$$Eff_{s,p} = \beta_0 + \beta_1 morality_p + \beta_2 intpol_p + \beta_3 network_s + \beta_4 pop_p + \beta_5 center_s + \epsilon_{s,p},$$

where *center* is a dummy which is equal to 1 if the service is provided by the Central government (i.e. for justice and education).[20]

By pooling together observations referring to different sectors we impose strong restrictions on the parameters of the empirical model. As a consequence, the R-squared is very low (remember also that the correlations between efficiency measures across sectors are quite low as well). The

19 The two thresholds are defined by the following indifference conditions:

$$C^{*cen} = U(q^{cen} + \frac{1 - q^{cen}}{2}) - U(\frac{1 - q^{cen}}{2});$$
$$C^{*dec} = U(q^{dec} + \frac{1 - q^{dec}}{2}) - U(\frac{1 - q^{dec}}{2}) - \Delta C$$

20 To introduce the center dummy, we replaced in the OLS regression our dependent variable, the ratio of EfffVT to its sector-specific mean with EfffVT itself.

results (shown in the first column of Table 8) confirm that *intpol* is the most important among our explanatory variables. Instead, the government level at which the service is provided does not seem to matter.

Table 8: OLS and quantile estimations - dependent variable: output efficiency (DEA) score (t-statistics in parentheses)

	OLS		Quantile regression: deciles							
			0.1		0.25		0.75		0.9	
Constant	0.268	**	-0.496	**	0.211		0.647	***	0.258	
	(1.93)		(-2.60)		(0.83)		(5.42)		(1.00)	
Morality	0.001		0.007	**	0.003		0.001		-0.001	
	(0.67)		(2.23)		(0.88)		(0.38)		(-0.35)	
Intpol	0.003	*	0.007	***	0.006	**	0.007	**	0.018	***
	(1,62)		(4.17)		(3.05)		(3.05)		(5.45)	
Net	0.001		0.004	**	0.002		-0.001		0.001	
	(0,79)		(2.79)		(1.24)		(-0.64)		(0.65)	
Center	-0.032		0.111	*	0.031		-0.050		-0.120	*
	(-1.12)		(2.56)		(0.69)		(-1.54)		(-1.81)	
R^2	0.02		0.12		0.05		0.05		0.11	
Observations	397		397		397		397		397	

To test whether the mean effects of decentralization on PSE are different from the effects on the lower and the upper tails of the efficiency distribution, we perform quantile regressions. While *intpol* remains the main determinant of PSE at all levels of efficiency, the effect of decentralization (the coefficient of the dummy for Central government provision) is positive and significant for the lower quantiles (Table 8, columns 2 to 5). They become negative (and significant) in the upper part of the efficiency distribution. This suggests that being managed at the central level improves PSE in areas where efficiency is low. In contrast, within the provinces where the quality of public services is higher, decentralized services are more efficient than centralized ones.

6 Conclusions

In this paper we build objective measures of PSE for Italian provinces. Using within country data not only allows to control for differences in formal rules and laws and reduces omitted variable bias, but also gives us the possibility to exploit the unique peculiarities of Italy's extremely long and rich political history. It turns out that, as Putnam (1993) imagined, this history still has an impact on today's italian political life. We find that historically-determined values and attitudes toward politics still influence the quality of Italian public sector, much more than supposedly "amoral" and "selfish" attitudes do.

Our point is that, whatever the level of government involved, a well-functioning government requires active citizens, able and willing to monitor and sanction inefficient politicians. As Putnam puts it: "citizens in civic communities expect better government, and (in part through their own effort) they get it [...] if decision makers expect citizens to hold them politically accountable, they are more inclined to temper their worst impulses rather than face the public protests."

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Tax and economic growth*

By

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Abstract:

This paper investigates the design of tax structures to promote economic growth. It suggests a "tax and growth" ranking of taxes, confirming results from earlier literature but providing a more detailed disaggregation of taxes. Corporate taxes are found to be most harmful for growth, followed by personal income taxes, and then consumption taxes. Recurrent taxes on immovable property appear to have the least impact. A revenue neutral growth-oriented tax reform would, therefore, be to shift part of the revenue base from income taxes to less distortive taxes such as recurrent taxes on immovable property or consumption. The paper breaks new ground by using data on industrial sectors and individual firms to show how re-designing taxation within each of the broad tax categories could in some cases ensure sizeable efficiency gains. For example, reduced rates of corporate tax for small firms do not seem to enhance growth, and high top marginal rates of personal income tax can reduce productivity growth by reducing entrepreneurial activity. While the paper focuses on how taxes affect growth, it recognises that practical tax reform requires a balance between the aims of efficiency, equity, simplicity and revenue raising.

JEL classification codes: H23; H24; H25; O40; O43; C33

Key words: taxation; tax design; tax policy; economic growth; productivity; investment

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1 Summary and conclusion

Tax systems are primarily aimed at financing public expenditures. Tax systems are also used to promote other objectives, such as equity, and to address social and economic concerns. They need to be set up to minimise taxpayers' compliance costs and government's administrative cost, while also discouraging tax avoidance and evasion. But taxes also affect the decisions of households to save, supply labour and invest in human capital, the decisions of firms to produce, create jobs, invest and innovate, as well as the choice of savings channels and assets by investors. What matters for these decisions is not only the level of taxes but also the way in which different tax instruments are designed and combined to generate revenues (what this paper will henceforth refer to as *tax structures*). The effects of tax levels and tax structures on agents' economic behaviour are likely to be reflected in overall living standards. Recognising this, over the past decades many OECD countries have undertaken structural reforms in their tax systems. Most of the personal income tax reforms have tried to create a fiscal environment that encourages saving, investment, entrepreneurship and provides increased work incentives. Likewise, most corporate tax reforms have been driven by the desire to promote competition and avoid tax-induced distortions. Almost all of these tax reforms can be characterised as involving rate cuts and base broadening in order to improve efficiency, while at the same time maintain tax revenues.

This paper focuses on the effects of changes in tax structures on GDP per capita and its main determinants. Focusing on tax structures rather than levels is desirable because cross-country differences in overall tax levels largely reflect societal choices as to the appropriate level of public spending, an issue that is beyond the scope of tax policy analysis. Conversely, investigating how tax structures could best be designed to promote economic growth is a key issue for tax policy making. Yet, in practice, it is hard to completely separate the analysis of the overall tax burden from that of tax structure: countries that have a relatively high level of taxes may also have a tax structure that differs from that of other countries, and the response of the economy to a change in the tax structure varies across countries, depending on their tax level. Even more importantly, fully disentangling the revenue raising function of the tax system from its other objectives, *e.g.* equity, environmental or public health matters is difficult. In order to make the assessment of the effects of the tax structure on economic performance manageable, these objectives are not dealt with in great detail in this study, except when there is a clear trade off between them and tax reforms aimed at raising GDP per capita. Nevertheless, the ways in which governments use the tax system to achieve these other objectives have been extensively studied by the OECD (for instance, see OECD, 2005c, on equity and OECD, 2006d, on the environment).

Most of the discussion on the link between changes in the tax structure and economic performance focuses on the effects on GDP levels. This paper, however, recognises that in practice it may be difficult to distinguish between effects on levels and growth rates. Indeed, any policy that raises the level of GDP will increase the growth rate of GDP because effects on GDP levels take time. Also, transitional growth may be long-lasting, and so it has not proved possible to distinguish effects on long-run growth from transitional growth effects, although some elements of the tax system are likely to have a bearing for long-run growth. For instance, it is possible that taxes that influence innovation activities and entrepreneurship may have persistent long-run growth effects, while taxes that influence investment also can have persistent effects on growth but these will fade out in the long-run. In contrast, taxes affecting labour supply will mainly influence GDP levels. In this spirit, this study looks at consequences of taxes for both GDP per capita levels and their transitional growth rates, with a large part of the

empirical analysis devoted to assessing the effects of different forms of personal and corporate income taxation on total factor productivity growth.

In open economies the design of a national tax system will need to consider the design of tax systems in other countries, since countries are increasingly using their tax systems to improve their ability to compete in global markets. Globalisation may also increase the opportunities for tax avoidance and evasion especially as concerns mobile capital income tax bases. Therefore, the mobility of the tax base plays some part in the design of tax reforms at the national level, and increased international tax policy cooperation among countries may allow for efficiency gains in some areas (for a discussion on this see Box 1).

However, there are important issues that this study addresses only cursorily. First, optimal taxation, or how to minimise the excess burden of taxation, is an important topic that is largely outside the scope of this project, although some references are made to the main insights provided by research in this area. Likewise, tax incidence, or who bears the burden of a tax, is not explicitly addressed in this work, except when it has implications for the way the tax structure affects the determinants of growth.

Second, the transition costs of tax reform are not considered. These include not only the costs to the public administration but also the costs to businesses in adapting to policy changes. In some circumstances, it might also include the costs of 'grandfathering' some of the old tax provisions (or some other form of compensation) if taxpayers have made substantial investments based on the expectation that these provisions would be maintained. The existence of these costs implies that tax reform will only be attractive if it can be expected to produce offsetting gains in economic performance.

Against this background, the analysis in the paper is organised as follows. First, it reviews tax structures and general trends in taxes that are particularly relevant for growth. Second, drawing on theory, existing and new evidence, and the practical experience of member countries, it investigates how the structure of the tax system can have an impact on GDP per capita through its components, labour utilisation and labour productivity. Taking a bottom-up approach, the impact on performance of each of the main categories of taxes (consumption, property, personal and corporate taxation) is discussed and some conclusions are drawn concerning efficient tax design in each of these areas. Third, in the light of this discussion, the final section sketches possible reform avenues for moving towards an overall tax structure that may enhance aggregate economic performance, conditional on the specificities of each country. The proposed framework for describing the main channels through which tax structures affect GDP per capita could in the future be used to identify tax policy priorities in the context of the "Going for Growth" exercise.

1.1 Main findings

General tax trends

- Despite cross-country differences in the tax structure, most OECD countries rely on three main sources of tax revenues: personal and corporate income taxes, social security contributions and taxes on goods and services. During the past three decades there has been a reduction in the share of tax revenues accounted for by personal income tax while the revenue shares of corporate income taxes and social security contributions have increased. The share of consumption taxes in total revenues has declined, with the mix of taxes on goods and services changing noticeably towards greater use of general consumption taxes (mainly VAT) and away from taxes on

specific goods and services. The share of property taxes and environment-related taxes has been fairly constant over time.

- In many OECD countries a change towards flatter personal income tax schedules has occurred, with one of the most pronounced changes in personal income taxation being the reduction in the top statutory income tax rates. In contrast, average workers have not seen their taxes being cut to the same extent. A number of countries have introduced various in-work tax measures to encourage work incentives of marginal workers.

- The reduction in the personal income tax rates has been accompanied by cuts in the corporate income tax rate, partly financed by base broadening in many countries. Likewise, the overall top marginal rate on dividends has decreased mainly as a result of the reduction in the corporate income tax rate. Several countries have introduced tax incentives for investment in research and development.

Broad policy options for reforming the overall tax mix

The tax policy changes that are most likely to increase growth in any particular country will depend on its starting point, in terms of both its current tax system and the areas (such as employment, investment or productivity growth) in which its current economic performance is relatively poor. The discussed reforms should be seen as small tax changes rather than suggesting that shifting the revenue base entirely to one particular tax instrument provides more of a growth bonus since it is probable that there are diminishing growth returns to adjusting taxes.

The analysis in this paper suggests some general policy options that could be considered:

- The reviewed evidence and the empirical work suggests a "tax and growth ranking" with recurrent taxes on immovable property being the least distortive tax instrument in terms of reducing long-run GDP per capita, followed by consumption taxes (and other property taxes), personal income taxes and corporate income taxes.

- A revenue neutral growth-oriented tax reform would be to shift part of the revenue base from income taxes to less distortive taxes. Taxes on residential property are likely to be best for growth. However, the scope for switching revenue to recurrent taxes on immovable property is limited in most countries both because these taxes are currently levied by sub-national governments and because these taxes are particularly unpopular. Hence, despite the advantages of drawing on an immovable tax base in a period of globalisation, few countries manage to raise substantial revenues from property taxes, with returns on housing generally taxed more lightly than returns on other assets.

- In practical policy terms, a greater revenue shift could probably be achieved into consumption taxes. However, with consumption taxes being less progressive than personal income taxes, or even regressive, a shift in the tax structure from personal income to consumption taxes would reduce progressivity. Similarly, shifting from corporate to consumption taxation would increase share prices (by increasing the after-tax present value of the firm) and wealth inequality as well as increasing income inequality by lowering capital income taxation. Such tax shifts therefore imply a non-trivial trade-off between tax policies that enhance GDP per capita and equity, which is likely to be evaluated differently across OECD countries.

- However, changing the balance between different tax sources should not been seen as a substitute for improving the design of individual taxes. Indeed, the reform of individual taxes can complement a revenue shift. For example, broadening the base of consumption taxes is a better way of increasing their revenues than rate increases, because a broad base improves efficiency while a high rate encourages the growth of the shadow economy. More generally, most taxes would benefit from a combination of base broadening and rate reduction.

- Looking within income taxes, relying less on corporate income relative to personal income taxes could increase efficiency. However, lowering the corporate tax rate substantially below the top personal income tax rate can jeopardize the integrity of the tax system as high-income individuals will attempt to shelter their savings within corporations.

- Focusing on personal income taxation, there is also evidence that flattening the tax schedule could be beneficial for GDP per capita, notably by favouring entrepreneurship. Once again, this implies a trade-off between growth and equity.

Possible avenues for tax reforms to enhance the performance of the various drivers of GDP

Labour utilisation

Reforms of labour income taxation will generally have to differ depending on whether the aim is to raise participation or hours worked. Reducing average labour taxes could be desirable for raising participation, while lowering marginal rates may be preferable for increasing hours worked. Any such reform should, however, take into account joint effects with existing benefits, which could affect the effective average and marginal tax rates, particularly for low-skilled workers or second-earners. Also, reductions in the marginal tax rate will lead to greater income inequality. Moreover, the effects of changes in labour taxes on employment are also likely to be dependent on labour market institutions, such as wage-setting mechanisms and minimum wages, which affect the pass through of taxes on to labour cost.

There may also be gains, both in the quantity and the quality of labour supply, from reducing the progressivity of the personal income tax schedule. Estimates in this study point to adverse effects of highly progressive income tax schedules on GDP per capita through both lower labour utilisation and lower productivity (see below) partly reflecting lesser incentives to invest in higher education. Again, this implies a potential trade-off between growth-enhancing tax policies and distributional concerns. However, there may be win-win labour tax reforms in this area. For example, "in-work benefits" increase the income of low-income households, thus reducing inequality, and may also improve efficiency if the gain in labour force participation outweighs the adverse incentives on hours worked by job-holders (as benefits are withdrawn) and on human capital formation (as the returns from up-skilling are reduced) as well as the distortionary costs of the tax increases that are needed to finance the in-work benefits.

Investment

Reducing corporate tax rates and removing special tax relief can enhance investment in various ways.

- Especially, if the primary aim is to reduce distortions that hold back the level of domestic investment and to attract foreign direct investment, reducing the corporate tax rate may be preferable to reducing personal income taxes on dividends and capital gains.

- Evidence in this study suggests that favourable tax treatment of investment in small firms may be ineffective in raising overall investment.

- Lowering the corporate tax rate and removing differential tax treatment may also improve the quality of investment by reducing possible tax-induced distortions in the choice of assets.

- Providing greater certainty and predictability in the application of corporate income taxes may lead to higher investment, which in turn, could enhance growth performance.

Productivity

There are several ways in which tax policy can influence productivity:

- One option is to reduce the top marginal statutory rate on personal income since it has an impact on productivity via entrepreneurship by affecting risk taking by individuals. While empirical research has pointed to conflicting ways in which entrepreneurship could be affected, in this study a reduction in the top marginal tax rate is found to raise productivity in industries with potentially high rates of enterprise creation. Thus reducing top marginal tax rates may help to enhance economy-wide productivity in OECD countries with a large share of such industries, though the trade off with equity objectives needs to be kept in mind. It is also possible that cutting top marginal tax rates could increase economy-wide productivity through composition effects, by increasing the share of industries with high rates of enterprise creation.

- A second option is to reform corporate taxes, as they influence productivity in several ways. Evidence in this study suggests that lowering statutory corporate tax rates can lead to particularly large productivity gains in firms that are dynamic and profitable, *i.e.* those that can make the largest contribution to GDP growth. It also appears that corporate taxes adversely influence productivity in all firms except in young and small firms since these firms are often not very profitable. One possible implication is that tax exemptions or reduced statutory corporate tax rates for small firms might be much less effective in raising productivity than a generalised reduction in the overall statutory corporate tax rate. This reduction could be financed by scaling down exemptions granted on firm size as they may only waste resources without any substantial positive growth effects.

- A widely-used policy avenue to improve productivity is to stimulate private-sector innovative activity by giving tax incentives to R&D expenditure. This study finds that the effect of these tax incentives on productivity appears to be relatively modest, although it is larger for industries that are structurally more R&D intensive. Nonetheless, tax incentives have been found to have a stronger effect on R&D expenditure than direct funding.

- Lower corporate and labour taxes may also encourage inbound foreign direct investment, which has been found to increase productivity of resident firms. In

addition, multinational enterprises are attracted by tax systems that are stable and predictable, and which are administered in an efficient and transparent manner.

Again, it needs to be emphasised that policymakers will need to examine very carefully the trade-off between these growth-enhancing proposals and other objectives of tax systems – particularly equity.

2. Broad trends in taxation in the OECD

The level and mix of taxation vary markedly across OECD countries but there have been a number of common trends. Many countries have cut personal and corporate tax rates while broadening the tax base and increasing social security contributions. Meanwhile, there has been increased use of Value-Added Taxes (VAT) and a general trend to higher VAT rates. The data presented in this section and throughout the paper refer to taxes levied by all levels of government.

2.1 The level of taxation

Between 1975 and 2006, there has been a persistent and largely unbroken upward trend in the ratio of tax to GDP across the OECD area increasing on average in the OECD by over six percentage points of GDP (Figure 1, see Annex 1 for Tables and Figures and Annex 2 for a description of the tax indicators), followed by some more recent signs of stabilisation in the tax revenue in the OECD as a whole. Several countries deviate from this trend. Iceland, Italy, Portugal and Spain all increased their tax to GDP ratios by more than ten percentage points over the period (although all starting from lower than average tax levels), while the increase for the United States was less than three percentage points and the Netherlands experienced a fall in the ratio of over one percentage point. In addition, the Czech Republic, Hungary and the Slovak Republic have reduced their ratios since joining the OECD. Measures of total tax to GDP ratios are routinely used for international comparisons of overall tax burdens, but these measures can be influenced by measurement issues. For example, in some countries transfers to households (such as benefits) are taxed in the same way as earnings, in others they are taxed at reduced rates, consequently affecting the measure of the tax to GDP ratio.[2] Despite these conceptual and statistical problems, it is useful for policy analysis to consider the level and structure of taxation distinctly.

[Figure 1. Tax-to-GDP ratios in the OECD area, 1975-2006]

2.2 The tax mix

Despite some significant differences in the distribution of the tax burden between tax instruments, most OECD countries extract the bulk of revenue from three main sources: income taxes, taxes on goods and services, and social security contributions (other payroll taxes are zero or very small in most countries). The share of total tax revenue accounted for by these three

2 Social expenditure to GDP ratios are also influenced by the tax system because most countries have significant taxes on benefits. Adema and Ladaique (2005) found that adjusting gross social spending for the impact of direct taxation cross-country divergences in aggregate social spending are much smaller than implied by the raw numbers. The implication is that a similar relation would hold in the area of taxation, with raw numbers of tax burdens exaggerating cross-country differences.

main tax instruments has evolved over time (see Table 1 for the unweighted OECD averages). Some of these changes in the tax mix are endogenous while others are policy induced. Globalisation and the increased openness of economies may also be one factor driving the recent trends in taxation in OECD countries (Box 1). The main patterns for the OECD unweighted average over the last thirty years can be summarised as follows, although there are significant variations across countries in both the shares of individual taxes and the trends (Figure 2):

- There has been a reduction in the share of tax revenue accounted for by personal income tax, although the share has been fairly constant in Austria, Greece, Italy and the United Kingdom. In France and Iceland, the personal income tax revenue share has increased considerably.

- There has been a continuously growing share of social security contributions, which by 2005 accounted for 26% of total tax revenues, apart from France, Italy, the Netherlands and Spain where the share has decreased.

- The share of the corporate income tax in total tax revenues has increased in the majority of the OECD countries but not in the large OECD countries (France, Germany, Italy, Japan and the United Kingdom), except in the United States where the revenues have increased since 2005.

- The share of taxes on consumption (general consumption taxes plus specific consumption taxes) has declined gradually, but the mix of taxes on goods and services has changed markedly towards the greater use of general consumption taxes, particularly VAT. However, in Belgium, Denmark, Italy, Norway and the United States, the share of general consumption taxes remained rather constant while it decreased in Austria, France, Iceland and Turkey.

- The share of property taxes (on immovable property, net wealth, inheritances and legal transactions) has been approximately constant but not in France, Ireland, Korea, Luxembourg and Spain where the share has increased by more than 2.5 percentage points since 1980 and in New Zealand where it decreased more than 3 percentage points.

[Table 1. Revenue shares of the major taxes in the OECD area]

[Figure 2. Tax structures in the OECD, 1985 and 2005 (selected countries/areas)]

Box 1. The role of globalisation

Globalisation – the increased openness of economies to trade and investment combined with reduced transport costs and improved communications – has several effects that need to be taken into account in formulating tax policy:

Taxes can affect the costs of producing goods and services, and so change the relative international competitiveness of some sectors, prompting structural changes.

Tourism and cross-border shopping mean that even VAT and sales taxes, which do not normally apply to exports, can influence the demand of foreign residents for domestically produced goods and services.

Personal income taxes can influence workers, particularly those who are highly paid, in the choice of

the country in which they work.

Corporate income taxes can influence the choice of location of factories and offices. The tax system is only one factor among many in improving countries' competitiveness otherwise there would have been a large outflow of capital and activities from high to low tax countries, but there is evidence that location decisions are becoming more sensitive to tax.

These factors mean that individual countries are likely to make different tax policy choices from those they would have made in the past, when there was less mobility. Also, as mobility depends on relative tax rates and is most likely to take place between nearby countries, it also means that groups of countries (such as the European Union) may be differently affected when they co-ordinate tax policy changes than would their individual member countries acting alone.

It is generally assumed that choices related to corporate taxation are most affected by globalisation because of the ease with which multinational enterprises can move the location of at least some of their activities. However, highly skilled workers are also becoming more mobile and some countries are taking this into account in designing their personal tax systems. In contrast, the taxation of lower-skilled workers and of consumption is seen as being less affected by globalisation because these tax bases are less mobile. Finally, the taxation of immovable property is seen as the least affected by globalisation.

The effects of this general ranking can be seen in the discussion of taxation trends in this section of the paper, with tax rates falling most for the more mobile tax bases. The ranking can also be expected to be a major factor driving the empirical results reported in this paper, as countries that ignore the pressures of globalisation may be expected to grow more slowly. But, a shift in the tax structure from mobile income taxes to less mobile taxes, such as consumption taxes, would reduce progressivity since consumption taxes are in general less progressive than income taxes. Therefore, such tax shifts imply a trade-off between growth enhancing tax reforms and equity.

The remainder of this section briefly reviews the most important changes to consumption taxes, property taxes, personal income taxes and corporate income taxes in the past thirty years.

Consumption taxes

As shown above, the main changes to consumption taxes have been the decline in the revenue share of specific consumption taxes (such as the excise duties on alcohol, tobacco and vehicle fuels) and the large rise in revenues from general consumption taxes. The main factor behind the growth of general consumption tax revenues has been the spread of VAT – the United States is now the only OECD country that does not use VAT – and the gradual increase in the rates applied in many countries except in Canada, the Czech Republic, France, Hungary, Ireland and the Slovak Republic (Table 2).

There has also been growing interest in the use of environmentally-related taxes, with several countries introducing new taxes to deal with specific environmental problems. However, as shown in Figure 3, there has not been a general upward trend in their revenues as a proportion of GDP. Excise duties on motor fuels are the largest single source of environmentally-related tax revenue.

[Table 2. The evolution of standard value-added tax rates]

[Figure 3. Revenues from environmentally-related taxes in per cent of GDP]

Property taxes

Despite their general low revenue shares, property taxes remain an important source of revenue in some OECD countries, with the United Kingdom, Korea, the United States and Canada obtaining at least 10% of tax revenue from this source in 2005. This group of taxes are diverse in both their design and their effects, as they include recurrent taxes on immovable property (paid by both households and businesses), taxes on net wealth (paid by both households and corporations), taxes on gifts and inheritance and taxes on financial and capital transactions. The evolution of the OECD average revenues from each of these taxes is illustrated in Figure 4. This shows that recurrent taxes on immovable property – mainly levied at the sub-national level - account for approximately half of total property taxes, while taxes on transactions account for about half of the rest. There are no strong trends in the revenues from any of these taxes as a share of GDP despite short-term variations. As a percentage of GDP, the recurrent taxes on immovable property have increased by 0.5 percentage points or more only in France, Italy, Portugal, Spain and Sweden and decreased by more than 0.5 percentage points in the United Kingdom. The taxes on financial and capital transactions, in percent of GDP, have increased by more than 0.4 percentage points in Belgium, Greece, Ireland, the Netherlands, Spain and the United Kingdom while they decreased by more than 0.4 percentage points only in Japan.

[Figure 4. The evolution of property taxes (as a percentage of GDP)]

Owner-occupied housing is taxed favourably in many countries, as can be seen from Table 3. Imputed rental income is not taxed under the income tax (except in Belgium, the Netherlands, Norway and Sweden), although this should be seen in the context of most countries levying property taxes. At the same time, mortgage interest payments can be deducted from the personal income tax base in many countries, but not in Canada, Germany, France (they became partly deductible in 2007) and the United Kingdom. Some countries, like Belgium and Spain, even allow for a deduction of the principal repayments. Moreover, realised capital gains on owner-occupied houses are often not subject to capital gains tax, though the value of the house is subject to inheritance tax in most countries, except Canada and Sweden. Moreover, some countries levy a high transaction tax on the purchase of houses.

[Table 3. Taxation of residential property, 2002]

Personal income taxes

One of the most marked changes in taxation over the past 25 years has been the steep decline in the top rates of personal income tax in OECD countries (Figure 5). The OECD unweighted average has fallen from 67% in 1981 to 49% in 1994 and 43% in 2006.[3] The largest reductions are observed in Japan (-43 percentage points), Portugal (-42.4 percentage points), the United States (-34 percentage points) and Sweden (-31 percentage points). However, in general, this has not been matched by a reduction in the average income tax levied on the labour incomes of average production workers (Figure 6), where the OECD unweighted average has fallen by less than five percentage points from slightly below 19% in 1985 to slightly above 14% in 2004. This difference has partly been due to the fact that marginal rates at lower income levels have not been reduced so much and partly due to the fact that most countries have not increased tax thresholds in line with the increase in average earnings. The largest reductions are observed in Ireland (-16.2 percentage points), Sweden (-11.6 percentage points) and Denmark (-

3 If the average is only applied to the countries for which data were available in 1981, the 1994 percentage becomes 50 and the 2006 percentage becomes 46.

9.4 percentage points). The average income tax has decreased by more than 7 percentage points also in New Zealand, Turkey and Luxembourg. Since 1985, the average income tax has strongly increased in Iceland (+11 percentage points) and France (+5.7 percentage points). Despite the strong reduction in the top personal income tax rates in Japan, Portugal and the United States, the average income tax rate has decreased (comparing the values in 2004 with 1985) only by 3 percentage points in Japan, 1.3 percentage points in Portugal and 5.3 percentage points in the United States.

[Figure 5. Top statutory personal income tax rates on wage income]

[Figure 6. Average income tax for a single individual at average earnings]

The concentration of personal income tax cuts at the top of the income distribution has been reflected in a reduction of the progressivity of the personal income tax in most OECD countries.[4] The progressivity measure in Figure 7, which compares marginal and average tax wedges for single workers, focuses on taxes at the average wage level. Since 1995, the largest reductions (more than 8 percentage points) are observed in Canada, Iceland, Ireland, France and the Netherlands. This measure does not take into account the impact of tax changes on lower and higher-incomes. In fact in recent years, the tax system has become slightly more progressive when the average tax burden on low and high-income earners is compared. This is mainly the result of the introduction of in-work tax credits in many countries (*e.g.* Finland, France, the United Kingdom and the United States), which have reduced the tax burden on low-income earners more than the reduction in the tax burden on high-incomes caused by the reduction in top statutory income tax rates. Another recent trend in personal income taxation is that some OECD countries, mostly Scandinavian countries, have introduced a dual tax system which taxes personal capital income at low and proportional rate while labour income continues to be taxed at high and progressive rates (Box 2). Several other countries have moved away from comprehensive towards 'semi-dual' personal income taxes.

[Figure 7: Statutory income progressivity for single individuals at average earnings]

Box 2. Dual income tax systems in OECD countries

Finland, Norway, Sweden and to a lesser extent Denmark introduced a dual income tax system in the early 1990s. The purest dual income tax system has been established in Norway. The main characteristics of the Norwegian system in 2005 were:

A flat personal income tax rate of 28% on net income, which includes wage, pension and capital income less tax deductions. The same rate is used for corporate income. This implies:

a symmetrical treatment of all capital income with no double taxation of dividends and capital gains on shares and full deductibility of all interest expenditures. At the same time, double taxation of distributed profits was prevented through a full imputation system. Shareholders were permitted a tax credit against the personal income tax on dividends for the corporate tax that could be imputed to the dividends they have received.

a broad tax base, aiming to bring taxable income in line with true economic income and a

4 The measure of progressivity used is the difference between the marginal and average personal income tax rates, divided by one minus the average personal income tax rate, for an average single production worker. A higher number indicates higher progressivity at the earnings of an average worker.

reduction of the number and the value of tax allowances, as all remaining allowances are deductible only at the flat 28% tax rate.

Progressive taxation of wage and pension income in addition to the flat rate, by means of surtax on gross income from wages and pensions above a certain threshold level. The highest surtax rate on wages and pensions was 13% when the tax reform was implemented in 1992; it increased to 19.5% in 2000 and it decreased to 15.5% in 2005.

In order to ensure an equal tax treatment of wage earners and the self-employed, the dual income tax system splits the income of the self-employed into a labour income component as a reward for work effort and a capital income component, which is the return to the savings invested in the proprietorship. The part considered as labour income is taxed according to the progressive rate schedule, while the part considered as capital income is taxed at the flat rate. This so-called split-model imputes a return to the capital invested and categorizes the residual income as labour income (Sørensen, 1998).

In general, the main problems with the dual income tax system are twofold. First, dividends and capital gains on foreign shares are often taxed more heavily than dividends and capital gains on shares in domestic companies (for instance because the imputation credit is provided only to domestic shares). A second problem of dual income tax systems arises because of the large difference in top marginal tax rates on labour and capital income. This difference provided taxpayers with a tax-induced incentive to have their income characterised as capital income rather than as labour income, for instance by incorporating themselves. These income shifting problems are observed in most countries where the tax burden on capital income deviates from the tax burden on labour income. The fact that social security contributions are often levied only on labour income just strengthens the income shifting.

In practice, a majority of OECD countries may be characterized as having 'semi-dual' income tax systems, which are defined as tax systems that use different nominal tax rates on different types of income, typically by taxing some forms of capital income at low and often flat rates and remaining forms of income at higher and progressive rates. An example is the Box system in the Netherlands, which was introduced in 2001. The tax reform reduced the tax rates and broadened the base, replaced tax allowances by tax credits, replaced the wealth tax and the taxation of personal capital income with the taxation of an imputed income from capital. Instead of a tax on the actual return on saving income, a 30% proportional tax rate is applied on a notional return of 4% on the net value of the assets owned by the shareholder. This presumptive capital income tax, which ensures that all forms of personal capital income are taxed equally, is therefore equivalent to a tax on net wealth of 1.2%. Progressivity is obtained through a basic tax-free allowance.

Source: OECD (2006b): "Fundamental Reform of Personal Income Tax".

Social security contributions

All OECD countries except Australia and New Zealand levy compulsory social security contributions on labour income, in addition to personal income tax. As noted above, there has been a general upward trend in these contributions. This has resulted in a smaller reduction in the overall taxation of labour income than would be observed by considering personal income taxes alone. Figure 8 shows the evolution of the tax wedge (incorporating both social security contributions and personal income tax)[5] applied to the earnings of the average production worker. The OECD unweighted average has fallen by less than one percentage point from 1985 to 2004, much less than the fall in personal income tax of about 5%, noted above. Even though the OECD average has hardly changed over this period, the tax wedge for the average production worker declined by more than 5 percentage points in Denmark, Ireland, Luxembourg, New Zealand, the Netherlands and the United Kingdom. Meanwhile, the tax wedge increased by more than 5 percentage points in Australia, Canada, Germany, Iceland, Japan and Turkey.

5 The tax wedge measures the amount of personal income tax, employees' and employers' social security contribution and payroll taxes less cash benefits as a proportion of labour costs, defined as the wage plus employers' social security contributions and payroll taxes.

[Figure 8: Tax Wedge for single individual at average earnings]

A few OECD countries (*e.g.* Australia, Austria and Canada) levy payroll taxes (also included in the tax wedge), which are similar to employers' social security contributions but do not give an entitlement to social benefits. The amounts of revenue involved are generally small and do not show any particular time trend.

Taxes on corporate income

The reduction in personal income taxes has been accompanied by cuts in corporate tax rates. Since 1994, the largest rate reductions have been implemented in Hungary (-16 percentage points), the Czech Republic (-18 percentage points), Italy (-20 percentage points), Poland and the Slovak Republic (-21 percentage points), Turkey (-26 percentage points) and Ireland (-27.5 percentage points). The corporate tax rate has increased only in France and Finland (+1.1 and +1 percentage point respectively) (Figure 9). In the OECD area, the unweighted average corporate tax rate has dropped from 47% in 1981 to 40% in 1994 and 27.6% in 2007. The corporate tax rate reductions have been partly financed by corporate tax base broadening measures in many countries -- for instance through the implementation of less generous tax depreciation allowances, the reduction in the use of targeted tax provisions and stricter corporate tax enforcement policies enacted by OECD countries.[6] As the rate cuts were not fully financed by reductions in depreciation allowances, effective tax rates also fell although, as noted earlier, corporate tax revenues have tended to increase reflecting, inter alia, rising corporate profits. This increase in corporate profits is partly a result of increased incentives for businesses to incorporate, especially in the European Union (De Mooij and Nicodème, 2007). The revenue effects of lower corporate tax rates will therefore partly show up in lower personal income tax revenues rather than lower corporate income tax revenues (OECD, 2007b).

[Figure 9. Statutory corporate income tax rates]

The rate of taxation on dividends combines features of both the personal and corporate tax systems. It has been of particular interest in recent years, given the policy focus on the relevant advantages, disadvantages and methods of integrating corporate and personal level taxation of distributed income. Figure 10 reports the top marginal tax rates on the distribution of domestic source profits to a resident individual shareholder, taking account of the fact that profits are usually taxed both at the corporate level and again when they are distributed as dividends (although double taxation may be reduced by introducing imputation systems, tax credits or reduced tax rates on dividends).

Many European countries have moved away from full imputation systems to systems where dividends are taxed at a lower rate at the personal level.[7] Germany introduced the so-called half-income system in 2002, whereby 50% of dividends are taxed as personal income.[8] Several other countries have introduced or are introducing similar partial inclusion systems where some

6 Some OECD countries (*e.g.* the United States and Mexico) have implemented an alternative minimum tax, which is a tax that eliminates many tax reliefs and so creates a tax liability for an individual or corporation with high income who would otherwise pay little or no tax.

7 Under a full imputation system, dividends paid by a resident firm out of income that has already borne company tax can be passed on to resident shareholders by giving imputation credits for company tax paid

8 This was abolished in Germany as part of the 2008 corporate tax reform.

proportion of dividends are taxed as personal income, *e.g.* Finland, France, Italy, Portugal and Turkey.

[Figure 10. Overall statutory rates on dividend income (2000 and 2007)]

On average, the top marginal tax rate on dividends in OECD countries was reduced by more than 7 percentage points between 2000 and 2007 to 43% (Figure 10). The largest part of this reduction is attributable to the reduction in the corporate income tax rate. The part of the tax that is paid as corporate income tax has decreased by more than 5 percentage points to 27.6% on average in the OECD. A smaller part of the reduction in the statutory tax burden on dividends is due to the decrease in personal income tax rates.[9] Since 2000, the top marginal tax rate on dividends has increased only in Finland and Norway (as a result of the introduction of the partial inclusion system in Finland and the allowance for shareholder equity tax system in Norway) and in Korea.

In many countries, interest payments are taxed at the household level at higher rates than dividends in order to (partly) offset the corporate tax rate that has been levied on equity income while interest payments are deductable from the corporate tax base (Table 4). Also, capital gains are taxed at the household level differently from dividends in many OECD countries (see Section 3 below).

[Table 4. Taxes on capital income taxation at the household level in selected OECD countries (2004/2005)]

In the OECD, ten countries levy a reduced corporate income tax rate on the profits of small businesses that are below a certain ceiling (Table 5). In order to benefit from the reduced rate, other conditions have to be fulfilled as well. In some countries, small businesses benefit from other special corporate tax provisions, such as expensing of investments.

[Table 5. Standard and reduced (targeted) corporate income tax rate for small businesses (2005)]

A growing feature of corporate tax systems is the use of tax credits or special deductions for research and development (R&D) expenditures. These are now available in more than half the OECD countries. Figure 11 reports the value of the tax subsidies for R&D that is provided by these measures.[10] Norway, the Czech Republic, Portugal, Mexico and Spain are the countries that provide the most generous R&D tax treatment. Some countries provide more generous tax subsidies for R&D in small- and medium-sized enterprises than for large companies. This is especially the case in Canada and the Netherlands.

[Figure 11. Tax subsidies for one US$ of research and development in OECD countries 2007)]

9 The reduction of the effective tax rate was 10.8 percentage points in the United States, due to the recent introduction of a reduced tax rate on dividends at the personal level.

10 Figure 11 shows a negative value for tax subsidies in some countries. This is because the baseline of the definition (which gives a value of zero for the measure) represents the immediate deductibility of the capital costs for R&D from the corporate tax base (immediate expensing), which is more generous than the typical tax treatment given to capital costs for other activities. Therefore, a negative value in the figure does not imply that the tax treatment of R&D is less favourable than for other forms of investment.

3 Effects of different taxes on GDP per capita

As discussed in the previous section, there are large differences in both tax levels and tax structures across OECD countries. Economic theory suggests that these differences may play a role in explaining differences in economic performance. The structure of the tax system can have an impact on GDP per capita by affecting the amount of hours worked in the economy (labour utilisation), and the amount of output that is produced per hour (labour productivity) or both. However, it is generally difficult to assess the overall effect of a tax reform on output performance for several reasons. First, changes in any single tax may simultaneously affect several determinants of GDP per capita. For instance, a reduction in the average labour tax may increase employment (ultimately affecting labour utilisation) but at the same time it increases the opportunity cost to undertake higher education and, assuming progressivity is not influenced, therefore reduces incentives to invest in education (ultimately affecting labour productivity). Second, tax reforms typically involve changes in several kinds of tax instruments at once, with complementary or offsetting effects on the determinants of GDP per capita. Third, the effects of changes in taxation often depend on the design of other policies and institutions. Thus, the adverse effect of labour taxes on employment is typically dependent on wage-setting institutions, including minimum wages, which affect among other things the pass through of taxes on to labour cost.

This section focuses on the influence that the design of the different taxes - consumption, property, personal and corporate taxes - can have for GDP per capita levels and growth rates. The described effects are partial, since the effect of one tax on GDP per capita and its determinants are assessed holding all other taxes constant. Section 4 explores the combined effects on GDP per capita of changes in several tax instruments as well as their joint effects with policies and institutions that are country-specific. Throughout the analysis, a bottom-up approach looking at the influence of one tax on the various determinants of GDP will be used (as sketched in Figure 12). Two important limitations with this approach are that an empirical comparison of the magnitudes of the different tax effects on economic performance is not possible and that not all potential joint effects between different taxes or between taxes and institutions may be fully explored.

[Figure 12. Taxes affect the determinants of growth]

An alternative to this "bottom-up" analysis would be to develop simulation or general equilibrium models. These models have the advantage that they often have a detailed description of the magnitude of the effect of the various kinds of taxes on different categories of taxpayers and account for the inter-linkages between different markets. But most often these models are designed on a country specific basis and the parameters of the model are calibrated to replicate the dynamics of a specific country. Therefore, these models are useful for assessing the effects of tax reforms in individual countries, but they are not practical for cross-country analysis since it is difficult to develop and empirically calibrate a model that takes into account the structure and dynamics of a large number of countries. In addition, the dynamics of these models can be difficult to interpret and often only very long-term relationship can be discussed.

3.1 Consumption taxes

Consumption taxes can be categorised as either general consumption taxes, typically VAT or sales tax (which are applied on a broad range of goods and services), or specific consumption taxes, such as excises and import duties, which are applied on a limited number of goods and

services. In general, consumption taxes and particularly VAT are often thought to have a less adverse influence on the decisions of households and firms and thus on GDP per capita than income taxes. However, these advantages have to be balanced against equity concerns that arise from their lack of progressivity.

Consumption taxes are neutral to saving…

Since consumption taxes apply the same tax rate on current and future consumption (provided that tax rates are constant over time) they do not influence the rate of return on savings and individual's savings choices as income taxes do. Hence, consumption taxation is often seen as favouring private savings relative to income taxation. However, the empirical evidence on the sensitivity of private savings to after-tax interest rate changes is inconclusive: some studies found sizeable effects of interest rates on savings while other studies found no effects at all (*e.g.* Hall, 1988; Summers 1982). In an open economy with mobile capital, any changes in private savings are likely to over-state the resulting change in the capital stock, and hence GDP. Nonetheless, increased private savings can be expected to increase future net national income, provided that budgetary policy remains stable and allows the savings to flow into (possibly foreign) income-earning investments.

…but they may affect employment and hours of work in the same way as income taxation.

Because they lower the purchasing power of real after-tax wages, consumption taxes may curb labour supply in much the same way as a proportional income tax. Consumption taxes can also reduce labour demand in the short-term if they add to wages and labour cost.[11] The extent and persistence of this effect depends on labour market settings (*e.g.* bargaining systems). The empirical evidence of the impact of consumption taxes on labour supply and employment is sparse. Most empirical studies that assess the effect of taxation on employment exclude consumption taxes from the relevant wedge (*e.g.* Pissarides, 1998, Bassanini and Duval, 2006). However, some recent studies that include the consumption tax in the overall labour tax wedge find that a rise in this wedge reduces market work, though no separate effect of consumption taxes on employment is estimated (*e.g.* Nickell, 2004).

Differentiated consumption taxes can encourage work...

The pattern of consumption taxes can also affect labour supply. Relatively high consumption taxes on goods complementary to leisure (such as golf clubs) encourage work, as can relatively low consumption taxes (or even subsidies) on goods complementary to work (such as child care). Corlett and Hague (1953) show that the benefits of (sufficiently small) non-uniformities in taxation outweigh the harm of distorting consumer choice. It can be shown (Heady, 1987) that this is a generalisation of the famous 'inverse elasticity rule' derived by Ramsey (1927) that can also be used to justify (aside from public health considerations) the high taxes that are often applied to alcohol and tobacco products. In practice, it is difficult to clearly identify those goods for which the efficiency gain of taxation at a special rate outweighs the additional administrative and compliance costs. So, as argued by Ebrill *et al.* (2001), the few goods for which it can be justified are probably best dealt with by special excise taxes or (in the case of child care) subsidies rather than by a multi-rate VAT or sales tax system.

...and can yield environmental benefits...

11 Short-term inflationary effects may influence wages and labour cost, but what matters for long-run employment is the total tax wedge and what matters for long-term inflation is monetary policy.

Specific consumption taxes that penalise the production and consumption of "bads" can improve environmental outcomes while generating revenues that can be used to offset other taxes on, for example, labour. Examples are excise duties on petrol and diesel. A similar argument can be made for "bads" that affect consumers' health, with potential social externalities (*e.g.* tobacco or alcohol), though the extent of such externalities is controversial (*e.g.* Jeanrenaud and Soguel, 1999; Guhl and Hughes, 2006).

...but are an inefficient way of reducing income inequality..

Many OECD countries use differentiated consumption taxes to reduce inequality by exemptions and zero ratings on certain goods and services, for instance, basic groceries. The reduced efficiency linked with VAT exemptions should be weighed against the benefits associated with the public policy of exempting these goods and services. Deaton and Stern (1986) show that direct lump-sum payments to households, depending only on their socio-economic characteristics, are better for both equity and efficiency, while Ebrill *et al.* (2001) argue that direct targeted transfers to low-income households are more effective in enhancing equity than VAT exemptions/zero-ratings. The reason is that higher income households consume relatively more of the low-taxed goods and therefore will benefit more from the lower rates than low-income households.

…and would not be a solution to the underground economy…

A high uniform consumption tax, such as VAT, will encourage certain easily hidden activities to move into the underground economy. Some countries have taken the view that the way to deal with this is to apply a lower rate of tax to the goods and services these activities produce. However, it is difficult to exactly identify the goods and services that fall into this category, especially since many consumer purchases can be made with cash. Also, it should be noted that even the underground economy pays a non-zero rate of VAT as it is unable to reclaim the VAT paid on its inputs. In these circumstances it may be administratively easier to counter the incentive to enter the underground economy by a combination of avoiding excessively high rates of tax, having a fairly high VAT threshold and a well-targeted audit programme than by a multi-rate VAT system. Moreover, the introduction of lower rates risk being a slippery slope, likely triggering rent-seeking activities by producers of other goods and services also wishing to be covered by reduced rates.

…so the argument for single rate VAT is strong.

Overall, therefore, there are valid arguments for the use of specific consumption taxes in particular cases, mainly related to the environment and work incentives. However, the arguments related to equity are much weaker, because alternative approaches to the problem are more effective. Also, none of the arguments provide against a broad-based single-rate VAT or sales tax. Indeed, they suggest that such a tax should be the main source of consumption tax revenues.

One measure of the broadness of the tax base, the extent of reduced rates and the effectiveness with which taxes are collected is the so-called "C-efficiency" for VAT, which expresses the revenue collected from the actual VAT in a countries as a proportion of the revenue that would be raised if the main rate of VAT were applied to all consumption. A high ratio suggests a uniformly applied VAT on a broad base with effective tax collection while a low ratio may indicate an erosion of the tax base either by exemption or reduced rates, poor compliance or poor tax administration or a combination of these. In 2003, this ratio varied between 100% (New Zealand) and 31.8 % (Mexico) (Figure 13).

[Figure 13. C-efficiency for VAT (Average 2002-2004)]

The international dimension

It is also important to consider the international dimension when assessing the advantages and disadvantages of consumption taxes. Higher consumption taxes in one country may induce individuals to consume in countries with lower taxes, though cross-border shopping is relatively small-scale except in cases where large population centres are close to a border or the tax differences are very large (which happens most commonly for excise duties on tobacco and alcohol). However, consumption taxes have the advantage of mainly being 'destination based', so that the taxes are refunded on exports and applied to imports. Thus, aside from cross-border shopping (including some cases of e-commerce sales to final consumers), VAT and other destination-based consumption taxes do not affect the pattern of international trade.[12]

3.2 Taxes on property

Property taxation in OECD countries takes four main forms: recurrent taxes on land and buildings, taxes on financial and capital transactions, taxes on net wealth and taxes on gifts and inheritances. These taxes generally share the aim of taxing the relatively wealthy and reducing inequality. However, they vary widely in their effectiveness and their distortionary costs.

Recurrent taxes on land and buildings have a small adverse effect on economic performance...

Recurrent taxes on land and buildings (especially residential buildings) are generally argued to be more efficient than other types of taxes in that their impact on the allocation of resources in the economy is less adverse. This is because these taxes do not affect the decisions of economic agents to supply labour, to invest in human capital, to produce, invest and innovate to the same extent as some other taxes. This conjecture is supported by the new empirical work undertaken in this project (see Section 4). Another advantage of property taxes is that the tax base is more stable and the tax revenue generated from this tax is therefore more predictable than for revenues obtained from labour and corporate taxes, partly due to less cyclical fluctuation in property values (*e.g.* Joumard and Kongsrud, 2003). Also, as real estate and land are highly visible and immobile these taxes are more difficult to evade, and the immovable nature of the tax base may be particularly appealing at a time when the bases of other taxes become increasingly internationally mobile. Property taxes also encourage greater accountability on the part of government, particularly where they are used to finance local government. Property taxes, with regular updating of valuation (which, with modern technology, is now feasible), can also increase the progressivity of the tax system (for example, by the exemption of low value properties), provided that special arrangements are made to reduce the liquidity constraints that the tax may imply for the relatively small number of people with low incomes and illiquid assets.

…and they could contribute to the usage of underdeveloped land…

The design of property taxes on land and buildings can also be used as an instrument to affect land development and land use patterns. For example, low taxes on vacant property and

12 Recently there has been an increasing trend in VAT fraud linked to international trade, taking advantage of tax refund on exports from one country to another, so called "carousel fraud". This has involved substantial revenue losses for some (mainly European Union) countries and has resulted in the introduction of a number of strong measures to improve enforcement.

undeveloped land can encourage the under-utilisation of land which may lead to a reduced supply of land for housing particularly in urban areas.[13] Linking the assessment value to market value may increase incentives for developing land as market prices also reflect the development potential of land. But, in many OECD countries the assessment values of land lag substantially behind the actual development in land prices generating gaps between taxable land values and current land prices, which are politically difficult to close (*e.g.* Finland, the United Kingdom).[14]

...while preferential housing tax treatment may distort capital flows

As described in Section 2, owner-occupied housing has a favourable tax treatment relative to other forms of investment in many OECD countries through reduced tax rates or exemption for imputed rental income, mortgage interest payment deductibility and exemptions from capital gains tax. While the favourable treatment of owner occupation is often justified by the specific nature of housing and the positive externalities for society associated with its consumption (OECD, 2005a), they may distort the flow of capital out of other sectors and into housing. They can also reduce labour mobility and thus the efficient allocation of labour. In these circumstances, raising taxes on immovable property could improve economic efficiency and growth. The distortion between housing and other investments should be removed by taxing them in the same way: taxing the imputed rent and allowing interest deductibility. However, most OECD countries do not tax imputed rent at all, while those that do often under-estimate the rental value. In such circumstances, the denial of mortgage interest relief and the use of property taxes can provide a 'second best' approach, though local government control over property taxes makes it difficult in many cases to implement this approach in a co-ordinated fashion.

By contrast, taxes on financial and capital transactions are highly distortionary...

It is always less distortionary to tax the income and services provided by assets than the transaction involved in acquiring or disposing of them. This follows from the Diamond and Mirrlees (1971) result that taxes on intermediate transactions are inefficient, in the sense that the same revenue and distributional effect can be obtained at a lower distortionary cost by taxing income (including capital income) or consumption (consumption of housing services). The lower distortionary effect arises because both transaction taxes and taxes on income/consumption discourage the ownership of the assets, but the transaction taxes have the added distortionary cost of discouraging transactions that would allocate these assets more efficiently. For example, they discourage people from buying and selling houses and so discourage them from moving to areas where their labour is in greater demand. In fact, the distributional effects of transaction costs are probably also less desirable, as the tax falls more heavily on people who trade more frequently, such as people who need to move frequently for their jobs. Nevertheless, governments have found these taxes attractive for two reasons: they are relatively easy to collect and they compensate for the difficulties of applying VAT to the financial sector. Capital gains taxes, which are paid only upon realisation, suffer from some of the same shortcomings as taxes on intermediate transactions.[15]

...net wealth taxes are potentially less distortionary...

13 For instance, in the Barker Review (Barker, 2006) of the land use planning system of England a set of recommendations dealt with the more efficient use of land where, among other things, changes were suggested to encourage business property to be kept in use and to provide incentives for the use of vacant previously developed land.

14 In many countries, these taxes are set at the local level which adds to the difficulty to reform them.

15 However, as discussed in Section 3.3, below, capital gains taxes also have advantages.

In principle, net wealth taxes can be used to redistribute income from the wealthy if they are based on total net wealth and have an exemption level that is high enough to exclude the life-cycle savings of all but the wealthy. They are also a very useful backup to personal income taxes since they provide tax authorities with information that enables them to identify inconsistencies between income flows and wealth held by taxpayers. However, these taxes discourage savings of the people to whom they apply, and may encourage people to move their wealth offshore, though these arguments apply just as strongly to taxes on transactions (which also distort the allocation of assets, as explained above). In practice, net wealth taxes often exempt certain assets, such as pension fund assets, thus distorting the portfolio choice and providing a method of tax avoidance: borrowing money (that will reduce net wealth) to purchase tax exempt assets.

...and inheritance taxes are even less distortionary.

Inheritance taxes are rather like net wealth taxes, except that they are levied only at the end of a person's life. This has the advantage of avoiding the taxation of most life-cycle savings. Inheritance taxes may also be seen as a way of taxing income or capital gains that were not taxed while the person was alive. Also, as argued by Auerbach (2006), these taxes have less distortionary effects than annual wealth taxes because a large part of inheritances are unplanned (being a hedge against the uncertain date of death). As with wealth taxes, it makes sense to have an exemption level that avoids taxing the majority of people who leave small inheritances. This reduces the number of people affected without losing much of the potential revenue. As one method of avoiding this tax is to make gifts during one's lifetime, a gift tax is a useful anti-avoidance measure although it could reduce growth by delaying the transfer of assets between generations. Most countries that have an inheritance tax, levy it on the inheritors, as a function of their individual inheritance but a few levy it on the value of the deceased person's estate. The advantage of levying it on the individual inheritor is that: *i)* it encourages distribution of wealth to larger number of inheritors, each of whom has a personal exemption; and *ii)* it allows the rate to vary between different inheritors.

These brief descriptions demonstrate the wide variety of property taxes and their effects on economic efficiency. One important set of differences between them is the way that they treat different classes of assets differently, including the different treatment of real and financial assets. Recurrent taxes on immovable property obviously affect only one class of real assets, while net wealth taxes typically exempt certain types of assets, particularly pension rights but sometimes other assets as well. Also, taxes on financial and capital transactions usually apply lower rates to financial transactions than they do to the transfer of land and buildings. It is generally thought that differences in tax treatment within a class of closely substitutable assets cause greater changes in behaviour. For example, financial assets are generally more substitutable for each other than are real assets and so are more responsive to differences in tax treatment. However, this does not necessarily mean that differences in tax treatment between financial assets are more damaging for growth, as the mix of financial assets may be much less important for growth than the mix of real assets, for example between housing and business assets.

3.3 Personal income taxes

This section focuses on personal income tax and social security contributions, as these are the main ways in which incomes are taxed in OECD countries, and examine their impact on GDP. The following aspects of these taxes are examined: average and marginal tax wedges; tax progressivity; top marginal income tax rates; effective taxes on returning to work and extending hours of work; and taxes on capital income.

Average and marginal tax wedges are likely to affect labour utilisation and productivity

Taxes on labour such as personal income taxes and employers' and employees' social security contributions can potentially have adverse effects on labour utilisation by affecting both labour supply and labour demand (see Box 3 for an overview of recent OECD evidence). Labour taxes affect labour supply through both the decision to work (the extensive margin) and average hours worked (the intensive margin) (for an overview see Meghir and Phillips, 2007, Koskela, 2002). A decrease in labour taxes can have both a substitution and an income effect[16] on participation and hours worked, with the net effect on labour supply being an empirical matter. Labour taxes also influence firms' cost of labour especially when the tax burden cannot be shifted on to lower net wages. In this case, lower taxes bring down labour costs and firms respond by increasing labour demand (Nickell, 2004; Koskela, 2002; Pissarides, 1998; Layard *et al.* 1991).[17] In equilibrium, employment and average hours worked can, therefore, be affected by changes in personal income taxes and contributions.

It has been argued (*e.g.* Disney, 2004) that social security contributions have a smaller impact on labour supply than other taxes because the eventual social benefits that workers receive are related to the amount of contributions that they have paid. However, in many countries there is only a loose relationship between the amount of social security contributions paid and the amount of benefits received. Indeed, the empirical analysis for this paper found only weak evidence that employees' social security contributions have less of an impact than personal income taxes in terms of reducing GDP per capita.[18] One reason for the difficulty to identify such differential effects in the data could be that the relationship between contributions and benefits varies widely across OECD countries. As well, repeated reforms in social security schemes have sometimes made the link between contributions and benefits even less evident, increasing the tax character of contributions.

Empirical studies have found hours worked to be only modestly responsive to labour taxes while participation is much more responsive to them (*e.g.* Heckman 1993; Blundell *et al.* 1998). Most empirical studies also find that the estimated elasticity of hours worked with respect to the after-tax wage is very small (close to zero) for men while for women/second-earners it is positive (Blundell and MaCurdy, 1999; Klevmarken, 2000; Evers *et al.* 2006; Alesina *et al.* 2005b; Causa, 2008). As women tend to be more responsible for child care or other non-market activities (providing therefore a closer substitute for market work than is the case for men) the labour supply decision of women tends to be more responsive to taxes than that of men. Studies looking at employment in various partial equilibrium models controlling for other institutional characteristics have found that high labour tax wedges curb employment by raising labour costs

16 The substitution effect of a decrease in labour taxes would increase labour supply as the reward for additional work has increased, while the income effect would reduce labour supply as it increases household income and thus increases the demand for leisure.

17 There is evidence that high labour taxes at the lower end of the earnings distribution price low-skilled, low-productivity workers out of work, especially when these taxes interact with relatively high (statutory or contractual) minimum wages, since this limits the possibility of increases in non-labour costs being passed onto lower net wages (OECD 2007a).

18 Attempts have been taken to empirically assess the effect of social security contributions on GDP per capita by splitting personal income taxes into social security contributions and other personal income taxes. In some of these regressions, there was some indication that social security contributions are less harmful to GDP per capita than personal income taxes, with this difference being primarily driven by the less adverse effects of social security contributions levied on employees. Although these findings were significant in some specifications, they were not robust to slight changes in the sample or year coverage, or to minor redefinitions of the indicators.

(Daveri and Tabellini, 2000; Koskela, 2002; Nickell *et al.* 2003; Prescott, 2004; Nickell, 2004; Bassanini and Duval, 2006).[19]

To the extent that labour taxes affect the relative price of capital and labour this could lead to a reallocation of inputs within and between firms and/or industries that could have transitional growth effects. For instance, a change in the relative factor price could lead to less usage of one of the production inputs (or possibly both) in a firm and/or industry. It is possible that all inputs not used in this firm/industry are either re-allocated to other less productive firms/ industries or not used at all, thereby lowering the efficiency in the use of production inputs, *i.e.* the so-called total factor productivity (TFP) growth.[20] Indeed, new empirical results based on industry-level data for a sub-set of OECD countries, find some evidence that employer and employee social security contributions (SSC) negatively influence TFP. The analysis also provides weak hints that this effect tends to be stronger in countries with sizeable administrative extension of collective wage agreements (for details see Box 4).

Box 3. Existing OECD evidence on the effects of personal income taxes

The 2007 reassessment of the OECD Jobs Strategy explored the direct impact of taxation and possible interactions between taxation and other policies on employment and unemployment (the extensive margin of labour supply). After controlling for other policies (*e.g.* product market regulations, employment protection legislation, union density and corporatism, childcare and leave weeks) the tax wedge between labour cost and take-home pay is found to have a negative effect on the employment rate: According to the results from the baseline specification, in the study a ten-percentage-points reduction of the tax wedge in an average OECD country would increase the employment rate by 3.7 percentage points (OECD, 2005b). Furthermore, tax incentives for second-earners to start working, either full or part-time, are found to have a significant impact on prime-age female employment rates.

Family taxation may discourage labour market participation of second-earners due to effectively heavier taxation of married women relative to that of men and single women in many OECD countries (Jaumotte, 2003). The high effective taxation of second-earners is partly explained by the existence of a dependent spouse allowance and of other family-based tax measures in many OECD countries, which are lost if both spouses work. Taxes also influence female participation through the progressivity of the income tax system which is likely to reduce employment and hours worked of second-earners in the case of joint family taxation.[1]This suggests that a more neutral tax treatment of second-earners could raise female participation. A combination of taxes and certain means-tested benefits such as child tax credits can create so-called "inactivity traps" where available employment opportunities become financially unattractive. In such cases an increase in gross in-work earnings fails to translate into a sufficient net income increase to justify starting work due to higher taxation and benefit withdrawals (Immervoll and Barber, 2005). This discourages labour market participation by certain groups, especially lone parents and second-earners.

The OECD project on factors explaining differences in hours worked (OECD, 2007f) considers the impact of taxes on hours worked (the intensive margin of labour supply). The theoretical net effect of the impact of labour taxes on labour supply is unclear. Taxes reduce labour supply through the substitution effect while the income effect raises labour supply. The study suggests that a high marginal tax wedge on second-earners is a key factor in explaining the relatively low working hours among this group. This finding is supported by disaggregated empirical evidence showing that the marginal tax wedge has a considerably stronger impact on the hours worked by women than on those worked by men. A one percentage point increase in the marginal rate is estimated to reduce the hours worked by women by around 0.7% whereas for men the impact of a same increase in the tax rate is close to zero (Causa, 2008).

19 The magnitude of the impact of taxes varies widely across studies but, excluding the high estimates, Nickell (2004) found that a 10 percentage point rise in the tax wedge reduces employment by around 1% to 3% of the working-age population.

20 TFP measures the change in output that cannot be accounted for by a change in inputs and is thus a measure of how efficiently the inputs are used.

The OECD study on the determinants of tertiary education shows that the rate of return to education, measured by the private internal rate of return (IRR), is an important factor driving the demand for tertiary education and human capital formation (Oliveira Martins *et al.* 2007). This measure summarises the economic incentives to take up tertiary education and tax policies can affect these incentives through their effects on the opportunity costs of taking up tertiary education (*i.e.* foregone earnings) and net wages after graduation (as well as, to a minor extent, on expected unemployment and pension benefits). Oliveira Martins *et al.* (2007) suggests that the impact of taxes on investment in tertiary education can be sizeable. The policy simulations show that a five percentage point reduction in marginal tax rates increases the IRR which leads to an average 0.3 percentage points increase in tertiary education graduation rates.

1. This effect is likely to be even stronger when child care costs are taken into account, though empirical cross-country evidence of this is not yet available.

It is also possible that labour taxes influence foreign direct investment adversely by increasing labour cost in the host country. For instance, Hajkova *et al.* (2006) found that the impact on FDI of labour taxes is generally substantially larger than that of cross-border effective corporate tax rates (see below).[21] This can hinder technology transfers and spill-overs of best practices from multinationals to domestic firms, thereby reducing TFP.

Tax progressivity may affect both labour utilisation and productivity

The notion is accepted in all countries that progressive income taxes play a role in achieving a more equal distribution of income and consumption. However, it is also widely acknowledged that progressivity has the undesirable effect of distorting individual decisions to supply labour and invest in human capital. There are a number of ways of defining progressivity. In this study, a progressive tax system is defined as one in which the average tax rate increases with income or, equivalently, in which the marginal tax rate is higher than the average tax rate at any income level.[22] While there is obviously a link between marginal and average tax rates – the average rate increases (falls) with income when the marginal tax rate is above (below) the average rate – it is possible to vary the two independently to some extent. For example, the average tax rate can be reduced for all taxpayers without altering the marginal tax rates of all but those on the lowest incomes by granting a general tax credit for a fixed amount.

Growth regressions undertaken for this study point to sizeable adverse effects of progressive income tax schedules on GDP per capita (see Arnold, 2008 for details), which go over and above the effects working through human capital accumulation. For example, consider the average OECD country in 2004, which had an average personal income tax rate of 14.3% and a marginal income tax rate of 26.5%. If the marginal tax rate were to decrease by 5 percentage points in this situation, thus decreasing the progressivity of income taxes, the estimated increase in GDP per capita in the long run would be around 1%. Given that this analysis controls for human capital, this effect could originate from the responsiveness of labour supply to progressivity. However, it is also possible that it partly reflects higher entrepreneurship and risk-taking, if the measure of progressivity used in this project is correlated with progressivity at higher levels of income (see below).

21 The effect on FDI of a one standard deviation change in the tax wedge on labour income is around ten times larger than the effect of a similar change in the marginal and average cross-border effective tax rate.

22 From a policy perspective it is the overall progressivity of the tax system which is relevant. Thus, for example, the potential regressive effects of VAT may be affected by progressive elements in other parts of the tax system.

These results suggest a non-trivial trade-off between tax policies that enhance GDP per capita and distributional objectives. However, there can be cases where this trade-off does not exist (see discussion of in-work benefits below).

The interaction between labour income taxes and the benefit system

It is possible that the interaction of the tax and benefit systems can create high average and marginal effective tax rates for certain groups, affecting labour force participation, hours worked and employment. For example, these joint effects can influence the financial reward from moving from inactivity to low-paid work and the incentives to re-enter the labour market – particularly for low-skilled low-pay workers and second-earners – after a period of unemployment. These high effective tax rates may have sizeable consequences on participation and employment, particularly if upward wage mobility is relatively limited at the bottom of the wage distribution.

Recent tax reforms in some OECD countries have aimed to reduce disincentives to participate in the labour market, especially for low-income and low-skilled households, by introducing so called "*in-work benefits*" or "*make-work pay policies*". These benefits or tax credits which top up the earnings of low-income earners have had some success in reducing "inactivity traps" of some groups of workers (Meyer and Rosenbaum, 2001; Blundell *et al.* 2000; Card and Robins, 1998). For example, "in-work benefits" increase the income of relatively low-income households, thus reducing inequality, and may also improve efficiency if the gain in labour force participation outweighs the reduced hours of those already in work.[23] That said, these schemes must be carefully designed (OECD, 2005b) to avoid worsening the incentives of those in part-time work to increase hours and to progress in work by up-grading their skills, thereby creating "low-wage traps" while avoiding high budgetary costs.[24] Thus, the two main ways in which the government can help people on low-incomes – by providing them with direct income support and by encouraging them to earn more – may be in conflict with one another (Adam *et al.* 2006a; 2006b). In addition, these benefits need to be financed which may imply raising some other taxes.

Top marginal statutory rates mainly affect productivity

Top marginal statutory rates on labour income have an ambiguous impact on TFP via entrepreneurship by affecting risk taking by individuals. On the one hand, high top statutory income taxes reduce the post-tax income of a successful entrepreneur relative to an unsuccessful one and can reduce entrepreneurial activity and TFP growth. On the other hand, high tax rates provide for increased risk-sharing with the government if potential losses can be written off against other income (tax payments), which may encourage entrepreneurial activity (Myles, 2008). However, Gentry and Hubbard (2000) suggests that the higher is the difference between the marginal tax rates when successful and unsuccessful (a measure of tax progressivity) the lower is risk-taking as the extra tax that applies to high profits is greater than the tax saving that is produced by losses, effectively reducing the strength of the risk-sharing effect.

23 In-work benefits conditional on employment encourages participation in the labour market and reduce the likelihood of "unemployment" or "inactivity traps". But, they also tend to increase marginal tax rates for workers earning relatively low wages, due to the phasing out of these in-work benefits. Therefore, in terms of their potential effect on labour supply, these benefit schemes trade off higher participation against lower working hours of certain groups already in work.

24 A similar "win-win" situation can also sometimes arise with other methods of encouraging low-wage workers into the workforce, such as targeted reductions in social security contributions. These are of course subject to the same caveat in terms of the implied budgetary costs.

Industry-level evidence covering a sub-set of OECD countries suggests that there is a negative relationship between top marginal personal income tax rates and the long-run level of TFP (see Box 4 for details). The magnitude of the estimated impact of a change in top personal income taxes differs across countries depending on the composition of their business sectors, increasing with the proportion of industries with structurally high entry rates. One possible policy implication may be that countries with a large share of their industries characterised by high firm entry (or wishing to move in this direction) may gain more from lowering their top marginal tax rate than other countries. However, it is likely that some other policies and institutional settings, such as product market regulation, have a more direct impact on entrepreneurship (Scarpetta and Tressel, 2002; Brandt, 2005; Conway *et al.* 2006). Additionally, the magnitude of the impact of tax reform may depend on the stance of these policies. Indeed the empirical analysis shows that the negative impact of top marginal tax rates on TFP is stronger in countries with a high level of the OECD indicator of product market regulation (PMR)[25], suggesting complementarities between taxation and product market policies.[26]

Box 4. Estimating the effect of labour taxes on total factor productivity (TFP)

Gauging the direct effect of taxation on TFP based on industry-level data is difficult as available tax indicators are not differentiated by industries, although their impact may vary across industries. An indirect way to test for these tax effects is to see whether some industries are more affected by taxes due to some salient industry characteristics, such as technology or organisational features (for a detailed overview of this approach see Vartia, 2008). To test this, the analysis identifies industry-specific characteristics relevant for different tax policies and examines the interaction between these characteristics and the appropriate taxes. This interaction term is then used in the empirical model as the main variable of interest together with other relevant variables to explain changes in TFP (see *e.g.* Rajan and Zingales, 1998). For example, the estimation assumes that one channel through which labour taxes affect TFP is industries' labour intensity, while top marginal taxes affect TFP through the channel of firm entry. If the results of the econometric analysis support the hypothesis that the negative impact of taxes on TFP is stronger in certain industries due to these salient characteristics, then the estimated coefficient of the interaction term should be negative whereas if tax incentives have a stronger positive effect on TFP in industries with certain characteristics, the coefficient should be positive. One important caveat to this approach is that the estimated effect only captures the effect of a tax working through a specific channel. Any direct effect of the specific tax on TFP (unrelated to the industry characteristics) is captured in the fixed effects. TFP at the industry-level is calculated as the "Solow-residual" from a production function where the factor shares in the production function are proxied by the cost shares in value-added. The empirical analysis is based on a model that captures technological catch-up with the leading firms/industries and persistence of TFP levels over time. The same empirical approach is used in assessing the effects of corporate taxes on TFP. In general, this empirical approach provides reliable findings about the qualitative effects of various taxes on TFP, but the quantitative effects should be interpreted with caution. The main empirical results of the effect of labour taxes on TFP, as summarised in Table 6, are (see Vartia, 2008 for details):

Employer and employee social security contributions (SSC) have a more negative influence on TFP in industries that are relatively more labour intensive (Columns 1,2). However, the magnitude of the effect of SSC on the long-run level of TFP is estimated to be relatively small.

Top marginal personal income tax rates have a more negative effect on TFP in sectors characterised by high firm entry rates (Column 3). A simulation experiment indicates that the effect of a reduction of the top marginal tax rate from 55% to 50% on the average yearly TFP growth rate (over 10 years) would be 0.05 percentage points larger for industries with the median firm entry rate than for industries with the lowest level of firm entry. Under the assumption that the effect of top marginal rates are close to zero in industries with the lowest

25 The PMR indicator includes, among other things, measures of the administrative burden on firms and regulatory barriers for start-ups.

26 This finding may reflect that potential entrepreneurs weigh the total cost against the potential return of starting up a business. Since taxes add to cost on top of the regulatory costs, the overall cost is increased, which may tilt the balance towards not becoming an entrepreneur in business environments where taxes are high at the same time as regulations are burdensome.

level of firm entry, this may be interpreted as a median effect. The effect of this tax reduction on TFP depends on the industry structure and this tax cut would increase the average annual productivity growth rate by 0.06 percentage points more in an industry at the 75th percentile of firm entry than in an industry at the 25th percentile of the distribution of firm entry.

There is weak evidence that the negative effect of SSC tends to be stronger in countries with a sizeable administrative extension of collective wage agreements to non-unionised firms (Column 4). The extension of wage agreements may magnify the effects of SSC increases on labour cost by making it more difficult to shift the burden of this increase on workers' wages and more so in industries that are more labour-intensive.

[Table 6. Estimated effects of labour taxes on TFP: Industry-level]

Capital income taxes may affect investment and entrepreneurship through savings and firms' financing

Taxes on personal capital income may affect private savings by reducing their after-tax return. However, as discussed in Section 3.1, the effects of this on savings, and particularly on investment, are uncertain. Nonetheless, differences in the personal income tax treatment of different forms of savings can be expected to distort the allocation of savings and reduce the growth potential of the economy. As most OECD countries do favour certain types of savings (such as owner-occupied housing, private pension funds) over others (such as bank deposits), there is scope to increase growth by reducing these distortions.

High capital gains taxes may affect both the demand for venture capital through entrepreneurs' career choice and the supply of funds (*e.g.* Poterba, 1989). Since venture capital is one important source for financing high-technology firm start-ups, financial support for these start-ups may be hindered by high capital gains tax, thus lowering the potential contribution of new firm entry to TFP growth. However, there is little empirical evidence of this link. More generally, policymakers face difficult choices in relation to capital gains taxes (see OECD, 2006c). In particular, exempting capitals gains from taxation provides opportunities for tax avoidance by transforming taxable income into tax-free capital gains, but the application of capitals gains tax can "lock-in" investments and prevent the efficient reallocation of capital because (for reasons of practical administration) capital gains are taxed on realisation. It is, therefore, unsurprising that OECD countries differ widely in their taxation of capital gains.

The design of the capital income tax system and its interaction with corporate taxation may also influence firms' access to finance, which in turn can affect risk-taking and TFP (*e.g.* Feldstein, 2006). In most OECD countries, profits are taxed first at the corporate level and then at the personal level when they are distributed as dividends, and there has been a recent trend away from the use of imputation systems that give a credit at the personal level for taxes paid at the corporate level. Double taxation can create a bias towards financing investment with debt rather than equity, which may in turn discriminate against firms that have less access to debt financing. For instance, personal taxation of dividends has less influence on larger firms that can raise finance from foreign investors, who are generally not subject to the home country's personal taxes on dividends.

While the effects of high dividend taxes on financial structure are widely accepted, there is no consensus among corporate finance theorists on whether dividend tax cuts have a real effect on investment decisions or they are merely fully capitalised in share values (*e.g.* Auerbach, 2002).[27]

27 Under the "traditional" corporate finance view, firms' marginal source of finance is new share issuance and dividend tax cuts feed into firms' cost of capital and thus promote investment. The

Issues in the design of growth-oriented personal income tax systems

Tax design should try to reconcile the broad policy objectives of taxation (*e.g.* revenue raising potential, administrative simplicity and equity) with efficiency considerations. Thus, the tax system should, as far as possible, avoid encouraging economic behaviour that could influence market activity adversely. This generally requires a broad tax base and few differences in tax rates (OECD, 2006b). As discussed above, on the personal income side, some important design features are the tax unit/base (individual or joint family taxation), the progressivity of the tax schedule, tax compliance and the tax treatment of capital income which can have an influence on economic performance. But, one complexity is that reforms of personal income taxes are often difficult to evaluate in isolation from the rest of the tax and benefit system since changes in taxes often interact with existing benefits affecting the effective average and marginal tax rates.

The main purpose of family-based taxation is to increase vertical and horizontal equity in the taxation of households with different composition of income. One argument for equity being defined across households rather than across individuals is that the household is often the principal consumption unit. However, joint family taxation can create disincentives for (married) second-earners to enter the labour market and have adverse effect on GDP per capita. On the other hand, one problem with individual taxation is how to attribute non-labour income between the spouses, for instance, if it should be accredited to the spouse with highest income or if couples should be able to freely choose. While this has equity implications, it is unlikely to significantly influence economic behaviour. Thus, the choice between family and individual taxation involves a trade-off between equity concerns and the labour supply of second-earners which affects labour utilisation and GDP per capita.

The choice of tax schedule in a country is also likely to depend on how the trade-off between equity and tax distortions is valued. A flat tax system with few allowances and tax credits is generally simpler to administer and probably gives rise to fewer tax-induced distortions than other systems, but it puts less emphasis on redistribution (Box 5). By contrast, a highly progressive income tax system normally reduces incentives to work and to invest in human capital, although "in-work benefits" can improve work incentives for low-wage workers while increasing progressivity. High progressivity may also increase the incentives for tax avoidance and tax evasion and contribute to a growing shadow economy that reduces measured GDP, although it is arguable that the tax level is more important than its progressivity in this regard. This may reduce tax revenues and undermine the fairness of the system. There is also a possibility that high top marginal rates will increase the average tax rates paid by high-skilled and high-income earners so much that they will migrate to countries with lower rates resulting in a "brain-drain" which may lower innovative activity and productivity.

Another important issue is the taxation of capital income. Over the last 50 years, the traditional approach to income taxation was the comprehensive income tax, which applies a single tax schedule to a person's (or couple's) total income, combining labour income with all the different forms of capital income. However, many OECD countries have moved away from this approach to varying extents, by applying lower rates of tax to some or all capital income (OECD 2006b). A particularly interesting example of this is the dual-income tax system (Box 2), such as that used in most Nordic countries, which taxes all capital income at a single flat rate that is lower than the top rates applied to labour income. However, this creates an

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"new" view suggests that the marginal source of finance is retained earnings and that dividend tax reductions are capitalised into share values, but do not affect investment. Recent empirical evidence based on micro data shows that none of these extremes applies to all firms (Auerbach, 2002).

incentive for entrepreneurs to disguise labour income as capital income. The dual-income tax also raises equity concerns but it has several advantages: it reduces any disincentive to save; it may help offset the fact that capital income taxes are usually applied to the nominal rather than the real return on savings; it reduces the incentive for capital owners to move their savings offshore in an attempt to avoid taxation; and it reduces the scope for tax arbitrage between different sources of capital income. Several other countries have adopted a 'semi-dual' approach, in which different types of capital income are taxed at different rates. Countries may have different efficiency reasons for taxing interest, dividends and capital gains at lower rates than labour incomes. For example, many countries give special treatment to capital gains because of their association with risk-taking and do not see as great a necessity to reduce the general taxation on savings.

Box 5. Flat personal income tax reform experiences

Estonia was the first European country that introduced a flat tax levied at a rate of 26% on personal (and corporate) income in 1994. The flat rate is 21% in 2008, but Estonia is in the process of reducing the rate gradually to 18% from 2011 onwards. The other Baltic States soon followed the Estonian example, as did several other Central and Eastern European countries – among those is Russia where a flat personal income tax rate of 13% was introduced in 2001.

The Slovak Republic is the first OECD country to have a flat tax. The country introduced a 19% rate in 2004 that applies to both corporate and personal income, and which is also used as the value-added tax rate. The tax reform in the Slovak Republic broadened the tax base by eliminating almost all tax reliefs but increased the basic allowance. At the same time, the Slovak government reduced social assistance benefits and shifted the tax burden from direct to indirect taxation. They continue to levy high health and other social security contributions. Since 2006, also Iceland applies a flat income tax rate on labour income above a threshold (ISK 1 080 067 in 2007). The central government rate in 2007 is 22.75% and the local government's income tax rate varies between 11.24% and 13.03% between municipalities. In 1998, Iceland levied a surtax of 7% on higher incomes, but this rate has been gradually reduced over time and was abolished from 2006 onwards. Iceland levies a low fixed amount of employee SSC and employer SSC are levied at a low rate of 5.34% on gross wages in 2007. The Czech Republic has introduced a flat personal income tax in 2008. In addition, flat tax systems have been and still are discussed in several other OECD countries.

A common feature of all flat tax proposals is that the introduction of a single rate is combined with the abolition of all or most tax allowances and tax credits. This might improve the tax system's efficiency, especially if a low flat tax rate would be levied. Efficiency would be improved even further if the same flat rate is introduced for both personal and corporate income as this reduces or even removes the tax incentives for income shifting between the personal and the corporate sector. However, identical tax rates are not sufficient for these incentives to disappear, as they also depend on the definition of the tax base.

Progressivity in flat tax systems is achieved by means of a basic allowance or basic income provision. This might have a positive effect on redistribution, both because the value of deductions in a progressive tax rate system are increasing with income and because high-income persons are generally in a better position to take advantage of these allowances than are low and medium income persons. In addition, it is often argued that lowering tax rates stimulates the economy and leads to increased employment, which will normally have a positive effect on income distribution as well. On the other hand, the static/first-year effects of flat tax reforms will probably give by far the largest tax cuts to high-income individuals but also low-income earners might gain if the basic allowance is increased. It is however the middle-income earners that most likely will be worse off after a flat tax reform.

In addition to the personal income taxes, most countries levy social security contributions only on labour income (and not, for instance, on capital income). Social security contributions then undermine the 'flatness' of the tax system if they don't confer an actuarially fair entitlement to a possibly contingent future social benefit. One could then say that flat tax systems turn into (semi-) dual income tax systems with proportional instead of progressive taxation of labour income.

In some countries, having a flat tax on capital and labour income might require a rather high tax rate, which would reduce the tax system's efficiency and might raise problems because of the international mobility of the tax bases. On the other hand, implementing a rather low flat tax rate would undermine the benefit system in many OECD countries and would undermine income redistribution.

Source: OECD (2006b) "Fundamental Reform of Personal Income Tax".

The taxation of dividends is an area of special interest, not only because of recent moves away from imputation systems but also because of its links with corporate taxation. Some countries, such as Finland, moved away from imputation for publicly quoted companies partly because they wished to use the money saved to reduce the rate of corporate tax, in order to attract foreign direct investment. Moves of this sort increase the taxation of profits at the personal level in the country of the shareholder's residence and reduce the taxation of profit at the corporate level in the country in which the profits arise. In general in an open economy, a residence-based capital income tax (like dividend tax) may discourage savings without affecting domestic investment whereas a source-based capital income tax (such as the corporate tax) tends to reduce and distort domestic investment. The choice between these two approaches to the taxation of profits depends to some extent on whether the policy aim is to raise the level of domestic investment or saving.

Also, to encourage saving most OECD countries currently give tax incentives to certain forms of private saving, for example pensions (*e.g.* Yoo and de Serres, 2004). While these incentives are likely to lead to changes in the composition of savings there is little evidence that they result in increases in overall private savings and since the tax breaks involved are likely to reduce public savings, their effect on GDP is at best uncertain (OECD, 2006b, Box 6).

Box 6. Tax-favoured pension plans

Economic efficiency in the taxation of savings requires that, in the absence of an existing market failure, tax policy should not affect individuals' decisions about what assets they save in. But the government may want to encourage people to save in specific retirement saving instruments and many OECD countries use some type of tax incentives to encourage the development of private pension saving. These incentives may be put in place to reduce "moral hazard" of individuals who may be tempted to not save enough for their retirement during their working life and instead relying on the social safety net. Also, countries with an ageing population can find that these tax incentives are a way to smooth the transition from "pay-as-you-go" financing to "pre-funding" of pension schemes. One potential problem with taxing different forms of savings differently is that it results in saving decisions being driven not by underlying returns but by the tax system.

A savings scheme is usually considered as being taxed favourably when its tax treatment differs from a regime that treats all sources of income equally from a fiscal standpoint (the so called "comprehensive income tax regime"). There are several ways in which tax incentives for pension savings can be provided. For instance, in an "exempt-exempt-taxed" (EET) scheme both the funds contributed and the accrued return on the accumulated funds are exempted from taxation while the benefits are treated as taxable income upon withdrawal. But the tax incentives do not necessarily need to imply a tax-deferral, under a "taxed-exempt-exempt" (TEE) scheme the income tax on pension savings is pre-paid while the accrued returns and withdrawal is tax-exempt. In practice, there is a whole range of possible tax combinations going from a scheme of "taxed-taxed-taxed" to "exempt-exempt-exempt", but most OECD countries apply some form of the EET regime (Yoo and de Serres, 2004). The net tax cost in terms of foregone tax revenues of the tax favoured schemes, or the size of the tax incentives to invest in a private pension schemes, varies across OECD countries. It ranges from 40 cents per dollar or euro contributed (Czech Republic) to around zero (Mexico and New Zealand). Despite the variation, most OECD countries incur a sizeable net tax cost. Half of the countries incur a tax cost of more than 20 cents, and it exceeds 10 cents in most OECD countries (Yoo and de Serres, 2004).

These tax advantages in pension savings need to be weighed against poor targeting since the moral hazard problem does not affect individuals whose expected pension income is well above the social safety net. Moreover, it is highly likely that the favourable tax treatment of pension savings only distorts the composition of savings without increasing the overall level of savings at the expense of tax revenues (OECD 2006b; Antolin, *et. al.* 2004; OECD 2004).

3.4 Corporate income taxes

Corporate income taxes are levied on the corporation as an entity rather than on the individuals who own the corporation. This section describes the effect of the main components of corporate taxation on GDP in OECD countries. The tax variables considered are: statutory and effective corporate rates (including depreciation allowances), cross-border effective rates, and R&D tax incentives.

Corporate taxation may affect capital formation…

Corporate income taxes can affect the rate of capital accumulation and hence GDP per capita. Since firms' investment decisions are driven by the cost of and the expected return to investment projects, corporate taxes can have a negative effect on corporate investment by reducing its after-tax return. The extent of this effect can, in turn, be expected to depend on the degree of openness of the economy, with a more open economy likely to suffer more from an excessively high corporate tax than a more closed economy.[28] It is also possible that taxes on personal capital income affect investment decisions by small firms that are only able to access domestic savings, but since most investment is undertaken by large firms with access to international funds, personal capital income taxes are likely to have a small effect on GDP. Foreign direct investment (FDI) is affected in a similar way as domestic investment by corporate taxation. However, it is also affected by the tax treatment of cross-border income (see below). Moreover, the effect of corporate taxes on capital formation through FDI can also depend on the size of the economy, with larger economies able to attract FDI aimed at supplying their large markets even if they maintain relatively high tax rates. Also, the proportionate effect of FDI on the domestic capital stock may be larger in smaller economies. The effect of corporate taxes on investment may also depend on other policies and institutions. For instance, tight product market regulations and a large administrative burden on firms can make firms' investment decisions less responsive to cuts in corporate tax rates as these administrative and regulatory barriers increase the adjustment cost of capital (Alesina *et al.* 2005a).

Empirical evidence obtained from both firm-level data covering a sample of 14 European OECD countries and industry-level data covering 21 industries in 16 OECD countries suggest that investment is adversely affected by corporate taxation through the user cost of capital (see Box 7). There are several empirical findings worth mentioning:

- Increases in the tax-adjusted user cost are found to reduce investment at the firm level and the effect on firm-level investment is stronger in more profitable industries. This indicates that the tax component of the user cost contributes significantly to the reduction in investment by disproportionately increasing the user cost for firms with a large tax base.

- Differentiating the impact of the tax-adjusted user cost across firms of different size (number of employees) and age, it appears that older firms' investment, irrespective of firm size, responds more strongly to corporate taxation through the user cost than younger firms' investment. There are two possible interpretations. One possibility is that young firms are generally less profitable than older firms and therefore have a smaller tax base. A second possibility is that young firms benefit from targeted exemptions or reduced rates.

28 To the extent that, for an open economy, the (net of tax) interest rate is aligned to the world interest rate, no offsetting effects from increases in domestic savings can be expected to apply.

– The firm-level sensitivity of investment to the corporate tax rate finds confirmation at the industry-level. Since the user cost of capital takes into account depreciation allowances that are deductible from firms' tax liability at the rate of the corporate tax, the magnitude of the influence of a change in capital depreciation allowances also depends on the level of corporate tax rates.

Box 7. Empirical evidence on the effect of taxes on investment

The empirical results, both at firm and industry level, assessing the effect of taxes on investment are obtained by introducing the tax adjusted user cost in a standard investment equation with adjustment costs of capital (see Schwellnus, 2008 and Vartia, 2008 for details). The empirical approach is based on the user cost theory of capital which stems from a neoclassical investment model in which investment decisions are made to maximise the net present value of the firm (*e.g.* Hall and Jorgenson, 1967). In addition to the standard user cost components (the required rate of return to the investment, the economic depreciation rate and anticipated capital gain/loss due to a change in before-tax price of the asset) the tax-adjusted user cost takes into account taxes on profits and the present value of the tax savings from depreciation allowances. The industry-specific user cost is constructed as a weighted average of the asset specific user cost where the weights are the share of each asset in total industry investment. The advantage of framing the empirical analysis within the user cost theory is that estimations are closely linked to theory. But one disadvantage is that the tax effects on investment are not separable from the effects of the other components included in the user cost. The firm and the industry level investment equations are based on different non-linear specifications. At the firm level, a non-log specification including a quadratic term of the lagged investment-to-capital ratio capturing a non-linear adjustment of investment is used. The industry level equation is specified in log terms and the adjustment of investment is captured by the lagged investment-to-capital ratio.[1]

The main empirical findings at the firm-level, summarised in Table 7, are (see Schwellnus, 2008 for details):

Increases in the tax-adjusted user cost are found to reduce investment at the firm-level (Column 1). A simulation experiment indicates that a reduction of the statutory corporate tax rate from 35% to 30% reduces the user cost by approximately 2.8%. This implies a long-run increase of the investment–to-capital ratio of approximately 1.9%, given its long-run user cost elasticity of 0.7.

The size of the negative tax effect on investment appears to be similar for small and large firms (measured by the number of employees). In contrast, only older firms' investment appears to be negatively affected by increases in the tax-adjusted user cost (Column 3). One possible explanation is that young firms are generally less profitable than older firms and therefore less affected by corporate taxation. The other explanation may be that among young firms there is a disproportionately high share of small firms that benefit from exemptions or reduced rates.

[Table 7. Estimated effects of corporate taxes on investment: firm-level]

The main results obtained at the industry-level, summarised in Table 8, are (see Vartia, 2008 for details):

The investment-to-capital ratio is negatively affected by increases in corporate taxation. The long-run user cost elasticity is estimated to vary between -0.4 and -1, depending on the empirical specification. A simulation experiment indicates that a cut in the statutory corporate tax rate from 35% to 30% would increase the long-run investment-to-capital ratio by 1.0% and 2.6%, depending on the specification. These are lower and upper bound estimates at the industry level and the firm-level estimate lies within this interval. The estimated effect of this tax reduction is equivalent to an increase in the average investment-to-value-added ratio by 0.2 to 0.5 percentage points.

The corporate tax rate enters non-linearly into the user cost formula and as a result the magnitude of the effect of a change in the tax depends on the level of corporate taxes. Countries with a higher corporate tax rate experience a somewhat larger negative effect from the same increase in the tax than countries with a lower tax rate.

The effect of a five percentage point increase in the net present value of the depreciation allowance (of both machinery and structures) is estimated to increase the investment rate by 0.9% to 2.5%, depending on the empirical specification.[2] Since the depreciation allowances are deductible from firms' tax liability at the rate of the corporate tax, the magnitude of the impact of a change in capital depreciation allowances also depends on the level of corporate tax rates.

[Table 8. Estimated effects of corporate taxes on investment: industry level]

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1. In the firm-level data it is possible to capture the adjustment of the capital stock with a non-linear specification including a quadratic term, whereas at the industry level, capturing the adjustment of the capital stock with this specification is difficult. Therefore, the industry level analysis uses a log specification with the lagged dependent variable measuring the adjustment process.
2. The average value of the net present value of the depreciation allowance is 40% for structures and 78% for machinery.

...and productivity in several ways

There are several channels through which corporate taxation can affect TFP. First, as with labour taxes, corporate taxes can distort relative factor prices resulting in a re-allocation of resources towards possibly less productive sectors (*e.g.* non-corporate sector) which may lower total factor productivity (*e.g.* Boersch-Supan, 1998). Second, complex corporate tax codes can cause high tax compliance costs for firms and high administrative burdens for governments, which absorb resources that could be used for productive activities, causing productivity and efficiency losses. Third, high corporate taxes may reduce incentives to invest in innovative activities by reducing their after-tax return. Fourth, to the extent that corporate taxes reduce FDI and the presence of foreign multinational enterprises they can hinder technology transfers and knowledge spill-overs to domestic firms (see below).

Also, corporate taxes distort corporate financing decisions, favouring debt over equity because of the deductibility of interest from taxable profits. This can affect TFP by distorting the allocation of investment between industries, favouring those that find it easy to raise debt finance and disadvantaging those that have to rely more on equity, such as knowledge-based industries that invest heavily in intangible property. Even within an industry this can disadvantage innovative fast-growing firms that may rely on risk capital more than other firms. This has led to the consideration of a range of fundamental corporate tax reforms in several OECD countries (Box 8). It is also possible that corporate taxes affect the allocation and reallocation of resources across firms which can play an important role in accounting for aggregate productivity. A similar problem can arise from the "lock-in" effect of capital gains tax.

Box 8. Fundamental corporate tax reform

Many policymakers in OECD countries are concerned about whether they can maintain their current levels of corporate income tax revenues, especially in the light of increasingly mobile tax bases, and how they can create a more attractive investment climate for domestic and foreign investors. They are also concerned about the distortions induced by their corporate income tax systems – the corporate income tax is likely to distort the total amount of investment and the type of investment projects that are undertaken, the corporate sources of finance (debt, newly issued equity or retained earnings), the location of the corporate tax base, the choice of a business legal form and the tax might have an impact on corporate mergers and acquisitions. Policymakers also look for ways to reduce corporate income tax complexity. In principle, these goals can be achieved through fundamental corporate income tax reform. However, in practice, fundamental reform is often difficult to implement because of the trade-offs between simplicity, efficiency and fairness considerations and because of the potential international tax consequences, transitional implications and tax revenue consequences.

The allowance for corporate equity (ACE) tax system – as, for instance, implemented in Belgium – provides a deductible allowance for corporate equity in computing the corporation's taxable profits. Similar to the deductibility of interest payments from the corporate income tax base, the allowance for corporate equity equals the product of the shareholders' funds (generally the company's total equity capital) and an appropriate nominal interest rate (interest rate on medium term government bonds). The allowance therefore approximates the corporation's "normal" profits. The corporate tax is then confined to economic rents because only corporate profits in excess of the ACE are subject to corporate tax. As a

result, the ACE tax system does not distort the choice between debt and equity as sources of finance at the corporate level.

The allowance for shareholder equity (ASE) tax system – as implemented in Norway – exempts the normal return on equity from double taxation as well. However, it provides tax relief for the normal return on equity not at the corporate level as under the ACE tax system, but at the personal level instead. The ASE might be calculated as the value of the shares held by the household multiplied by an imputed return (interest rate on medium-term government bonds). As is the case for the ACE tax system, which is equivalent to a corporate cash-flow tax, the ASE tax is equivalent to a personal level cash-flow tax.

Governments might also implement other types of corporate income taxes as a full imputation system, the shareholder allowance for corporate equity tax system or the comprehensive business income tax (CBIT) system. The CBIT, for instance, allows no deduction of either interest payments or the return on equity from taxable corporate earnings. Except for the CBIT rate, no additional taxes would be imposed on distributions to equity holders or on payments of interest.

Finally, instead of taxing corporate income, government might implement a corporate cash-flow tax. Under a corporate cash-flow tax, income is taxed only when cash is received and costs are deductible immediately when purchases are made and interest costs are not deductible. The capitalisation of assets is therefore no longer required due to the immediate expensing of the investment and the economic depreciation of assets no longer has to be measured. A corporate cash-flow tax treats debt and equity symmetrically and so does not distort the firm's decisions on sources of finance.

Source: OECD (2007b) "Fundamental Reform of Corporate Income Tax".

The empirical findings at both firm- and industry-level suggest that there is a negative effect of taxes on TFP (see Box 9 for details). Allowing for heterogeneity in the tax impact across both firm size and age categories, it appears that the negative effect of corporate taxes is uniform across firms of different size and age, except that no such effects are found for firms that are both young and small. There are two possible explanations for this result. First, small firms benefit from exemptions and reduced rates of corporate taxes. However, this does not explain why small firms are negatively affected by corporate taxes after their initial five years of existence (*i.e.* after they become "old" according to the convention adopted here). A more convincing explanation, therefore, is that the category of young and small firms includes a large share of start-ups with low or zero profits, even in highly profitable industries. For these firms the effect of corporate taxes may therefore be negligible.

It is also possible that corporate taxes have a differential effect on firms that are in the process of catching up with the productivity performance of the best practice firms (catch-up firms) and firms that are falling behind (non catch-up firms), especially if profitability is higher in catch-up than in non catch-up firms. In this case, corporate taxes could have a particularly negative effect on innovation incentives for catch-up firms by disproportionately reducing their after-tax return to innovation. This conjecture is supported by empirical findings showing that only firms that are in the process of catching up with best practice are negatively affected by the statutory corporate tax rate (see Box 9 for details). These results suggest that lowering the corporate tax rate may be particularly beneficial for productivity growth of the most dynamic and innovative firms. This could be because such firms rely heavily on retained earnings to finance their growth.

Box 9. Estimating the effect of corporate taxes and R&D tax incentives on TFP

As with labour taxes, the empirical approach to estimate the effect of corporate taxation on TFP is based on identifying industry-specific characteristics that are expected to cause a differential effect of corporate taxes on industry TFP (described in Box 4). More specifically, the estimation approach (both at firm and industry-level) assumes that one channel through which corporate taxes affect TFP is industries'

corporate profitability (high returns).[1] Furthermore, to assess the effect of tax incentives for R&D expenditures and the resulting effect on TFP it is assumed that the channel through which these incentives influence R&D differently across industries is the R&D intensity of industries.[2] Firm-level TFP is calculated as the residual from the estimation of a logarithmic Cobb-Douglas production function using firm level data on value-added and labour and capital inputs while, as described in Box 4, industry-level TFP is measured as the "Solow-residual" from a production function. The empirical results draw on a specification that captures two empirical regularities, namely technological catch-up with the leading firms/industries and persistence of TFP levels over time (Scarpetta and Tressel, 2002; Griffith *et al.* 2006). As mentioned in Box 4, this empirical approach provides reliable qualitative indications regarding the qualitative effects of various taxes on TFP, though the size should be interpreted with caution.

The main empirical results concerning the influence of corporate taxes on TFP at the firm-level are (see Schwellnus, 2008 for details):

Lowering corporate taxes is estimated to boost firm-level TFP in profitable industries (Table 9, Column 1). A simulation experiment indicates that the effect of a reduction of the corporate tax rate from 35% to 30% on the average yearly TFP growth rate (over 10 years) would be 0.4 percentage points higher for firms in industries with median profitability than for firms in industries with the lowest level of profitability. Under the assumption that the effects of corporate taxation are close to zero for firms with the lowest tax base, this may be interpreted as a median effect. Given that trend TFP growth of OECD countries averaged around 1.1% over the period 2000-2005 (OECD, 2007e) the simulated increase in TFP growth due to a tax reduction would seem to be an upper bound estimate. The effect of this tax cut on TFP depends on the industry structure and this reduction would increase the average annual productivity growth rate by 0.4 percentage points more in an industry at the 75th percentile of profitability than in an industry at the 25th percentile of profitability.

The negative effect of corporate taxes is uniform across firms of different size and age classes, except for firms that are both small and young. This may either be due to some countries' exemptions or reduced rates targeted at start-up firms or to their low average profitability, which both reduces the amount of their effectively paid corporate (Table 9, Column 2).

Rising firms that are in the process of catching up with the technological frontier are particularly affected by corporate taxes (Table 9, Column 3). Even in sectors with low average profitability there is a subset of highly profitable firms that catch up with the technological frontier. These firms' tax base is large so that a high corporate tax rate increases their effective tax burden disproportionately relative to that of other firms.

[Table 9. Estimated effects of corporate taxes on TFP: Firm-level]

The main empirical results obtained at the industry-level are (see Vartia, 2008 for details):

Lowering corporate taxes is estimated to boost TFP in profitable industries (Table 10, Column 1). A simulation experiment indicates that the average effect (over 10 years) of a reduction of the corporate tax rate from 35% to 30% on the yearly TFP growth rate would be 0.08 percentage points higher for industries with the median profitability than for an industry with the lowest level of profitability. As mentioned above, this may be interpreted as a median effect. The effect of this tax cut on TFP depends on the industry structure and this reduction would increase the average annual productivity growth rate by 0.08 percentage points more in an industry at the 75th percentile of profitability than in an industry at the 25th percentile of profitability.

[Table 10. Estimated effects of corporate taxes on TFP: Industry-level]

The effect of tax incentives for R&D spending is obtained by using the B-index[3] as a proxy of the generosity of R&D tax incentives. The main result is:

R&D tax incentives are estimated to raise R&D spending (Table 10, Column 2). However, the average effect of tax incentives on the level of TFP is rather small, though it appears to be larger in R&D intensive industries. A simulation experiment indicates that the effect on the annual TFP growth rate of an increase of the tax incentives from 10% to 15% (equivalent to a 5 cents increase in tax subsidy per dollar invested in R&D) would be 0.01 percentage points larger for an industry having the median R&D intensity than for an industry with the lowest level of R&D intensity. Again, this may be interpreted as a median effect if it is assumed that the effect of tax subsidies is close to zero in industries with very low R&D intensity. The effect of R&D incentives could potentially be larger in R&D intensive industries. Indeed, this increase in tax incentives is estimated to raise the average annual productivity growth rate by

0.09 percentage points more in an industry at the 75th percentile of the distribution of R&D intensity than in a sector at the 25th percentile of R&D intensity.

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1. For example, some industries may tend to be more profitable not because of pure economic rents, but because they rely on high expected returns to capital to compensate for high-risk investment projects such as R&D or other intangible factors.
2. It is important to remember that this estimation approach only captures the effect of a tax working through a specific channel, here through industry's profitability and R&D intensity. Any direct effect of the specific tax on TFP (unrelated to the industry characteristics) is captured in the fixed effects.
3. The B-index measures the minimum value of before-tax income that a firm needs to cover the cost of R&D investment where the cost is standardised to one dollar. R&D tax incentives are measured as one minus the B-index.

Effective corporate tax rates are broader measures of the corporate tax burden than statutory corporate tax rates since they take into account both the rate at which corporate profits are taxed and the tax base to which it is applied. They may, therefore, capture additional channels through which corporate taxation affect TFP (Box 10). Indeed, the empirical results assessing the effect of the effective corporate tax rate on TFP using industry-level data suggest that high average effective corporate taxes have a negative impact on TFP.

Box 10. Effect of effective corporate tax rates on TFP

Effective tax rates are derived from theoretical investment models where firms maximise the after-tax net present value (NPV) of their investment projects given the tax system. Depending on the assumptions of the model the effective rates can refer to a marginal effective tax rate (METR) which is applied to incremental investment projects earning just their minimum required return or to an average effective tax rate (AETR) which is applied to discrete investment projects earning some economic rent. The empirical analysis in this study uses data on the effective tax rates computed by the Institute for Fiscal Studies (IFS) based on the methodology of Devereux and Griffith (2003). The focus is on two important elements of corporate tax codes: the depreciation allowances and statutory corporate tax rates.[1] Depreciation allowances are deducted from firms' taxable income and thus they reduce the cost of investment.

The empirical results using industry-level data on a panel of 12 OECD countries covering 21 industries over the 1981-2001 period suggest that the average effective corporate tax (AETR) has a negative effect on TFP. As pointed out in Box 4 and Box 9, the estimated effects are significant and give qualitative information about the sign of the effect of effective taxes on TFP, but the size of the effects is somewhat larger than expected. A simulation experiment indicates that the effect of a reduction of the effective tax rate from 35% to 30% on the average yearly TFP growth rate (over 10 years) would be 0.1 percentage points larger for an industry with the median profitability than for an industry with the lowest level of profitability. As discussed in Box 9, this may be interpreted as a median effect. The effect of this tax cut on TFP depends on the industry structure and this reduction would increase the average annual productivity growth rate by 0.1 percentage points more in an industry at the 75th percentile of profitability than in an industry at the 25th percentile of the distribution of profitability (see Vartia, 2008 for details).

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1. Thus, the rates ignore, for example, the personal taxes paid by the shareholders.

Targeted corporate rates: the dispersion of effective rates can also adversely affect TFP

While the statutory corporate tax rate applies mostly to large corporations, some firms are taxed with lower *targeted corporate tax rates*. These rates are intended to lessen the impact of corporate tax rates on investment of certain types of firms (mainly small- and medium-sized firms) or regions. As illustrated in the previous section, about half of OECD countries have some form of reduced corporate tax rates targeted at either small firms, certain business activities or firms operating in certain regions. The standard justification for differential tax treatment of small firms is that they could suffer from market failures.[29] However, this rationale

29 For example, these market failures could be asymmetric information on market or products, monopoly power of large firms making entry difficult for small firms or difficulties for small firms in raising finance (Crawford and Freedman, 2007).

is not always uncontentious, the targeting may be difficult to achieve and the implied tax relief may involve a waste of funds.[30] Also, this special tax relief may result in an economic inefficiency if, as a consequence, resources are allocated towards small, less productive firms, due for instance to threshold effects (Crawford and Freedman, 2007). It can also lead to the artificial splitting of firms to obtain the preferential rate. The unintended result could be to prevent some firms to grow to their optimal scale of production, with negative consequences on productivity performance.

Tax incentives have some effects on productivity through R&D

As already mentioned, corporate taxes can have a negative effect on investment in R&D, and thus TFP, in a similar way as taxes affect physical investment. But, other factors beyond taxation, such as market failures, may reduce private incentives for firms to invest in innovation, possibly preventing private investment from reaching socially optimal levels.[31] To counteract these possible market failures, many OECD countries grant some type of R&D tax incentives in order to stimulate private-sector innovative activity. A recent OECD study found that tax incentives could help to raise R&D expenditure and innovative activity, but with long time lags and a relatively modest overall impact (Jaumotte and Pain 2005a,b). Further, these tax incentives were found to have stronger effects on both R&D expenditure and patents than direct funding. These findings partly confirm earlier OECD work on the impact of public expenditure on R&D (Guellec and van Pottelberghe, 2000).

One advantage of R&D tax incentives, compared to other more direct forms of support for innovative activity, is that decisions on which R&D projects to undertake are taken by firms themselves and so are more likely to be successful than projects selected by government officials. At the same time, the deadweight losses may be larger for general tax incentives than for targeted direct grants. Moreover, tax incentives, like direct subsidies, are generally only available for formal R&D, which is mainly implemented in manufacturing industries. Tax incentives to raise R&D may, therefore, have little effect on productivity in the increasingly important service sectors, where innovations are often produced informally in the course of ordinary business operations. Additionally, the increasingly footloose nature of investment suggests that R&D spending in one country is also likely to respond to a change in incentives in other countries (Abramovsky, *et al*. 2005). Thus, if tax incentives that attract R&D activities of multinationals in one country are matched by similar benefits offered by other countries, the overall loss of tax revenue may exceed the benefits to be obtained locally from R&D externalities or knowledge spill-overs from MNEs.

Empirical results using industry-level data support previous findings in that tax incentives for R&D appear to enhance TFP (Box 9 for details). But, the effect of tax incentives on the level of TFP relative to best practice level seems to be rather small. For example, a five percentage points increase in these incentives (equivalent to an increase of the subsidy by 5 cents per dollar spent on R&D) would raise the yearly TFP growth rate in an industry with median R&D intensity by 0.01 percentage points more than in an industry with very low R&D intensity (see Box 9).[32] This corroborates the conclusion of Jaumotte and Pain, (2005a,b) that tax policies can

30 Similar conclusions are reached in International Tax Dialogue (2007).

31 Firms face difficulties in appropriating the benefits of their investments in innovation while preventing their competitors from doing so. The extent to which this is possible depends on both the strength of competition and the degree of protection of intellectual property rights

32 This increase corresponds to ½ of the standard deviation of tax subsidies across countries.

do relatively little to enhance innovative activity.[33] However, the analysis also shows that the effect of R&D incentives could potentially be larger in R&D intensive industries and, to the extent that tax-induced innovative activities in highly R&D intensive industries may translate in a persistent acceleration of TFP growth, tax reforms that enhance R&D spending may still be beneficial. In any event, conclusions about the advantage of these tax incentives over general cuts in corporate taxation for R&D outcomes should be based on the relative cost-effectiveness of these policies, which is an area that needs further investigation.

Effective cross-border tax rates may also affect the international allocation of fixed capital

Taxes influence investment incentives of foreign investors in a similar way as those of domestic investors. Aside from the effects of tax wedges on labour (see above), tax influences on FDI include both domestic tax rates and other tax arrangements affecting cross-border incomes. A country's attractiveness as a location for foreign direct investment (FDI) depends, among other things, on how its tax system compares with possible competitor destinations. The combined effect of the home and the host country's tax codes as well as bilateral and multilateral tax agreements matter, for example, withholding taxes that countries apply to payments abroad from firms operating in the domestic economy may depend on tax treaties (see *e.g.* Yoo, 2003).

The implications of FDI taxation regimes are likely to be different from those of taxation on domestic investment because FDI not only adds to capital formation but also generates technology and knowledge spillovers that can boost productivity of domestic firms (Keller 2004; Griffith *et al.* 2004; Criscuolo, 2006; Bloom *et al.* 2007). Furthermore, foreign affiliates may increase the level of competition and thus the incentives to improve productivity in the host country. Some non-policy factors also affect how FDI responds to changes in different taxes. In particular, FDI may be more sensitive to taxes in small countries (or countries having a small market size) or in countries facing comparative disadvantages related to distance or transaction costs. Recent empirical OECD work found evidence of an adverse effect of corporate taxes on FDI, however, the effect seems to be small relative to that of tax wedges on labour income and other policies affecting the business environment (Hajkova *et al.* 2006).[34] This result is consistent with the conclusions in an OECD literature review which finds considerable evidence of a negative relationship between FDI and host country taxation (OECD, 2007c).

Foreign direct investment allows firms to choose their location based *inter alia* on taxes. In turn, this can spur tax competition in order to attract both foreign affiliates and profits generated by activities elsewhere, which multi-national enterprises can shift to relatively low tax countries (see below). There is some evidence that multinational firms react to tax incentives (for overviews see Gordon and Hines 2002 and OECD, 2007c) and of tax competition taking place in recent years resulting in cuts in the corporate tax rates (see *e.g.* Devereux and Sorensen, 2006). The ongoing integration of world capital markets and the increase in the mobility of capital has affected the sensitivity of the capital base to tax changes. This can spur further tax competition and have important implications for the design and effect of tax policies.

A further factor that can influence the international allocation of fixed capital is whether the home country of a multinational firm exempts foreign dividends from tax, or subjects them to domestic taxation while providing a credit for taxes already paid in the source country. The economic rationale for the credit system is that, in principle, it removes any corporate tax

33 This may suggest that non-tax policies should be considered in addressing under investment in R&D and low total factor productivity in OECD countries, such as reforms in product markets, tertiary education and research policies and intellectual property rights regimes.

34 The study shows that a one percentage point increase in the effective corporate tax rate of the host country reduces its FDI stocks by 1% to 2%.

distortion between domestic and foreign investment by domestically owned firms, and between investments in different foreign countries (*i.e.* it furthers "capital export neutrality"). However, the credit system is never implemented in a way that fully achieves this: countries normally limit the credit to the amount of tax that would have been due under domestic law, and most countries grant deferral to 'active' business income so that it is only taxed when it is repatriated. In contrast, the economic rationale for the exemption system is that, if all countries adopted it, investments into a particular country would all be taxed the same, regardless of their country of origin (*i.e.* "capital import neutrality"). This promotes equal competition within any host country and also means that the transfer of ownership of a company from one multinational group to another would not affect the corporate taxes levied on its profits (thus facilitating the transfer of companies to the owners that will manage them most efficiently). However, as with the credit system, most countries do not employ a 'pure' exemption system, applying the credit system in certain situations. Over the past 15 years, there has been a gradual movement of countries moving from a credit to an exemption system, at least in part because of the competitive edge that this can give to their resident multinational firms.

Issues in the design of a growth-oriented corporate income tax system

Summing up, the main reason for imposing a corporate income tax is that the tax plays an important withholding function, acting as a "backstop" to the personal income tax (for an overview see OECD, 2007b). In the absence of corporate income taxation, business earnings that are retained escape taxation until the shareholder realises the corresponding capital gains or losses. And in the absence of capital gains tax, retained earnings would not be taxed at all. Therefore, by levying corporate income tax governments prevent shareholders from sheltering their equity income from taxation and, at the same time, avoid large differences in the tax burdens on capital versus labour income and on corporate versus unincorporated businesses.

There is a wide consensus that corporate taxation should avoid discouraging efficiency improvements and aim at ensuring neutrality and consistency, for instance, by not favouring some investment or firms at the expense of other, potentially more productive, investment or firms (*e.g.* Devereux and Sørensen, 2006). This would imply a reasonably low corporate tax rate with few exemptions. As described earlier, recently most tax reforms in the OECD have indeed involved tax cuts and base broadening (OECD, 2007b).[35] This approach minimises tax-induced distortions while raising revenues as efficiently as possible.

Besides the level of the corporate rate and the breadth of the tax base, the following areas could also be considered:

- ***Exemptions.*** The evidence reviewed and the empirical results in this section suggest that preferential tax treatment of or exemptions from corporate taxation for small firms are not likely to be justified. Investment decisions of small firms do not appear to be more sensitive to corporate taxes than those of large firms – indeed evidence points to the opposite. Moreover, TFP in small firms tends to be less sensitive to corporate taxation than TFP in other types of firms. Thus, special tax reliefs based on firm size could result in economic inefficiencies as resources may be wasted. Cutting back on these exemptions free resources for cuts in the overall statutory corporate tax rate, which were found to be beneficial for enhancing economic growth by favouring high return and rapidly catching up firms and industries.

35 The definition of the corporate tax base in OECD countries is complex as it involves legislation covering many areas such as allowances for capital expenditure, valuation of assets and to which extent expenses can be deducted.

- ***Tax incentives for innovation.*** Tax incentives for R&D to stimulate private-sector innovative activity seem to have larger effects than direct support, but these effects appear nonetheless relatively small outside R&D intensive industries. Other measures, such as pro-competitive product market reforms or reforms in tertiary education systems, may be more effective for enhancing innovation activities.

- ***Double taxation of equity.*** The choice of treatment of corporate equity income can have implications for economic growth. In many countries corporate equity is taxed both at the company and at the shareholder level in form of dividend and capital gains tax. The treatment of such income at the personal level is important since this "double taxation" creates disincentives to invest and discriminates against equity finance in favour of debt and thereby tilts the playing field in the direction of enterprises that easily obtain debt finance. Particularly personal taxes on corporate equity income distort the cost of equity capital for small firms without access to international stock markets. It also discourages firms from choosing to become corporations. Generally, double taxation of dividends may inhibit firm growth, with negative consequences on economic performance.

- ***Relation with personal income taxation.*** The possibility of tax minimisation by shifting income between corporate and personal taxation needs to be taken into account when designing the corporate tax system. If personal income is taxed at a significantly higher rate than corporate income this may encourage an entrepreneur to classify her/his income as corporate instead of personal, which would reduce tax liabilities, consequently eroding the tax base and lowering overall tax revenues collected.

- ***Tax complexity.*** Another issue is that the increasing complexity of the tax system may be harmful for growth. Complex tax codes tend to result in high tax compliance costs than can lead to a loss of efficiency as resources are wasted to comply with the tax system instead of being put into productive use. It may also contribute to make the business environment less friendly, deterring FDI. A complex tax system also contributes to low awareness of incentives and tax reliefs, especially among small firms, which may reduce investment and economic performance. One reason for the increasing complexity of the tax system is that governments react to tax planning by some firms with anti-abuse legislation that inevitably increases the administrative load on all firms. For instance, Slemrod *et al.* (2007) suggest that tax complexity in the United Kingdom has increased in recent years mainly because a significant volume of anti-avoidance legislation has been added to the tax code. However, measuring the complexity of the tax system is not easy and no representative cross-country tax indicator has been developed in this field. Even though there is yet no available cross-country evidence on the growth effects of tax complexity, a cautious approach in the design of corporate taxation is to aim for a simple tax system.

- ***International aspects***. It is not necessarily the case that a high tax rate produces high tax revenues since, with open economies, firms can choose to locate their activities, or their profits, in low-tax countries. The possibility of shifting incomes between different jurisdictions has become more important with globalisation. Multinational firms who are active in many countries may be able to shift profits between countries by using transfer pricing and intra-group loans to take advantage of lower levels of

corporate statutory tax rates.[36] Thus, countries may seek to compete over mobile capital and the corporate tax base by lowering effective and statutory tax rates. The empirical literature on tax competition suggests that the increasing mobility of capital has had some impact on lowering corporate statutory tax rates, which is consistent with the observed reductions in the statutory rates in OECD countries over the last two decades. The physical location decision of multinationals (MNEs) is important since they may contribute to the host country's growth by spurring competition and facilitating the transfer of new technologies adding to productivity growth. But it has to be recognised that tax is only one factor in influencing these decisions.

4 The overall tax design

4.1 Bringing together individual tax effects

The "bottom-up" approach adopted in the previous section gives a detailed description of the main growth linkages concerning each type of tax. But these separate effects need to be brought together in order to understand the overall impact of tax systems on economic performance. This section proposes a simple framework for attempting such a synthesis. In this framework, taxes are organised in an overview matrix (Figure 14) in four broad groups: consumption, property, personal income and corporate income tax. Within this broad tax mix, the differential impact of individual tax instruments on the drivers of GDP per capita is reported relying on the links highlighted in the previous section. Each entry in the matrix considers the impact of an increase in one tax, holding all other taxes unchanged, on a performance measure. A negative (positive) sign indicates that an increase in the tax adversely (positively) affects the driver of growth. However, some taxes may simultaneously influence, possibly in different ways, many drivers of growth. Reading down the rows in the matrix it is possible to consider the effect of a tax measure, for example the average personal income tax wedge, on all the determinants of growth. Similarly, looking across the columns in the matrix allows assessing the effect of all taxes on one of the drivers of growth. A memorandum item indicates if strong distributional effects arise from changes in those taxes. The last column compares performance in each of the drivers of GDP per capita relative to average OECD performance.

[Figure 14. Tax matrix]

The advantage with this set-up is that it can account for reinforcing or offsetting effects on overall economic performance of tax reforms involving the adjustment of several tax instruments. The level and design of taxes in a country relative to a benchmark (a country or OECD average) could be compared with the relative performance of the country on each of the drivers of growth that are affected by these taxes. Thus, it could be of some use in the annual "Going-for-Growth" exercise for identifying tax policy priorities in OECD countries. Clearly, the matrix by itself cannot provide policy guidance since, as explained in previous sections, additional country-specific factors must be taken into account in the design of tax reforms. These include the starting level of taxation and tax mix, interactions with country-specific policy and institutional settings in other areas (such as bargaining and other labour market

36 Transfer pricing is the mechanism adopted by MNEs for valuing the goods and services traded with their subsidiaries abroad. The OECD transfer pricing guidelines maintain the arm's length principle of treating related enterprises within a multinational group and affirm traditional transaction methods as the preferred way of implementing the principle (OECD 1995). The "Arms Length Price" represents the price charged in comparable transactions between independent parties, where the price is not influenced by the relationship or business interest between the parties in the transaction.

features), the effectiveness of tax administration and so on. The next paragraphs provide an attempt to account for such complexities within a broad framework for tax policy design.

Broad tax design: policy insights from the previous sections

All OECD countries rely on a mix of consumption, property, personal income, and corporate income tax. The evidence reviewed in the previous sections indicate that setting the right mix is important, because the distortionary effects of collecting revenue from different sources can be very different and there could be efficiency gains from replacing part of the revenues from income taxes with revenues from less distortionary taxes such as consumption or property taxes, especially recurrent taxes on residential property, for a given overall level of the tax burden (*e.g.* Dahlby 2003; European Commission, 2006). The empirical work undertaken for this project confirms this conjecture and, abstracting from other policy objectives, suggests a "tax and growth ranking" of the tax instruments with regard to their long-run effect on GDP per capita (see Box 11 for details).

The following results are worth mentioning:

- Taxing consumption and property appears to have significantly less adverse effects on GDP than taxing income.

- Corporate income taxes appear to have a particularly negative impact on GDP per capita. This is consistent with the previously reviewed evidence and empirical findings that lowering corporate taxes raises TFP growth and investment. Reducing the corporate tax rate also appears to be particularly beneficial for TFP growth of the most dynamic and innovative firms. Thus, it seems that corporate taxation affects performance particularly in industries and firms that are likely to add to growth. The adverse influence of corporate taxes on GDP per capita through TFP is also consistent with the additional linkages described in Figure 14, including those working through entrepreneurship, innovative activity and FDI.

- As discussed earlier and illustrated in Figure 14, the distortionary effects of property taxes on the allocation of resources in the economy are likely to be less severe than those of income and consumption taxes. Indeed, within non-income taxation, recurrent taxes on immovable property seem to have the least adverse effect on GDP per capita.[37]

Box 11. Empirical findings on the aggregate effects of the tax structure on GDP

The empirical findings at the macro level on the effect of the tax structure on long-run GDP were obtained by introducing a set of tax structure indicators into a panel regression of GDP per capita covering 21 OECD countries over the period 1970 to 2005 (for details see Arnold, 2008). Throughout the analysis, differences across countries in the overall tax burden are accounted for by including the level of the tax-to-GDP ratio. The setup also considers the government budget constraint and takes into account that more use of a given tax instrument reduces the amount of revenues that need to be raised from other taxes.[1] This allows drawing conclusions on the impact of a revenue-neutral shift from one tax instrument to another on long-run GDP. The main findings reported in Table 11 are:

Estimates of the effect on GDP per capita of changing the tax mix while keeping the overall tax-to-GDP ratio constant indicate that a shift of 1% of tax revenues from income taxes to consumption and property taxes would increase GDP per capita by between a quarter of a percentage point and one percentage point in the long run depending on the empirical specification. The magnitude of the estimated effect is

37 Separating recurrent taxes on immovable property into those levied on household from those levied on corporations suggests that taxes levied on households have the least adverse effect on GDP per capita.

larger than what would be reasonably expected. Given that there is a wide dispersion of the point estimates across specifications it is clear that the size of the effects cannot be measured precisely in a cross-country comparative setting. For example, the estimated effects may overstate the effect of a shift in the tax mix because this shift may trigger similar shifts in the trading partners' economies, which would reduce the benefits from such a shift in the home country. Thus, the magnitude of the effects should be interpreted with caution. Column 1 shows a negative growth impact for a move from consumption and property taxes to income taxes, while Column 3 estimates a similarly-sized positive effect for an opposite shift away from income taxes.

Column 2 reports results in which a decrease in corporate income taxes (financed by an increase in consumption and property taxes) has a stronger positive effect on GDP per capita than a similar decrease in personal income taxation.

Results reported in Column 4 break up the effect of an increase in consumption and property taxes, allowing a reduction in income taxation. While both of them are associated with higher GDP per capita than relying on income taxes, the effect is significantly larger for property taxes. Column 5 separates recurrent taxes on immovable property from all other property taxes and the positive effect on GDP is significant larger for recurrent taxes on immovable property than for all other property taxes and consumption taxes.

[Table 11. Estimated cross-country effects of the tax mix on long-run GDP per capita]

The qualitative empirical findings are robust to a large number of robustness checks and alternative specifications, including the addition of several other economic variables affecting long-run GDP. In contrast, the magnitudes of the estimated effects are sensitive to the exact empirical specification, including the number of other economic and policy variables accounted for in the analysis. Moreover, the results obtained need to be interpreted with some caution as it is possible that the overall tax burden and the revenues shares are not independent of each other in the data, possibly leading estimated coefficients to be biased in terms of the effects of revenue-neutral tax changes.

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1. It is possible that the effects of certain taxes may be different in settings where this tax instrument is already heavily used. To account for this, an alternative specification that allows for non-linearities in the effects of individual taxes by adding them as quadratic terms in addition to the linear specification has been tried. However, these estimations were not able to generate significant coefficient estimates.

Issues in a revenue neutral tax shift from income taxation to consumption and property taxation

The evidence surveyed in this study and the empirical work suggests that there could be gains in terms of long-run GDP per capita from increasing the use of consumption and property taxes relative to income taxes without changing overall tax revenues. One recent example of such a tax shift is in Germany where the VAT rate was increased in the beginning of 2007 from 16% to 19%, partly to finance a cut in social security contributions. However, it is likely that the response of the economy to such a revenue shift would vary across countries depending on the precise nature of the reform as well as country characteristics. For example, a shift away from personal income taxes towards consumption taxes can have potentially larger positive effects on GDP per capita if it takes the form of cuts in marginal personal income tax rates rather than increases in thresholds (although the latter would be more effective at reducing inequality). It is also possible that the effectiveness of such a tax shift would vary across countries depending on the efficiency in collecting VAT and consumption taxes (as indicated by the c-efficiency of VAT).

In the long-run a revenue-neutral shift from personal income to VAT/consumption taxes may not have much effect on the average total taxes paid by a typical employee and so is unlikely to affect their decisions as to whether or not to work. This is because a reduction in income taxes offset by an increase in VAT/consumption tax by the same amount does not affect the real net wage of workers and leaves labour supply unaffected. This is the case if labour supply depends on the total tax burden of a worker and VAT/consumption tax is largely paid by workers, in which case there is limited opportunity to affect labour supply through this reform (*e.g.* Layard *et al.* 1996). But since personal income taxes are generally more progressive than consumption taxes this reform will reduce the marginal tax rate of a typical worker and increase their incentive to work additional hours and thus promote economic growth although at the expense

of making the tax system less progressive. Also, if the increase in VAT/consumption taxes reduces the real income of those outside the labour force, it could increase the incentive to work.

If a shift from income to consumption taxation changes the incidence of taxation on different categories of workers, labour market institutions could also play a role in determining the effect of the change in tax policy on labour utilisation. For instance, the tax burden may be shifted to low-paid workers affecting their labour supply decision if they spend relatively more of their income on consumption goods that have experienced an increase in the price because of the tax increase. Likewise, the tax burden may also be shifted on to pensioners and other groups outside the labour market to the extent that their income follows gross wages. To the extent that wage-setting mechanisms, such as minimum wages, prevent the pass through of such additional tax burden on to wages, labour demand could be affected as well.

A reform towards greater use of taxes on consumption could raise GDP but it would also increase inequality, particularly at the lower end of the wage distribution as consumption taxes are less progressive than personal income taxes. This implies a trade-off between tax policies that enhance GDP per capita and equity. However, changes in the tax and benefits system could be used to offset some of the effects of this reform on inequality, although such changes would reduce work incentives and so offset (part or all of) the growth-enhancing effects of the tax shift. Some countries use reduced VAT rates on certain goods (*e.g.* food items) to lower the tax burden on low-income households, but this is a relatively ineffective way of reducing inequality. As discussed in Section 3.1, it is better to use the benefit system to deal with distributional concerns. Even so, it is possible that a large group of voters could lose out from a shift to consumption taxes, making it politically and socially difficult to implement. The redistributive implications of the tax shift may also have adverse effect on the labour force participation of marginal workers (European Commission, 2006). This may happen because, as wages and personal income taxes of low-skilled workers are already low, they would gain little from a cut in personal income taxes, but would lose from the increase in consumption taxes, reducing their likelihood of labour force participation.

A shift towards taxes on property appears to be even better for growth than a shift towards consumption taxes and has the added advantage that it would be less likely to raise equity concerns. The discussion in Section 3.2 suggests that the best form of the shift would be towards recurrent taxes on immovable property as this is the least distortionary type of property tax. Nonetheless, there are two practical drawbacks to a significant shift towards greater taxation of immovable property. First, these taxes are very unpopular in many countries, at least in part because of their visibility. This unpopularity could be reduced if the reforms suggested in Section 3.2 were implemented, especially the use of up-to-date valuations and provisions to deal with the situation of people with low incomes and illiquid assets. In some countries, an increase in the progressivity of the tax might make it more acceptable. The second practical drawback is that, in most OECD countries, property tax revenues belong to local governments and so a shift towards property taxes would require some changes to the revenue sharing arrangements. However, this difficulty should not be over-estimated as in most OECD countries local governments receive some income tax revenues (which could be substituted by property tax revenues) and/or substantial grants from higher levels of governments (which could be reduced as property tax revenues increased).

Annex 1: Tables and figures

Tables

Figures

Table 1: Revenue shares of the major taxes in the OECD area

	1975	1980	1985	1990	1995	2000	2005
Personal income tax	30	31	30	30	27	26	25
Corporate income tax	8	8	8	8	8	10	10
Social security contributions[1]	22	22	22	22	25	24	26
(employee)	*(7)*	*(7)*	*(7)*	*(8)*	*(8)*	*(8)*	*(8)*
(employer)	*(14)*	*(14)*	*(13)*	*(13)*	*(14)*	*(14)*	*(15)*
Payroll taxes	1	1	1	1	1	1	1
Property taxes	6	5	5	6	6	5	6
General consumption taxes	15	15	16	17	18	18	19
Specific consumption taxes	18	17	16	13	13	12	11
Other taxes[2]	1	0	1	3	3	3	3
Total	100	100	100	100	100	100	100

1. Including social security contributions paid by the self-employed and benefit recipients (heading 2300) that are not shown in the breakdown over employees and employers.

2. Including certain taxes on goods and services (heading 5200) and stamp taxes.

Source: OECD Revenue Statistics

Table 2: The evolution of standard value-added tax ratesPercent

	1975	1980	1985	1990	1995	2000	2005	2007
Australia	-	-	-	-	-	10	10	10
Austria	16	18	20	20	20	20	20	20
Belgium	18	16	19	19	20.5	21	21	21
Canada	-	-	-	-	7	7	7	6
Czech Republic	-	-	-	-	22	22	19	19
Denmark	15	22	22	22	25	25	25	25
Finland	-	-	-	-	22	22	22	22
France	20	17.6	18.6	18.6	20.6	20.6	19.6	19.6
Germany	11	13	14	14	15	16	16	19
Greece	-	-	-	18	18	18	19	19
Hungary	-	-	-	25	25	25	20	20
Iceland	-	-	-	22	24.5	24.5	24.5	24.5
Ireland	19.5	25	23	23	21	21	21	21
Italy	12	15	18	19	19	20	20	20
Japan	-	-	-	3	3	5	5	5
Korea	-	10	10	10	10	10	10	10
Luxembourg	10	10	12	12	15	15	15	15
Mexico	-	10	15	15		15	15	15
Netherlands	16	18	19	18.5	17.5	17.5	19	19
New Zealand	-	-	-	12.5	12.5	12.5	12.5	12.5
Norway		20	20	20		23	25	25
Poland	-	-	-	-	22	22	22	22
Portugal	-	-	-	17	17	17	21	21
Slovak Republic	-	-	-	-	23	23	19	19
Spain	-	-	-	12	16	16	16	16
Sweden	17.65	20.63	23.46	23.46	25	25	25	25
Switzerland	-	-	-	-	6.5	7.5	7.6	7.6
Turkey	-	-		10	15	17	18	18
United Kingdom	8	15	15	15	17.5	17.5	17.5	17.5
United States	-	-	-	-	-	-	-	-

Source: OECD Revenue Statistics

Table 3: Taxation of residential property (2002)

	Imputed rental income taxed	Tax relief on mortgages		Capital gains on housing assets taxable	Estate/ Gift/Inheritance tax
		Interest	Principal repayments		
Austria	N	Y (up to ceiling)	N	Y	Y
Belgium	Y (with fixed deduction)	Y (up to imputed rental income)	Y (within limit)	Y (if sold < 5 years) POOD are exempt	Y
Canada	N	N	N	Y (on 50% of gains) POOD are exempt	N (but subject to capital gains tax from which POOD are exempt)
Denmark	N	Y	n.a.	Y POOD are exempt	Y
Germany	N	N	N	Y (if sold <10 years) POOD are exempt	Y (lower than for financial assets)
Finland	N	Y (up to a ceiling)	n.a.	Y POOD exempt if sold > 2 years	Y
France	N	N	N	Y POOD are exempt	Y
Ireland	N	Y	N	Y POOD are exempt	Y
Italy	N (for POOD)	Y (for POOD)	N	Y (50% for POOD)	Y (until 2001)
Netherlands	Y	Y	N	N	Y (above tax free threshold)
Norway	Y	Y	N	Y (exempt if occupied by owner > 1 of 2 years preceding sale)	Y
Spain	N (for POOD)	Y	Y	Y (exempt if reinvested)	Y
Sweden	Y	Y	N	Y (exempt if reinvested)	N
United Kingdom	N	N	N	Y POOD are exempt	Y
United States	N	Y (up to ceiling)	N	Y (until 2002) (deduction for POOD if held > 2 years)	Y

Note: POOD = principal owner-occupied dwellings.
Source: Catte, P., N. Girouard, R. Price, and C. André (2004), "Housing Markets, Wealth and the Business Cycle", *OECD Economics Department Working Papers*, No. 394; Baunkjoer, C.F. (2004), "Housing Taxation", *Housing and Housing Policy in Nordic Countries*, M. Lujanen (ed.), Nordic Council of Ministers.

Table 4: Taxes on capital income at the household level in selected OECD countries (2004/2005)

	Dividend tax treatment at the shareholder level (2005)	Tax treatment of capital gains on portfolio equity shares (as of 1 July, 2004)	Tax treatment of capital gains on principal residence (as of 1 July, 2004)	Taxation of interest payments (2005)
Australia	Dividends taxed at marginal ordinary PIT rates (0%-17%-30%-42%-47%) but imputation credit is provided for corporate tax already paid (full imputation system).	Shares held < 1 year: capital gain included in assessable income. Shares held ≥ 1 year: 50% of capital gain included in assessable income. Capital gain taxed at marginal ordinary PIT rates.	Exempt (partial capital gains inclusion to extent used for business or rent).	Taxed at marginal ordinary PIT rates (0%-17%-30%-42%-47%).
Belgium	25% flat rate in general; 15% flat rate under certain conditions.	Shares purchased with speculative intent: 33% flat rate. Other shares: exempt.	Exempt. If gains deemed as speculative, taxed at 16.5% flat rate.	15% flat rate
Canada	Dividends taxed at marginal ordinary PIT rates (federal and provincial) but imputation credit is provided for corporate tax already paid (full imputation system in 2006)	Half (50%) inclusion in net taxable capital gains. Taxed at marginal ordinary PIT rates.	Exempt. Recognition of no more than 1 principal residence per family at any one time.	Taxed at marginal ordinary PIT rates.
Finland	43% of dividends from a quoted company are exempt, with the remaining 57% being taxed as the shareholder's income from capital (taxed at 28% rate).	Inclusion in income from capital, separate taxation at 29% flat rate (28% in 2005).	Exempt if owned and permanently occupied by taxpayer for ≥ 2 years prior to sale. Otherwise: 29% flat tax rate is levied (28% in 2005).	Taxed at flat rate of 28%.
Germany	50% of dividends are exempt (half-income system). Other 50% are taxed at ordinary progressive PIT rates.	Shares held ≤ 1 year: half of the profit is tax-exempt, other half is taxed at ordinary progressive PIT rates on taxable income. Shares held > 1 year and of less 1% of the nominal capital: exempt (if more than 1% of the nominal capital: taxed as shares held ≤ 1 year).	Exempt if occupied by owner for a minimum period of time. No exemption where residence is used in a business.	Taxed at marginal ordinary PIT rates.
Ireland	Taxed at marginal ordinary PIT rates (20%-40%)	Taxed at flat 20% rate	Exempt with land of up to 1 acre.	Taxed at marginal ordinary PIT rates (20%-40%).

	Dividend tax treatment at the shareholder level (2005)	Tax treatment of capital gains on portfolio equity shares (as of 1 July, 2004)	Tax treatment of capital gains on principal residence (as of 1 July, 2004)	Taxation of interest payments (2005)
Netherlands	Presumptive capital income tax treatment: a return of 4% is deemed to be received on the value of the underlying 'ordinary' shares (irrespective of actual return received); this deemed return is taxed at a rate of 30%; 25% flat rate on dividends from a substantial shareholding.	Same presumptive capital income tax treatment as dividends. Realized capital gains on shares that form a substantial shareholding: flat 25% rate.	Exempt, provided the residence is not used as business asset.	Same presumptive capital income tax treatment as dividends.
Norway	Dividends are included in taxable income and taxed at the flat 28% rate; the shareholder is entitled to a full tax credit for the underlying corporate tax paid.	Variable partial inclusion in taxable income, taxed at 28% flat rate, under the so-called RISK system, which steps-up acquisition cost of each share by pro-rate share of retained (after tax) profits.	Exempt, provided seller has owned residence for ≥ 1 year, and has used it as principal residence for at least one of two previous years, and provided the residence is not used as a business asset.	Taxed at flat 28% rate.
Slovak Republic	Exempt.	Included in net taxable income, taxed at flat 19% rate.	Exempt if owned/used as primary residence for ≥ 2 years. Taxable at 19% flat rate if used for business or was rented out.	Included in net taxable income, taxed at flat 19% rate.
United States	Qualified dividends taxed at a flat 15% rate (reduced to 5% for taxpayers with marginal PIT rate of 10% or 15% for ordinary tax purposes).	Shares held ≤ 1 year: taxed at marginal ordinary PIT rate. Shares held > 1 year: taxed at flat 15% tax rate (reduced to 5% for taxpayers with marginal PIT rate of 10% or 15% for ordinary tax purposes).	Gain is included in net capital gain (net of an exempt amount) and taxed at lower capital gains rate if owned and occupied by taxpayer as principal residence for ≥ 2 years over prior 5 years.	Taxed at ordinary marginal PIT rates.

Source: OECD Tax Database (www.oecd.org/ctp/taxdatabase), OECD (2006) "Taxation of capital gains of individuals" and European Tax Handbook (2005).

Table 5: Standard and reduced (targeted) corporate income tax rates for small businesses (2005)

	Standard corporate income tax rate (%) (2005) [1]	Small business corporate tax rate(s) (%) (2005) [2]	Range of taxable income where the reduced rate applies (2005)	Other conditions to benefit from the reduced rate(s) and/or additional qualifications (2005) [3]
Belgium	33.99	24.9775: 31.93: 35.535:	EUR 0 – 25 000 EUR 25 000 – 90 000 EUR 90 000 – 322 500	The company cannot be an investment company; entitlement to the reduced rates is not granted to companies of which at least 50% of the shares are held by one or more companies and to companies whose dividend distributions exceed 13% of the paid-up capital at the beginning of the financial year.
Canada	36.1	18.62 [4]	CAD 0 – 300 000 [5]	Applies only to the active business income of a Canadian controlled private corporation. Preferential rate phased out for taxable capital between CAD 10-15 million. The taxable income and capital limits are shared amongst all associated companies
France	35	15.225	Profits: EUR 0 – 38 120	Firms owned at least for 75% by individuals and with a turnover of EUR 7 630 000 or less.
Japan	39.54	29.34: 30.85:	JPY 0 – 4 000 000 JPY 4 000 000 – 8 000 000	Reduced rates only for corporations with capital of JPY 100 million or less.
Korea	27.5	14.3	KRW 0 – 100 million	
Luxembourg	30.4	20.8: 20.8 / 27.04:	EUR 0 – 10 000; Firms with taxable income between EUR 10 000 – 15 000 pay 20.8% on profits up to EUR 10 000 and 27.04% on remainder such that at EUR 15 000, they pay an average rate of 22.88% (standard central CIT rate)	
Netherlands	31.5	27	EUR 0 – 22 689	
Spain	35	30	EUR 0 – 120 202.41	
United Kingdom	30	0: 0 / 23.75: 19:	Profits: GBP 0 – 10 000; Firms with profits between GBP 10 001 – GBP 50 000 pay nothing on the first GBP 10 000 and 23.75% on the remainder, so that by the upper limit (GBP 50 000), they are paying at an average rate of 19%; Profits GBP 50 000 – 300 000.	All limits for taxable profits are proportionately reduced in cases where there are associated companies, and where the accounting period is less than 12 months.
United States	39.3	20.23 [6]	US$ 0 – 50 000	

1. Combined central government and sub-central government standard (top) corporate tax rate.
2. Combined central government and sub-central government corporate tax rate typically applying for or are targeted at 'small (incorporated) business', where such 'targeting' is on the basis of size alone (*e.g.* number of employees, amount of assets, turnover or taxable income) and not on the basis of expenditures or other targeting criteria.
3. This table summarises the main arguments presented in the Explanatory Annex to Table II.2 of the OECD Tax Database.

4. Includes the sub-central government small business tax rate for the Province of Ontario.
5. Different thresholds are applied by the provinces. Federal thresholds increased effective January 1, 2007.
6. The federal income tax rate of 15% applies to taxable income under US$ 50 000; 25% applies to taxable income over US$ 50 000 and under US$ 75 000; 34% applies to taxable income over US$ 75 000 and under US$ 10 million; and 35% applies to taxable income of US$ 10 million or more. The benefit of lower rates is recaptured for taxable incomes between US$ 100 000 and US$ 18 333 333 (federal rates have to be increased with the sub-central rate).

Source: OECD Tax Database: www.oecd.org/ctp/taxdatabase and European Tax Handbook (2005).

Table 6: Estimated effects of labour taxes on TFP: Industry-level[1]

The estimated empirical model is:

$$\Delta lnTFP_{i,j,t} = \delta_1 \Delta lnTFP_{F,j,t} + \delta_2 ln(TFP_{i,j,t-1}/TFP_{F,j,t-1}) + \delta_3 HK_{i,j,t} + \beta INDcharac_j * TAX_{i,t-1} + \varphi X_{i,j,t-1} + \sum_i \sum_t D_{i,t} + \sum_j D_j + \varepsilon_{i,j,t}$$

Dependent variable: TFP growth	(1)	(2)	(3)	(4)
Basic model				
Leader TFP growth	0.06	0.06	0.05	0.06
	(0.02)***	(0.02)***	(0.02)**	(0.02)***
TFP relative to leader TFP (t-1)	-0.01	-0.01	-0.01	-0.01
	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Human capital (t-1)	0.01	0.01	0.01	0.01
	(0.00)**	(0.00)**	(0.00)**	(0.00)**
Interaction between industry characteristics & tax				
Labour intensity & social security contributions (t-1)	-0.01			
	(0.00)**			
Labour intensity & employer's social security contributions (t-1)		-0.01		
		(0.00)**		
Labour intensity & social security contributions (t-1) with low adm. extension				-0.01
				(0.01)
Labour intensity & Social security contributions (t-1) with high adm. extension				-0.01
				(0.00)**
Entry rate & top personal income tax (t-1)			-0.04	
			(0.01)***	
Other policy variables				
Anti-competitive regulation impact (t-1)	-0.03	-0.03	-0.01	-0.03
	(0.01)***	(0.01)***	(0.01)	(0.01)***
Job turnover & employment protection legislation			-0.00	
			(0.00)	
Observations	2802	2802	2910	2802
Fixed effects:				
Country*year	yes	yes	yes	yes
Industry	yes	yes	yes	yes

1. In the estimated empirical model $\Delta lnTFP_{i,j,t}$, $\Delta lnTFP_{F,j,t}$, $ln(TFP_{i,j,t-1}/TFP_{F,j,t-1})$, $HK_{i,j,t}$, $INDcharac_j*TAX_{i,t-1}$, $X_{i,j,t-1}$, $+\sum_i\sum_t D_{i,t}+\sum_j D_j$ refer respectively to (i) TFP growth in a country *i*, industry *j* and year *t*; (ii) TFP growth in an industry in the best practice country; (iii) the relative difference between TFP in an industry and in that industry in the best practice country; (iv) a human capital measure; (v) the interaction term between industry characteristics and the relevant tax; (vi) other policy variables and (vii) fixed effects. The level of TFP is measured as the "Solow-residual" from a production function. The anti-competitive regulation impact is an industry-specific measure of the degree to which each industry in the economy is exposed to anti-competitive regulation in non-manufacturing sectors. In Column (4) the coefficients of the interaction term between social security contributions and labour intensity are distinguished by the degree of administrative extension of collective wage agreements. In Columns (1)-(2) and (4) the interaction term between job turnover and employment protection legislation is dropped as there may be some collinearity problems related to job turnover and labour intensity. The estimation sample includes 13 OECD countries and 21 industries over the 1981-2001 period. The results are robust to introducing other interaction terms with other tax variables. Robust standard errors are reported in the parentheses. * denotes significance at 10%; ** at 5%; *** at 1%

Table 7: Estimated effects of corporate taxes on investment: firm-level[1]

The estimated empirical model is

$$(I/K)_{icst} = \beta_1 (I/K)_{ics,t-1} + \beta_2 (I/K)^2_{ics,t-1} + \beta_3 (Y/K)_{ics,t-1} + \beta_4 (CF/K)_{ics,t-1} + \beta_5 UCtax_{cs,t-1} + \gamma_s + \gamma_{ct} + e_{icst}$$

Dependent Variable: Investment-to-capital ratio	(1)	(2)	(3)
Basic model			
Investment-to-capital ratio (t-1)	0.532***	0.531***	0.534***
	(0.026)	(0.026)	(0.026)
Investment-to-capital ratio squared (t-1)	-0.415***	-0.414***	-0.418***
	(0.025)	(0.025)	(0.025)
Output-to-capital ratio (t-1)	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Cashflow-to-capital ratio (t-1)	0.048***	0.048***	0.047***
	(0.003)	(0.003)	(0.003)
Tax adjusted user cost (t-1)	-0.829**	0.147	
	(0.410)	(0.689)	
Interactions between firm & sector characteristics & tax			
Profitability & tax adjusted user cost		-0.723**	
		(0.351)	
Tax adjusted user cost (Age<6&Empl<30)			-0.339
			(0.497)
Tax adjusted user cost (Age<6&Empl>=30)			-0.401
			(0.476)
Tax adjusted user cost (Age>=6&Empl<30)			-0.832*
			(0.437)
Tax adjusted user cost (Age>=6&Empl>=30)			-1.039**
			(0.430)
Long-run tax adjusted user cost elasticity	-0.69		
Observations	211,599	211,599	211,599
Fixed effects:			
Sector	yes	yes	yes
Size-age	no	no	yes
Country-year	yes	yes	yes
R^2	0.12	0.12	0.12

1. In the estimated empirical model *(i)* $(I/K)_{icst}$ denotes the investment-to-capital ratio; *(ii)* $(I/K)_{ics,t-1}$ its lag; *(iii)* $(I/K)^2_{ics,t-1}$ its squared lag; *(iv)* $(Y/K)_{ics,t-1}$ the lag of the output-to-capital ratio; *(v)* $(CF/K)_{ics,t-1}$ the lag of the cashflow-to-capital ratio; *(vi)* $UCtax_{cs,t-1}$ the lag of the tax adjusted user cost and *(vii)* γ_s and γ_{ct} sector and country-year fixed effects, respectively. The estimation sample contains 12 European OECD countries and only observations with investment ratios beween 0 and 1. Robust standard errors corrected for clustering at the country-sector level in parentheses. * denotes significant at 10%; ** at 5%; *** at 1%

Table 8: Estimated effects of corporate taxes on investment: Industry-level[1]

The estimated empirical model is:

$$ln(I/K)_{i,j,t}=\beta_1 ln(I/K)_{i,j,t-1}+\beta_2 UCtax_{i,j,t-1}+\beta_3 DlnY_{i,j,t-1}+\beta_4 PMR_{i,j,t-1}+\varepsilon_{i,j,t},$$

	(1)	(2)
Dependent variable: log of investment-to-capital	OLS	System GMM
Log of investment-to-capital ratio (t-1)	0.66	0.73
	(0.02)***	(0.05)***
Log of tax adjusted user cost (t-1)	-0.12	-0.26
	(0.03)***	(0.11)***
Log difference in value added (t-1)	0.35	0.65
	(0.10)***	(0.07)***
Anti-competitive regulation impact (t-1)	-0.21	0.33
	(0.08)***	(0.39)
Long-run tax adjusted user cost elasticity	-0.35	-0.98
Observations	3818	3818
Hansen J test		
Prob > chi2 =		0.334
Fixed effects		
country*industry	yes	
year	yes	yes

1. In the estimated empirical model $(I/K)_{i,j,t}$, $UCtax_{i,j,t-1}$, $DlnY_{i,j,t-1}$ and $PMR_{i,j,t-1}$ refer respectively to (i) investment-to-capital ratio in country *i*, industry *j* and year *t*; (ii) the tax adjusted user cost; (iii) the relative change in value added and (iv) the impact of anti-competitive regulation. The anti-competitive regulation impact is an industry-specific measure of the degree to which each industry in the economy is exposed to anti-competitive regulation in non-manufacturing sectors. The long run elasticity is computed as $\beta_2/(1-\beta_1)$. The effects are similar when a non-log version of the investment equation is estimated. The estimation sample includes 16 OECD countries and 21 industries for period 1983-2001. Robust standard errors are reported in the parentheses. * denotes significance at 10%; ** at 5%; *** at 1%.

Table 9: Estimated effects of corporate taxes on TFP: firm-level[1]

The estimated empirical model is

$$\Delta lnTFP_{icst} = d_1 DlnTFP_{Fcst} + d_2 ln(TFP_{ics,t-1}/TFP_{Fcs,t-1}) + d_3 Profit_s * TAX_{c,t-1} + \gamma_s + \gamma_{ct} + e_{icst}$$

Dependent Variable: TFP growth	(1)	(2)	(3)
Basic Model			
Leader TFP Growth	0.173***	0.173***	0.501***
	(0.019)	(0.019)	(0.022)
TFP Relative to Leader (t-1)	-0.190***	-0.190***	-0.115***
	(0.015)	(0.015)	(0.010)
Interactions between firm & sector characteristics & tax			
Profitability & tax	-0.307**		
	(0.128)		
Profitability & tax (Age<6&Empl<30)		-0.145	
		(0.176)	
Profitability & tax (Age<6&Empl>=30)		-0.275**	
		(0.130)	
Profitability & tax (Age>=6&Empl<30)		-0.285**	
		(0.127)	
Profitability & tax (Age>=6&Empl>=30)		-0.357***	
		(0.134)	
Declining & profitability & tax			-0.038
			(0.088)
Rising & profitability & tax			-0.251***
			(0.090)
Observations	287,727	287,727	287,727
Fixed effects:			
Sector	yes	no	no
Sector-size-age	no	yes	no
Sector-catchup	no	no	yes
Country-year	yes	yes	yes
R^2	0.10	0.10	0.44

1. In the estimated empirical model *(i)* $\Delta lnTFP_{icst}$ denotes TFP growth in firm *i*, country *c*, sector *s* and year *t*; *(ii)* $\Delta lnTFP_{Fcst}$ denotes TFP growth in the technological leader firm; *(iii)* $(TFP_{ics,t-1}/TFP_{Fcs,t-1})$ denotes the inverse of distance to the leader; *(iv)* $Profit_s * TAX_{c,t}$ the interaction between profitability and the corporate tax and *(v)* γ_s and γ_{ct} sector and country-year fixed effects, respectively. The estimation sample contains 12 European OECD countries over the period 1998-2004. TFP is the residual of a Cobb-Douglas production function estimated at the country-sector level. Robust standard errors corrected for clustering at the country-sector level in parentheses. * denotes significant at 10%; ** at 5%; *** at 1%

Table 10: Estimated effects of corporate taxes on TFP: Industry-level[1]

The estimated empirical model is:

$$\Delta lnTFP_{i,j,t} = \delta_1 \Delta lnTFP_{F,j,t} + \delta_2 ln(TFP_{i,j,t-1}/TFP_{F,j,t-1}) + \delta_3 HK_{i,j,t} + \beta INDcharac_j * TAX_{i,t-1} + \varphi X_{i,j,t-1} + \sum_i \sum_t D_{i,t} + \sum_j D_j + \varepsilon_{i,j,t}$$

Dependent variable: TFP growth	(1)	(2)
Basic model		
Leader TFP growth	0.04	0.05
	(0.02)*	(0.02)**
TFP relative to leader TFP (t-1)	-0.01	-0.01
	(0.00)***	(0.00)***
Human capital (t-1)	0.01	0.01
	(0.00)**	(0.00)**
Interaction between industry characteristics & tax		
Profitability & Corporate tax (t-1)	-0.04	
	(0.01)***	
R&D intensity & R&D tax incentives (t-1)		0.003
		(0.001)**
Other policy variables		
Anti-competitive regulation impact (t-1)	-0.01	-0.01
	(0.01)**	(0.01)**
Job turnover & employment protection legislation	-0.00	-0.00
	(0.00)	(0.00)
Observations	2910	2767
Fixed effects:		
Country*year	yes	yes
Industry	yes	yes

1. In the estimated empirical model $\Delta lnTFP_{i,j,t}$, $\Delta lnTFP_{F,j,t}$, $ln(TFP_{i,j,t-1}/TFP_{F,j,t-1})$, $HK_{i,j,t}$, $INDcharac_j*TAX_{i,t-1}$, $X_{i,j,t-1}$, $+\sum_i \sum_t D_{i,t} + \sum_j D_j$ refer respectively to (i) TFP growth in a country *i*, industry *j* and year *t*; (ii) TFP growth in an industry in the best practice country; (iii) the relative difference between TFP in an industry and in that industry in the best practice country; (iv) a human capital measure; (v) the interaction term between industry characteristics and the relevant tax; (vi) other policy variables and (vii) fixed effects. TFP is measured as the "Solow-residual" from a production function. The anti-competitive regulation impact is an industry-specific measure of the degree to which each industry in the economy is exposed to anti-competitive regulation in non-manufacturing sectors. The estimation sample includes 13 OECD countries and 21 industries over the 1981-2001 period. The results are robust to introducing other interaction terms with other tax variables. Robust standard errors are reported in the parentheses. * denotes significance at 10%; ** at 5%; *** at 1%.

Table 11: Estimated cross-country effects of the tax mix on long-run GDP per capita[1]

The estimated empirical model is:

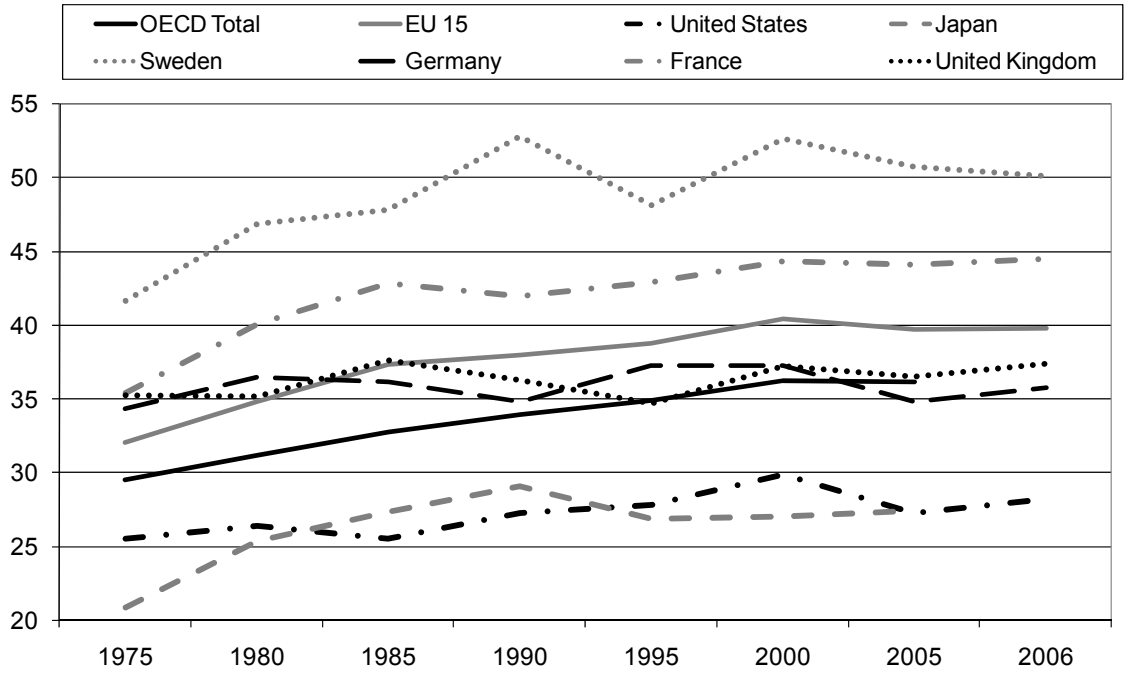
$$\Delta \ln y_{it} = -\Phi_i(\ln y_{it-1} - \theta_1 \ln s^k_{it} - \theta_2 \ln h_{it} + \theta_3 n_{it} + \sum \theta_j \ln V^j_{it} - a_{it}) + b_{1i} \Delta \ln s^k_{it} + b_{2i} \Delta \ln h_{it} + b_{3i} \Delta n_{it} + \sum b_{ji} \Delta \ln V^j_{it} + \varepsilon_{it}$$

Dependent Variable: Log GDP p.c.	(1)	(2)	(3)	(4)	(5)
Baseline Model					
Physical Capital	0.18 ***	0.25 ***	0.18 ***	0.16 ***	0.21
	(0.05)	(0.05)	(0.05)	(0.05)	(0.45)
Human Capital	1.19 ***	1.30 ***	1.18 ***	1.40 ***	1.57 ***
	(0.13)	(0.12)	(0.13)	(0.11)	(0.11)
Population Growth	-0.08 ***	-0.08 ***	-0.07 ***	-0.07 ***	-0.07 ***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Control variable					
Overall Tax Burden	-0.27 ***	-0.24 ***	-0.26 ***	-0.22 ***	-0.14 ***
(Total revenues / GDP)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)
Tax structure variables					
Income Taxes	-0.98 ***				
	(0.20)				
Personal Income Taxes		-1.13 ***			
		(0.19)			
Corporate Income Taxes		-2.01 ***			
		(0.32)			
Consumption & Property Taxes			0.93 ***		
			(0.20)		
Consumption taxes				0.74 ***	0.72 ***
(excl. property taxes)				(0.18)	(0.19)
Property taxes				1.45 ***	
				(0.43)	
Property taxes: Recurrent Taxes on Immovable Property					2.47 ***
					(0.84)
Property taxes: Other property taxes					-0.34
					(0.51)
Observations	696	675	696	696	698
Revenue-neutrality achieved by adjusting	Cons. & Prop. Taxes	Cons. & Prop. Taxes	Income Taxes	Income Taxes	Income Taxes

1. In the estimated model, y refers to output per capita, s^k to the investment rate into physical capital, h to human capital, n to the population growth rate, respectively. The vector V contains a set of policy variables. All equations include short-run dynamics, country-specific intercepts and country-specific time controls. Standard errors are in brackets. *: significant at 10 % level; ** at 5% level; *** at 1 % level.

Figure 1. Tax-to-GDP ratios in the OECD area (1975-2006)

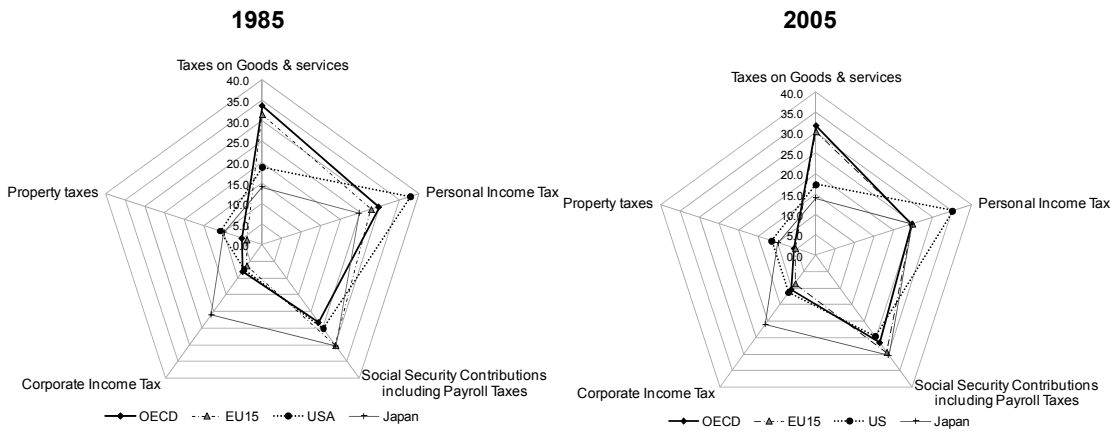
Per cent



Source : OECD (2007) Revenue Statistics 1965-2006

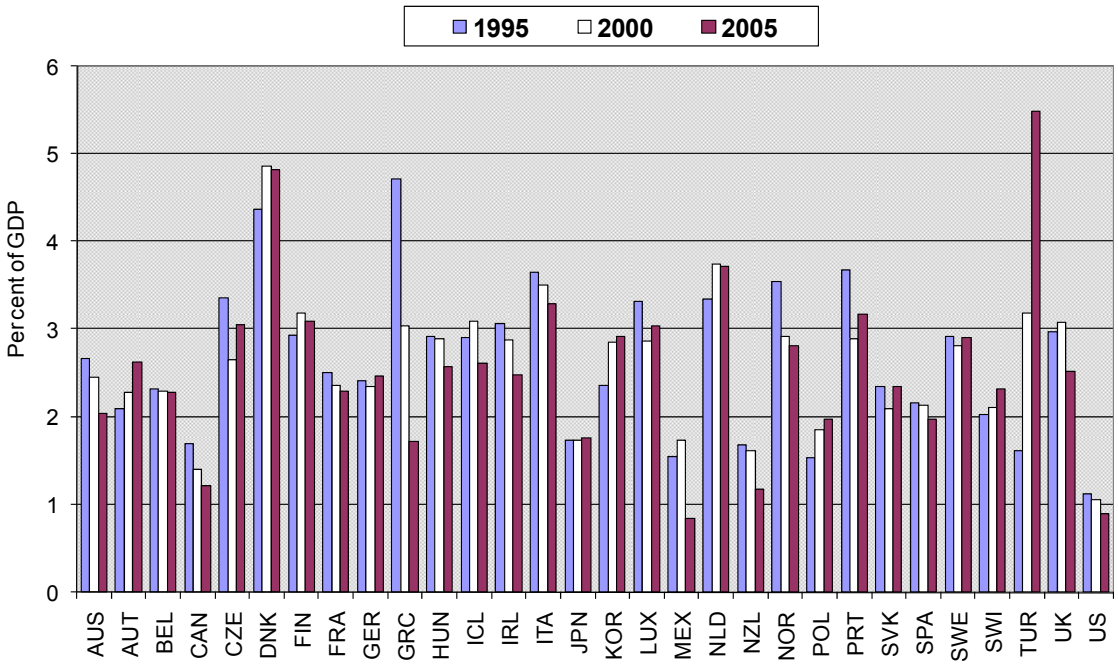
Figure 2. Tax structures in the OECD, 1985 and 2005 (selected countries/areas)

(per cent)



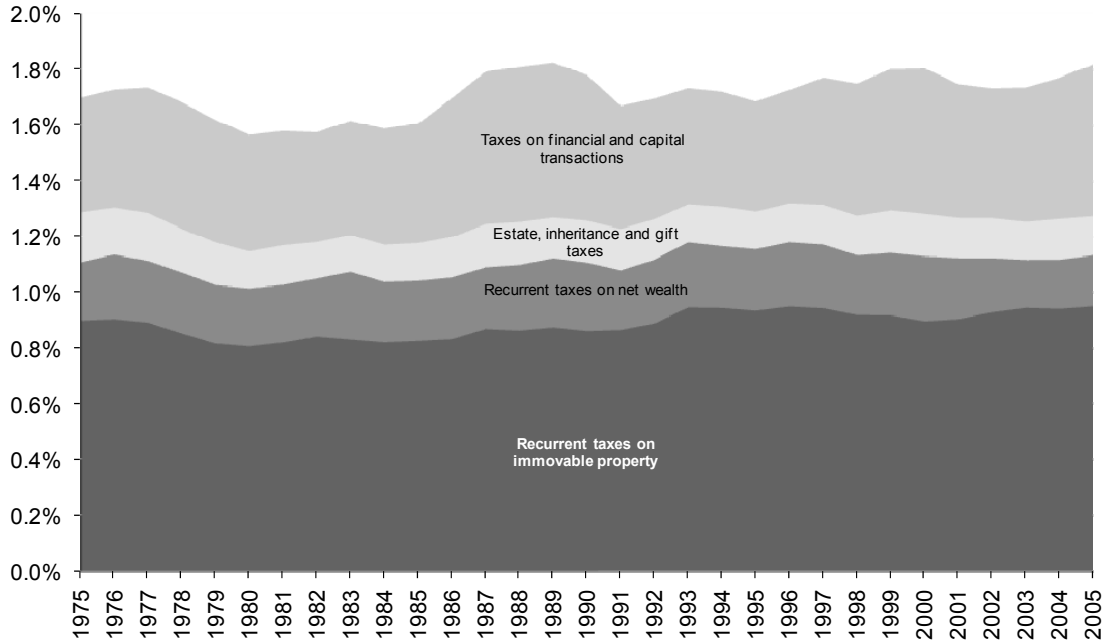
Source : OECD Revenue Statistics (2007).

Figure 3. Revenues from environmentally-related taxes in per cent of GDP



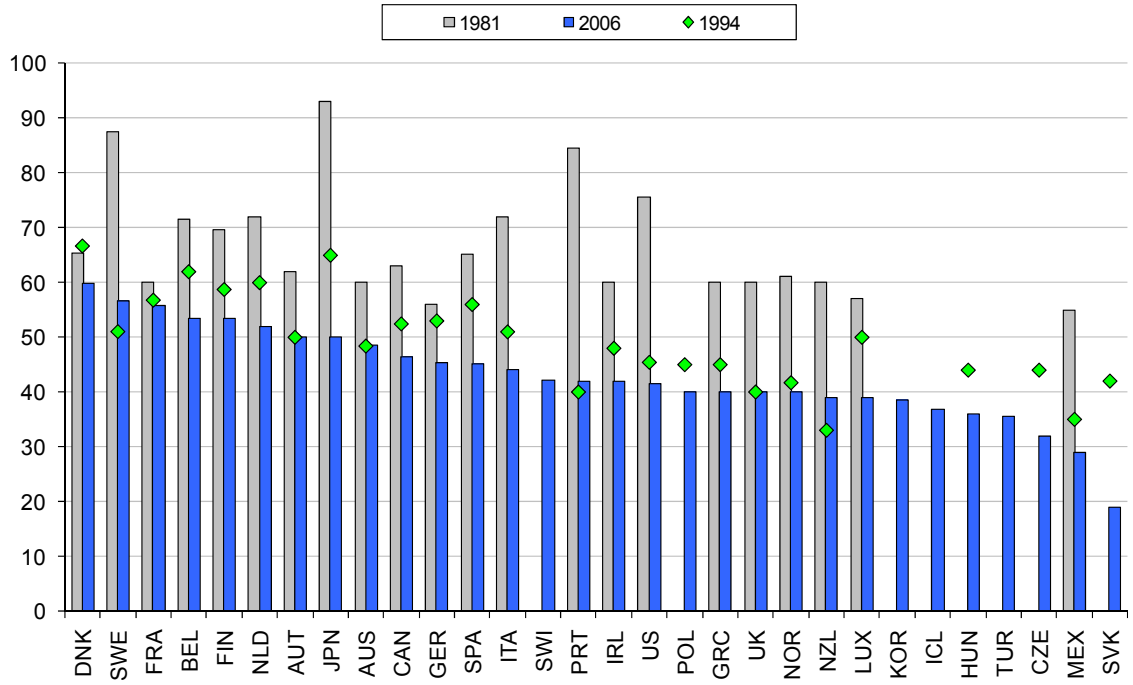
Note: 2005 data not available in the case of France and Iceland (2004 data used) and Korea (2003 data).
Source: OECD Revenue Statistics.

Figure 4.The evolution of property taxes (as a percentage of GDP)



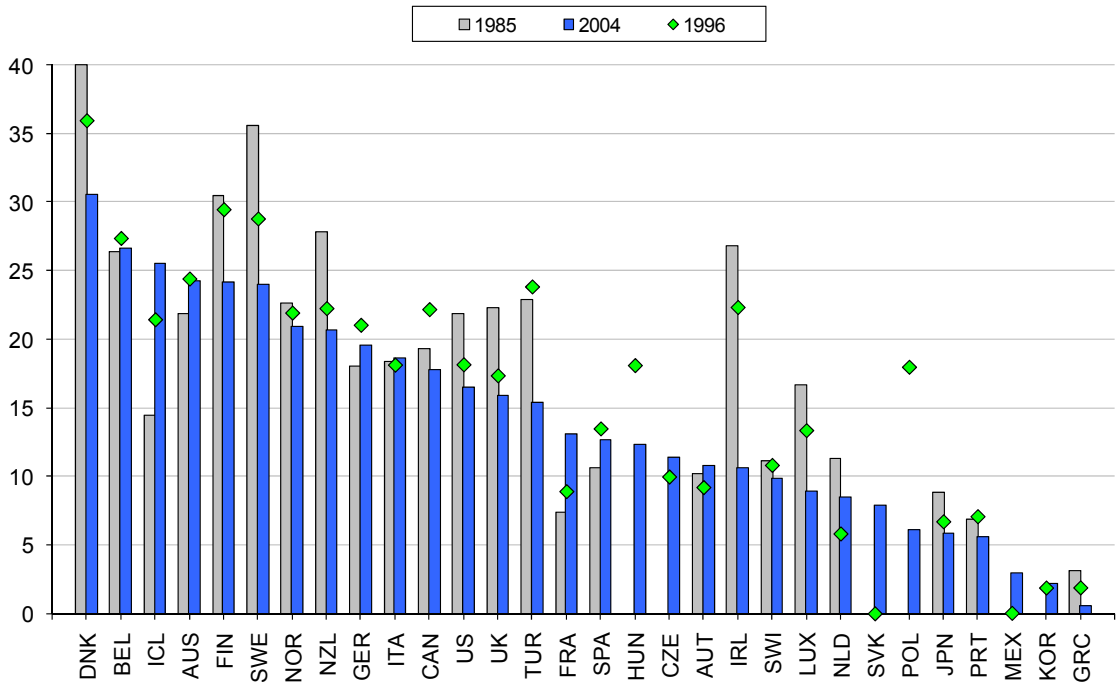
Source: OECD Revenue Statistics.

Figure 5.Top statutory personal income tax rates on wage income
(per cent)



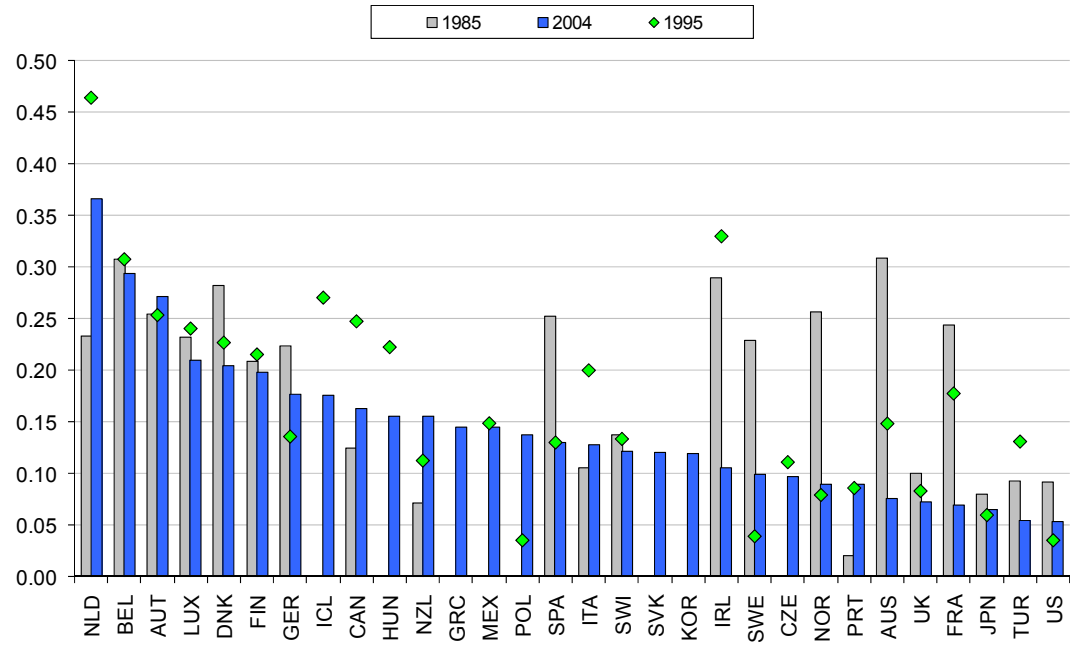
Source: OECD Taxing Wages 2006.

Figure 6. Average income tax for a single individual at average earnings
(in per cent of gross wage earnings)



Source: OECD Taxing Wages 2006.

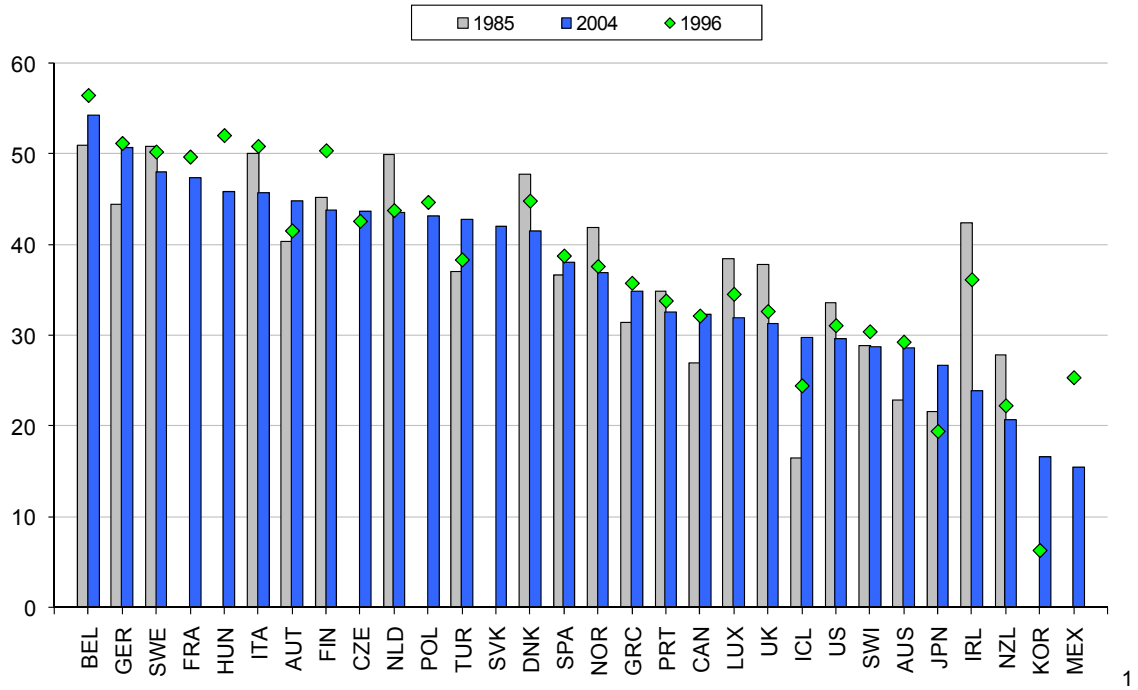
Figure 7. Statutory income tax progressivity for single individuals at average earnings[1]
(index increasing with progressivity)



1. The measure of progressivity used is the difference between the marginal and average personal income tax rates, divided by one minus the average personal income tax rate, for an average single production worker. Higher numbers indicate higher progressivity.

Source: OECD Taxing Wages 2006.

Figure 8. Tax wedge for a single individual at average earnings[1]
(in per cent of total labour costs)

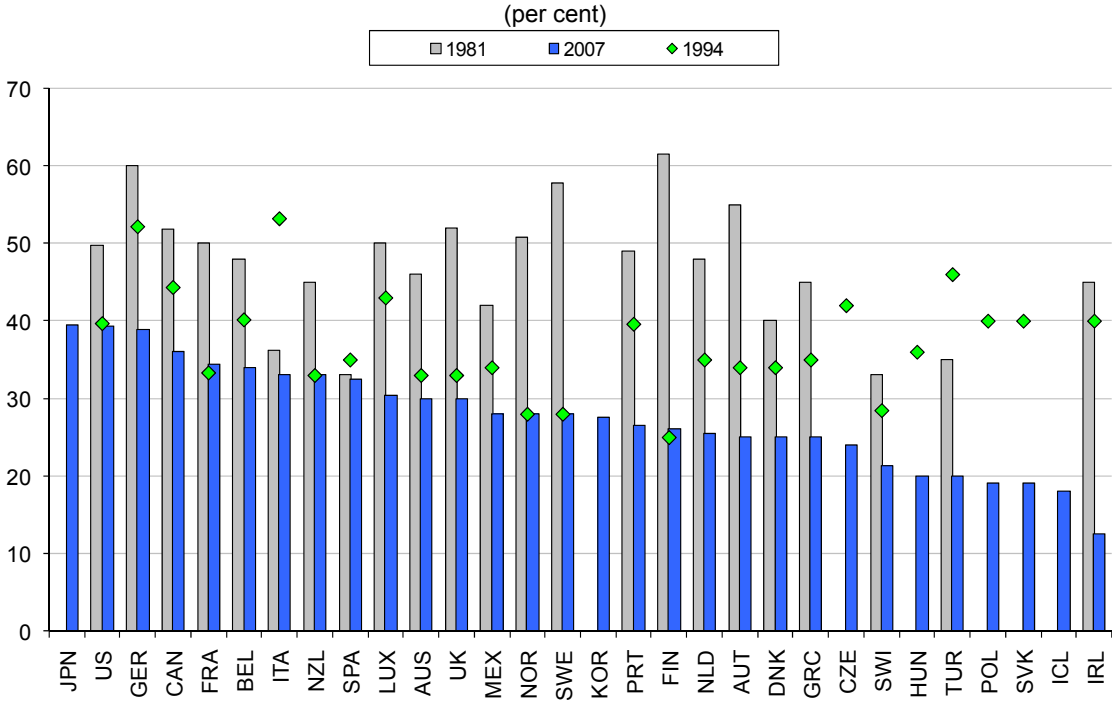


1
. The tax wedge measures the amount of personal income tax, employees' and employers' social security contribution and payroll taxes less cash benefits as a proportion of labour costs, defined as the wage plus employers' social security contributions and payroll taxes.

Source: OECD Taxing Wages 2006.

Figure 9.Statutory corporate income tax rates

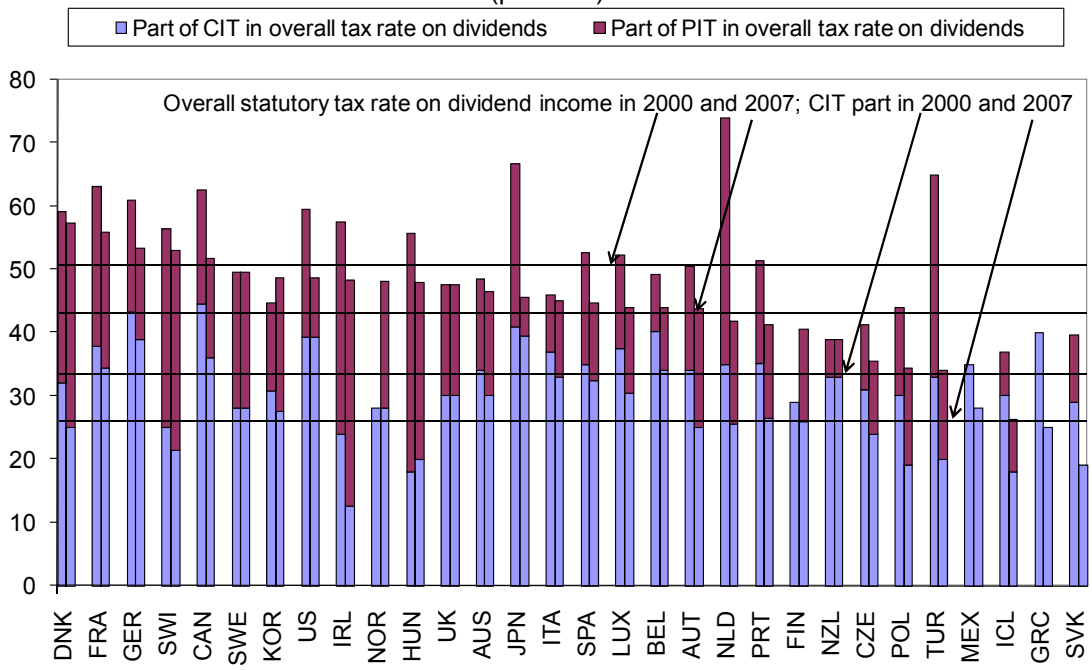
(per cent)



Source: OECD Tax database.

Figure 10. Overall statutory tax rates on dividend income (2000 and 2007)

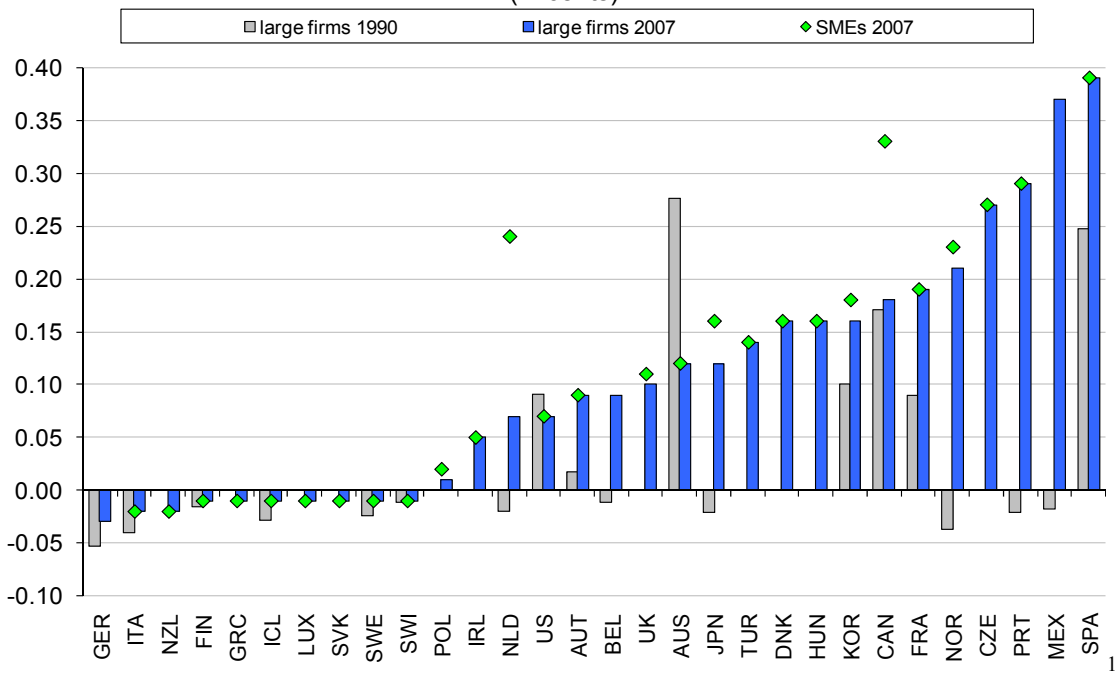
(per cent)



Source: OECD Tax database.

Figure 11. Tax subsidies for one US$ of research and development in OECD countries (2007)[1]

(in cents)



1. This figure shows the amount of tax relief for a unit of R&D expenditure compared to the benchmark situation of the immediate expensing of the R&D expenses." Negative values do not necessarily imply that R&D is not taxed favourably but only imply that R&D receives a tax treatment that is less generous than would be the case under full immediate expensing.

Source: OECD Scoreboard.

Figure 12. Taxes affect the determinants of growth

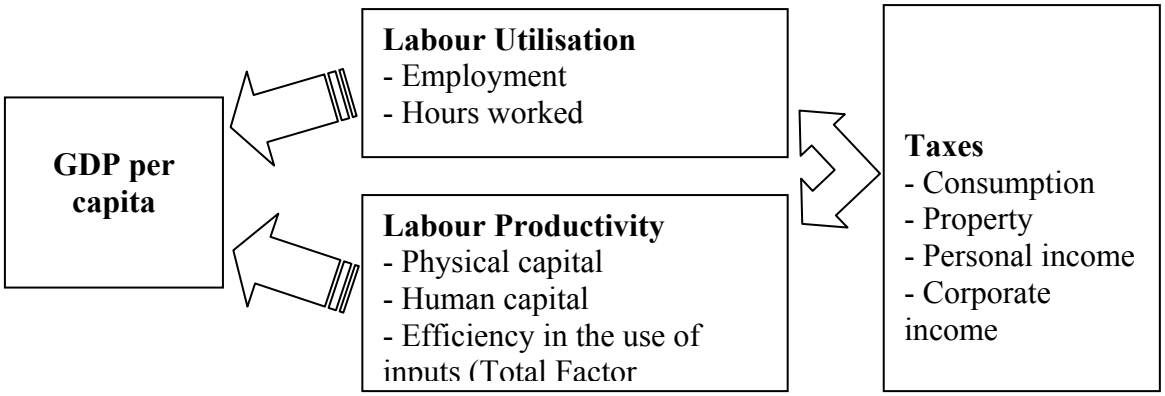
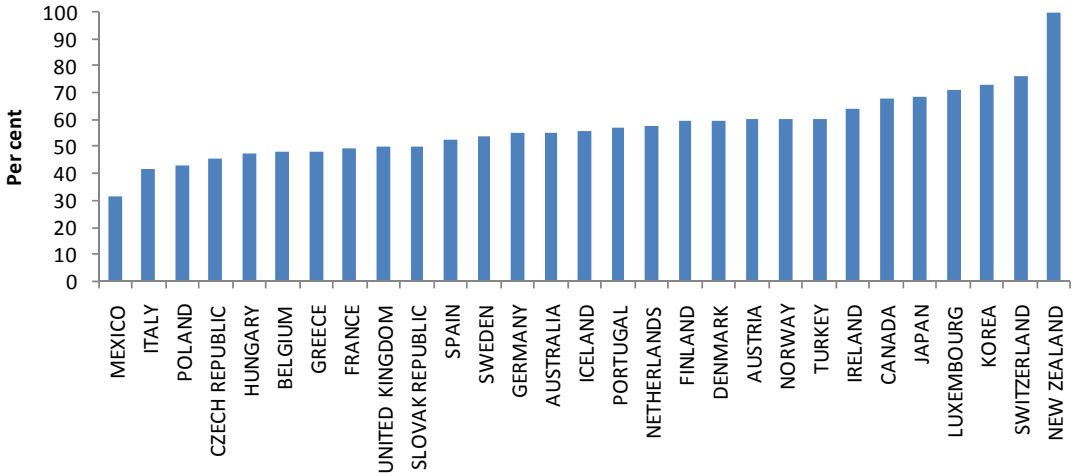


Figure 13. C-efficiency for VAT (Average 2002-2004)[1]
(index increasing in efficiency)



1. The c-efficiency is defined as the ratio of the share of VAT revenues to consumption divided by the standard rate, expressed as a percentage ((VAT revenues/National consumption × 100)/(Standard VAT rate))*100.

Source: OECD Consumption Tax Trends 2006 and OECD calculations.

Figure 14. Tax matrix

Drivers of GDP per capita		Tax instruments: Consumption	Property/ wealth	Personal income (PI)						PI tax expenditures	Corporate income (CI)		CI tax expenditures		Tax system design	Country performance relative to a benchmark
		Sales tax/VAT		Average tax wedge	Marginal tax wedge	Progressivity	Top statutory income tax	Dividend tax	Capital gains tax	in-work benefits	Corporate/ Effective corporate tax	Cross-border average effective tax on inv.	Tax incentives for R&D	Tax reductions for small firms	Tax complexity	
Employment	Overall	-		-						+	+/-					
	2-earner/woman			-	-	-				+/-						
	lowskilled			-												
Hours worked	Overall			+	-	-				-						
	2-earner/woman				-	-				-						
Capital deepening (K/L)	Overall			+/-				-	-		-					
	FDI			-							-	-				
Human capital				+	-	-	-									
TFP	Overall			-							-			+/-	-	
	R&D												+			
	FDI spillovers			-							-	-				
	Entrepreneurship						-(?)	-	-		-					
Effect on inequality		+	-			-	-	-	-	-					+(?)	

Annex 2: Description of tax indicators

Tax revenue and tax mix

Total tax revenue as percentage of GDP

Tax revenue of major taxes as a percentage of Gross Domestic Product (GDP) at market prices: personal income tax, corporate income tax, employees' and employers' social security contributions, taxes on payroll and workforce, property taxes, general consumption taxes, specific consumption taxes (excise taxes, import duties, environmental taxes).

Source: Revenue Statistics, OECD

Tax mix

The government's choice of how much revenue to raise from the different major taxes.

Source: Revenue Statistics, OECD

Labour taxes

Statutory personal income tax rates

Central plus sub-central tax rates applicable to personal labour income, taking into account any relief given at a higher level of government for taxes paid at a lower level.

Source: Taxing Wages, OECD Tax Database

Average tax wedge

The average tax wedge is the difference between total labour costs to the employer and the corresponding net take-home pay of the employee. It is calculated by expressing the sum of personal income tax, employees' plus employers' social security contributions together with any payroll tax less cash benefits, as a percentage of total labour costs, defined as the wage plus employers' social security contribution and payroll taxes.

Source: Taxing Wages, OECD Tax Database

Marginal tax wedge

The marginal tax wedge is the percentage of any small rise in labour costs that ends up as government revenue through the personal income tax and both employees' and employers' social security contributions and payroll taxes.

Source: Taxing Wages, OECD Tax Database

(All-in) Top marginal rate of personal income tax

Additional central and sub-central government personal income tax, plus employee social security contribution, resulting from a unit increase in gross wage earnings. This rate is calculated at the income level where the top statutory rate first applies.

Source: OECD Tax Database

Progressivity of the personal income tax system

Rate at which the income tax burden increases with income. The measure of progressivity used in this report is the difference between the marginal and average personal income tax rates, divided by one minus the average personal income tax rate, for an average single production worker. A higher number indicates higher progressivity.

Source: Taxing Wages, OECD Tax Database

Capital Taxes

(Standard) Statutory corporate tax rate

Central plus sub-central (non-targeted) tax rate levied on corporate profits, taking into account any relief given at a higher level of government for taxes paid at a lower level. This is the rate which applies to the majority of corporations. Where a progressive (as opposed to flat) rate structure applies, the top marginal rate is used.

Source: OECD Tax Database

Targeted or reduced combined corporate rate for small business

Central government corporate rate plus the sub-central rate (net rate where the central government provides a deduction in respect of sub-central income tax) typically applying for or targeted at 'small (incorporated) business', where such 'targeting' is on the basis of size alone (*e.g.* number of employees, amount of assets, turnover or taxable income) and not on the basis of expenditures or other targeting criteria.

A 'small business corporate tax rate' may be a special statutory corporate tax rate applicable to (all or part of) the taxable income of qualifying 'small' firms (*e.g.* meeting a turnover, income, or asset test), or an effective corporate tax rate below the basic statutory corporate rate provided through a tax deduction or credit for 'small' firms determined as a percentage of qualifying taxable income (*e.g.* up to a given threshold). These reduced rates are intended to reduce the effect of corporate taxation on the investment of these corporations.

Source: OECD Tax Database

Tax capital depreciation allowances

Present value of deductions from taxable income due to depreciation of capital over time.

Source: Institute for Fiscal Studies (IFS).

Average effective tax rate

The average effective tax rate (AETR) measures the impact of corporate taxation on investments as the proportion of the pre-tax economic profit taken by the government; *i.e.* the AETR measures how taxation affects the net present value of a firm for a given pre-tax rate of return. It takes into account not only the statutory corporate tax rate but also other aspects of the tax code such as, for example, depreciation allowances. It is a forward-looking measure in the sense that it computes the net present value of a hypothetical potential investment in the presence and absence of tax.

Source: Institute for Fiscal Studies (IFS).

Marginal effective tax rates

The marginal effective tax rate (METR) measures the impact of taxation on marginal investments under the assumption that all potential investment projects earn at least the cost of capital; *i.e.* the minimum pre-tax rate of return on an investment required by the investor (marginal finance rate of return). It takes into account not only the statutory corporate tax rate but also other aspects of the tax code such as, for example, depreciation allowances. It is a forward-looking measure in the sense that it computes the net present value of a hypothetical potential investment in the presence and absence of tax, in contrast to use actual data on tax revenues or the tax liabilities of firms (backward-looking measures).

Source: Institute for Fiscal Studies (IFS).

Cross-border average effective tax rates

The cross-border average effective tax rate measures the impact of corporate taxation on cross-border investments as the proportion of the pre-tax economic profit taken by the host and home governments. It takes into account different aspects of home and host countries tax codes that are relevant for foreign direct investment (FDI) decisions by multinational enterprises (MNEs) such as home/host statutory corporate tax rates, withholding taxes, depreciation allowances in the host country, tax treatment of foreign source income in the home country. It is a forward-looking measure in the sense that it computes the net present value of a hypothetical potential investment in the presence and absence of tax, in contrast to use actual data on tax revenues or the tax liabilities of firms.

Source: Yoo, 2003.

Overall taxation of dividend income

Effective corporate plus personal tax rate on distributed profit calculated as:

[(pre-tax distributed profits - distributed profits + net personal tax)/pre-tax distributed profits]*100;

where:

For a distribution of 100, the distributed pre-tax profit is calculated as 100/(1-u) where u denotes the corporate income tax rate on distributed profits.

The net personal tax is defined as the net top statutory rate to be paid at the shareholder level, taking account of all types of reliefs and gross-up provisions at the shareholder level.

Source: OECD Tax Database

R&D tax subsidies / incentives

Tax subsidies for R&D include R&D tax credits that are deductible from taxable income, and investment and depreciation allowances that are deductible from tax liability. To measure the generosity of R&D tax subsidies, this report employs a measure of R&D tax treatment called the B-index (Warda, 2006). The B-index measures the minimum value of before-tax income that a firm needs to cover the cost of R&D investment where the cost is standardized to one dollar. R&D tax subsidies are determined as one minus the B-index which captures the tax subsidy per dollar invested in R&D. Negative values do not necessarily imply that R&D is not taxed favourably but only imply that R&D receives a tax treatment that is less generous than would be the case under full immediate expensing.

Source: OECD Science, Technology and Industry Scoreboard.

Consumption taxes

C-efficiency for VAT

The C-efficiency ratio for VAT is a measure of the broadness of the tax base, the extent of the use of reduced rates and of the effectiveness with which taxes are collected. It expresses the revenue collected from the actual VAT in a country as a proportion of the revenue that would be raised if the main rate of VAT were applied to all consumption. A high ratio suggests a uniformly applied VAT on a broad base with effective tax collection while a low ratio may indicate an erosion of the tax base either by exemption or reduced rates, poor compliance or poor tax administration or a combination of these.

Source: OECD Tax Database; OECD Consumption Tax Trends (2006)

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Growth and public infrastructure

By

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Abstract:

The paper analyzes a multi-country extension of the Barro model of productive public expenditure. In the presence of infrastructural externalities between countries the provision of infrastructure will be inefficiently low if countries do not coordinate. This provides a role for a supra-national body, such as the EU, to coordinate the policies of the individual governments. It is shown how the supra-national body can ensure the efficient level of infrastructure provision and, as a result, obtain an increased rate of growth. The results of the paper also show how capital flows between countries act to equalize growth rates. This can help explain why there is limited empirical evidence for tax rates causing a difference in growth rates between countries. This is not the same as saying taxation does not affect growth: if production requires public infrastructure then taxation is needed for growth. The flow of capital acts to distribute the benefit of this across countries.

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1 Introduction

One factor promoting endogenous growth is the supply of public infrastructure that complements the investments of the private sector. The importance of infrastructure is widely recognized, not least by the EU which pursues an active programme to support the investment activities of member states. The policy problem facing the EU is to ensure that member states undertake an efficient level of infrastructural expenditure that ensures the maximum rate of growth. The determination of the level has to take into account the full consequences of an infrastructure project for the EU, not just the direct benefits for the member state undertaking the investment. There are three significant issues that confront this policy programme. First, infrastructural investment has significant spill-overs across member states. Second, mobility of the tax base results in tax externalities between the member states, and between the member states and the EU. Third, the EU is faced with a decision on how to allocate support for infrastructural expenditure across the different member states. This interacts with the process of revenue-raising, and with the extent to which the projects are financed jointly by the EU and member states.

The economic modelling of the impact of infrastructure on economic growth has focussed on the Barro (1990) model of public expenditure as a public input and its extensions (Chen *et al*. 2005, Turnovsky, 1999). This literature has identified the concept of an optimal level of expenditure, and has highlighted the deleterious effects of both inadequate and excessive expenditure. These are important insights, but do not address the spill-over issues that confront the EU. Infrastructural spill-overs between member states can be positive, which occurs when improvements in infrastructure in one member state raise productivity in another, or they can be negative if they induce relocation of capital between member states. In either case, it is important that the consequences of spill-overs are addressed in order that the role of productive public expenditure can be fully understood. Ignoring either form of spill-over will result in an inefficient level and allocation of expenditure.

The financing of infrastructure in the Barro model is through a simple tax on output levied at the national level. The position in the EU is much more complex. Each member state levies national taxes. Part of these taxes are retained by the member states, the remainder is remitted to, and redistributed by, the EU. In economic terms, if there is mobility of the tax base then there are horizontal tax externalities between member states, and a vertical tax externality between member states and the EU. These tax externalities have a key role in determining the growth-maximizing level of expenditure.

In this paper we construct multi-country extensions of the Barro model of productive public infrastructure. In addition, the benefits of infrastructure spill-over between countries. The spill-over between countries is a form of positive externality which results in inefficient investment in infrastructure if countries act independently. If there are infrastructural externalities between countries then the provision of infrastructure will be inefficiently low when countries do not coordinate policies. This gives a role to a supra-national body, such as the EU, to act as a coordinator of the policies of individual governments. By ensuring the efficient level of infrastructural investment it is possible for the supra-national body to counter the externality and obtain a higher rate of growth.

The results of the paper also show how capital flows between countries act to equalize growth rates. The observation that capital flows reduce growth differentials between countries has been made previously by Razin and Yuen (1997). They argued that labour mobility equalized incomes across countries when there were human capital externalities. We demonstrate that the mobility of physical capital equalizes the growth rate across countries. Similar issues have also been addressed by Bianconi and Turnovsky (1997), but in a model that does not have public infrastructure. A substantial empirical literature has failed to find a convincing link between the

rate of tax and the rate of economic growth. Our model provides a possible explanation for this: In a cross-section of countries the infrastructural externality and the flow of capital equalize the growth rate across countries regardless of the tax policy that each country operates. This is not to say that taxation does not matter. Actually, the opposite is correct: Taxation is even more important than in a world without spill-overs since additional public infrastructure in one country can raise the growth rate in all. This holds if all countries are operating with less than the optimum level of infrastructure, as they will be in an equilibrium without policy coordination.

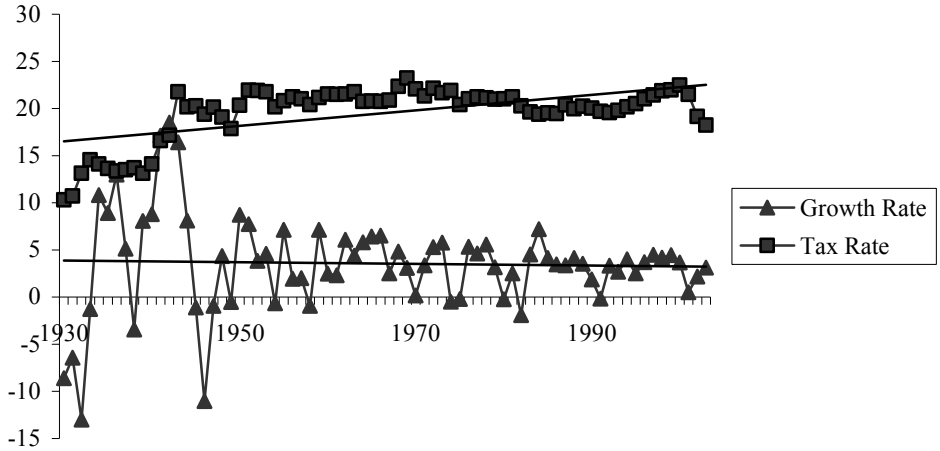
Section 2 of the paper provides a brief review and discussion of evidence on the link between taxation and economic growth. A basic version of the endogenous growth model with a productive public input is analyzed in Section 3. Section 4 studies the role of a supra-national body in coordinating the choices of individual countries when there is an infrastructural externality. The analysis is extended to incorporate capital mobility in Section 5. Conclusions are given in Section 6. An appendix provides the calculations that support the results reported in the main text.

2 Empirical evidence

There is a considerable body of published work that investigates the link between the level of taxation and the growth rate of gross domestic product (GDP). Much of this literature is summarized in Myles (2007). The conclusions that can be drawn from that literature are open to debate and interpretation, but the essential issues can be identified from considering some standard data.

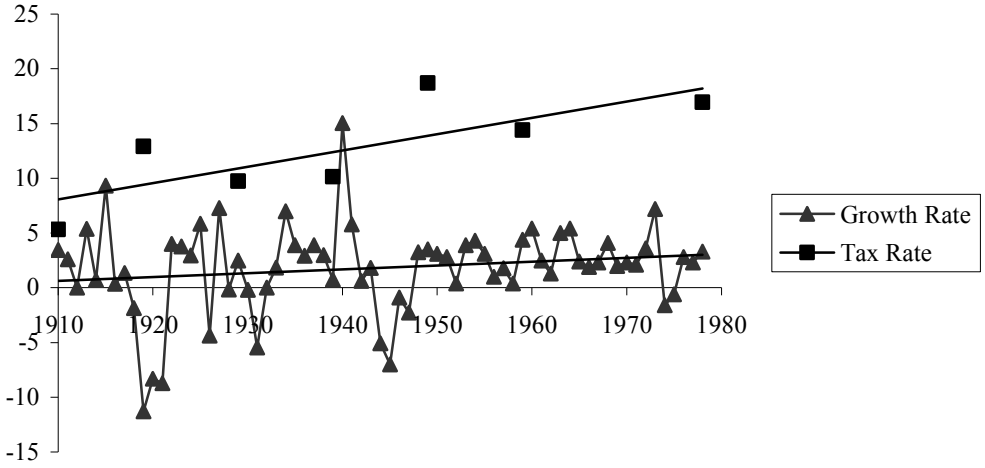
Consider the data presented in Figures 1 and 2. Figure 1 plots the growth rate of US GDP and federal government tax revenue as a percentage of GDP since 1930. Trend lines have been fitted to the time series using ordinary least squares. The two trend lines show a steady rise in taxation (the upper line) and a very slight decline in the growth rate (the lower line). Although the variance of the growth rate is lower after 1940, statistical tests on US data have found no significant between the average rate of growth prior to 1942 and after 1942. The data for the UK in Figure 2 tell a very similar story. The trend lines show an increase in taxation but, in contrast to the US, an increase in the rate of growth. Over the long periods illustrated in these figures no clear relationship between the average tax rate and the growth rate of GDP is apparent.

Figure 1: US Tax and Growth Rates



Source: US Department of Commerce: www.bea.doc.gov

Figure 2. UK Tax and Growth Rates



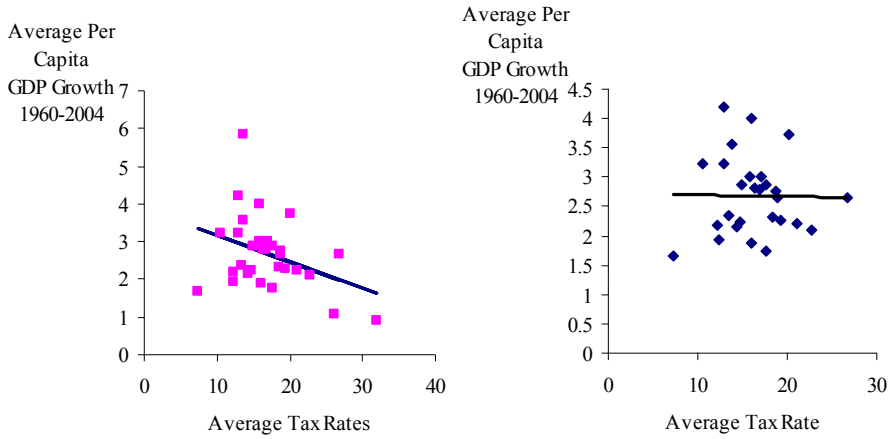
Source: Feinstein (1972), UK Revenue Statistics, Economic Trends

The interpretation of these figures must be considered carefully. There are two reasons for this. First, a contrast between the tax rate and the growth rate across time cannot answer the counter-factual question "if taxes had been lower, would growth have been higher?" An answer to this question requires, at least, a study involving a range of countries with different regimes. Second, there are substantive issues that have to be resolved about the definition of the tax rate that should enter into any such comparison. In particular, economic theory focuses on the marginal rate of tax as the determinant of behaviour but the figures employ the average rate of tax.

One route through which the first issue can be addressed is to consider the same data for a cross-section of countries. This approach was pioneered by Plosser (1993) who calculated the correlation between the rate of growth of per capita GDP and a range of variables for the OECD countries. The share of income and profit taxes in GDP was found to have a correlation of -0.52 with the growth rate of GDP. However, Plosser warns against taking the correlation as evidence of causality and presents several potential explanations for the lack of robustness in regression equations: most policies operate through investment; policies are complex and not easily represented by variables in regressions; and policies are highly correlated. Even so, the work of Plosser is often cited as evidence that an increase in taxation leads to a fall in the growth rate.

The left-hand panel of Figure 3 displays an updated version of Chart 6 in Plosser (1993) that extends the sample period through to 2004. The data points are found by averaging the growth rate and the tax rate over this period for each country. A straight line fitted by least squares shows the negative relationship between the growth rate and the average tax rate. There are three countries that are unusual in this data set: Korea (the only Asian Tiger in this sample), the Czech Republic and the Slovak Republic (both newly liberalized). These countries represent the three outliers in the data set. The right-hand panel shows the effect of removing these outliers: the negative relationship virtually vanishes (formally, it is statistically insignificant). This observation supports the claim that the negative relationship cannot be accepted until it has been shown to survive the consideration of all relevant covariates in a regression analysis.

Figure 3: Real income growth and tax rates in OECD countries 1960 -- 2004



Source: Penn World Table Version 6.2

The second issue is the definition of the appropriate tax rate. The figures above use a measure of the average rate but economic theory argues that it is the marginal tax rate that matters for the degree of distortion introduced into choices. Using an average rate of tax to explain growth does not capture this important feature of taxation. This issue was addressed by Koester and Kormendi (1989) who used IMF data on 63 countries to construct measures of the average tax rate and the marginal tax rate. Their results are reported in Table 1. There is little evidence of an effect of either the average or the marginal tax rate upon the growth rate, but the marginal tax rate is claimed to have an effect on the level of activity. The tax rates are significant when used as the sole regressor but become insignificant when the level of initial GDP is included in the regression.

Table 1: Regressions on marginal and average tax rates

Variable	*A*	*B*	*C*	*D*
Constant	0.060	0.053	0.058	0.060
Average tax	-0.074 (-2.18)		-0.005 (-0.11)	
Marginal tax		-0.25 (-1.87)		-0.011 (-087)
Initial GDP			-0.052 (-2.65)	-0.048 (-3.03)
R^2	0.072	0.05	0.17	0.18

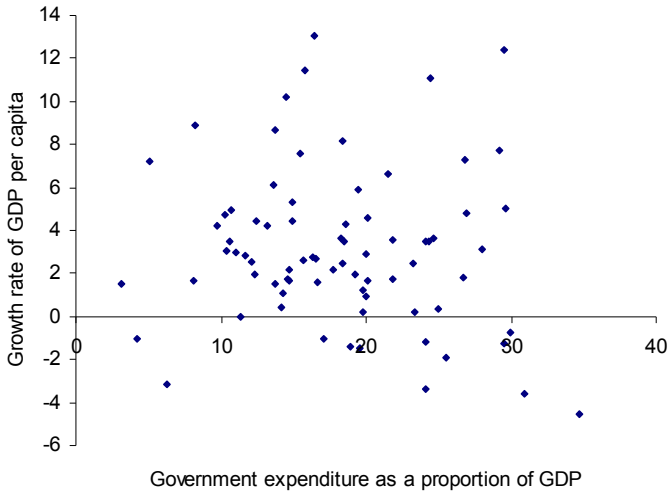
Source: Koester and Kormendi (1989)

This methodology is also open to criticism since it assumes a constant marginal rate of tax despite significant changes in the tax systems in several of the countries over the period of the data set. There is also an issue concerning aggregation bias since the industrialized and non-industrialized countries may have very different responses of growth to taxation. Easterly and Rebelo (1993) employ several different measures of the marginal rate of tax plus a range of other potential determinants of growth (initial income, school enrolments, assassinations,

revolutions and war casualties). They conclude "The evidence that tax rates matter for economic growth is disturbingly fragile".

The reasons for why no strong relationship is evident in the data are explored in Slemrod (1995). Figure 4 provides an updated view of the data used by Slemrod. The figure plots growth in per capita GDP against government expenditure as a proportion of GDP for 78 countries in 2004 using data from the Penn World Tables. As Slemrod observed there is no discernible pattern in this data. If there were a strong link between government and growth it should be evident in the figure.

Figure 4. Growth and government expenditure 2004.



Source: Penn World Tables Version 6.2

The main argument of Slemrod (1995) is that the data is generated by the interaction of two structural relationships. On the one hand, an increase in government expenditure results in higher taxes implying further distortions that reduce the growth of GDP. On the other hand, growth in GDP affects the demand for government expenditure (for example, demand will increase if Wagner's law applies). The estimation methodology has not adequately resolved the simultaneity between these two relationships and therefore the estimated coefficients do not represent the underlying structural equations. Moreover, if the level of government expenditure is chosen to maximize the rate of growth then the data should exhibit little variation: if the countries are similar the observations represent points clustered around the maximum of the relationship. If there are any differences in the relationship between expenditure and growth across countries then, combined with an underlying optimization process, this will make for an even less meaningful relationship in the data.

There is much evidence in favour of the argument that the data reviewed above demonstrates no significant effect of the tax rate upon the rate of growth. The remainder of the paper is devoted to exploring the extent to which the observation of no link between taxation and growth in cross-country data can be consistent with a world in which taxation does affect economic growth. There are two components to the ideas we explore. First, we adopt the idea from endogenous growth theory that public sector expenditures are productive. In particular, we consider expenditure to be made on infrastructure that increases economic output. Therefore, taxation is not just a cause of distortion but supports expenditure that contribute to output. It can be expected that governments will exercise rationality in the choice of the tax rate. This is a formalization of the argument that the data should represent countries clustered around an optimum. Second, we explore the existence of a mechanism through which growth is

endogenously equalized between countries, or at least the differences are reduced. In our modelling this occurs in two ways: spill-overs of the benefits of public infrastructure between countries and the mobility of capital. The consequence of these mechanisms is that an increase in taxation in one country can (in certain circumstances) raise growth in all countries; hence, cross-country comparisons taken at one point in time will reveal no systematic relationship. These comments agree with a general perspective that what should be explained is not the differences in the growth rates between countries but instead why growth rates have been so similar over such large time spans.

3 Public infrastructure

Endogenous growth can occur when capital and labour are augmented by additional inputs in a production function that otherwise has non-increasing returns to scale. One interesting case for understanding the link between government policy and growth is when the additional input is a public good or public infrastructure financed by taxation. The need for public infrastructure to support private capital in production provides a positive role for public expenditure and a direct mechanism through which policy can affect growth. Introducing infrastructure permits an analysis of the optimal level of public expenditure in an endogenous growth model.

This section first reviews the Barro (1990) model of productive public expenditure. In this model public expenditure is financed by a tax on output. We then introduce the approach we adopt to analyze externalities by re-phrasing the analysis as a comparison across balanced growth paths with a tax upon the private capital input.

Public infrastructure can be introduced by assuming that the production function for the representative firm at time *t* takes the form

$$Y_t = AL_t^{1-\alpha} K_t^{\alpha} G_t^{1-\alpha}, \qquad (1)$$

where A is a positive constant and G_t is the quantity of public infrastructure. The form of this production function ensures that there are constant returns to scale in labour, L_t, and private capital, K_t, for the firm given a fixed level of public infrastructure. Although returns are decreasing to private capital as the level of capital is increased for fixed levels of labour and public input, there are constant returns to scale in public input and private capital together. For a fixed level of L_t, this property of constant returns to scale in the other two inputs permits endogenous growth to occur.

The analysis of Barro (1990) assumes that public infrastructure is financed by a tax upon output. Assuming that capital does not depreciate, the profit level of the firm is

$$\pi_t = [1-\tau] AL_t^{1-\alpha} K_t^{\alpha} G_t^{1-\alpha} - r_t K_t - w_t L_t, \qquad (2)$$

where r_t is the interest rate, w_t the wage rate, and τ the tax rate. The government budget constraint requires that tax revenue finances the public infrastructure, so

$$G_t = \tau Y_t. \qquad (3)$$

Now assume that labour supply is constant at $L_t = 1$ for all t and that the economy's representative consumer has preferences described by the utility function

$$U = \sum_{t=1}^{\infty} \beta^t \frac{C_t^{1-\sigma} - 1}{1-\sigma}. \tag{4}$$

This specific form of utility is adopted to permit an explicit solution for the growth path. The optimality condition for intertemporal choice is

$$\frac{\partial U / \partial C_t}{\partial U / \partial C_{t+1}} = \frac{C_t^{-\sigma}}{\beta C_{t+1}^{-\sigma}} = 1 + r_{t+1}, \tag{5}$$

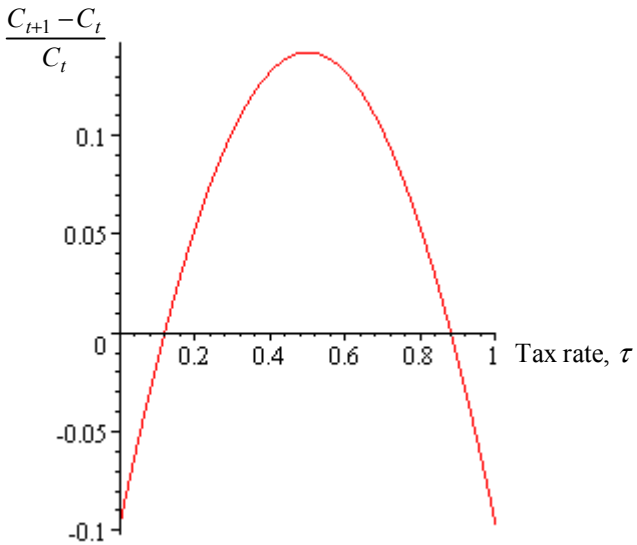
which can be combined with the input choices of the firm to show that the growth rate of consumption is related to the tax rate by

$$\frac{C_{t+1} - C_t}{C_t} = \beta^{1/\sigma} \left[1 + [1-\tau] \alpha A^{1/\alpha} \tau^{[1-\alpha]/\alpha} \right]^{1/\sigma} - 1. \tag{6}$$

The result in (6) demonstrates the two channels through which the tax rate affects the growth rate of consumption. Taxation reduces the growth rate of consumption through the term $1-\tau$ which represents the effect on the marginal return of capital reducing the amount of capital used. The tax rate increases growth through the term $\tau^{[1-\alpha]/\alpha}$ which represents the gains through the provision of the public input.

Further insight into these effects can be obtained by plotting the relationship between the tax rate and consumption growth. This is shown in Figure 5 under the assumption that A = 1, α = 0.5, β = 0.95 and σ = 0.5. The figure displays two notable features. First, for low levels of the public input the rate of growth is negative, so a positive tax rate is required for there to be consumption growth. Second, the relationship between growth and the tax rate is non-monotonic: there is a tax rate which maximizes the growth rate of consumption.

Figure 5. Tax Rate and Consumption Growth



Differentiation of (6) determines the tax rate that maximizes consumption growth as

$$\tau = 1 - \alpha. \tag{7}$$

For the values in the figure, this optimal tax rate is $\tau = 0.5$. To see what this tax rate implies, observe that

$$\frac{\partial Y_t}{\partial G_t} = [1-\alpha]\frac{Y_t}{G_t} = 1, \tag{8}$$

using $G_t = \tau Y_t$ and $\tau = 1-\alpha$. Hence, the tax rate that maximizes consumption growth ensures that the marginal product of the public input is equal to 1 which is also its marginal cost.

The analysis of growth described above works successfully for this particular form of the model. However, it is difficult to generalize the approach to more complex settings in a way that permits explicit results to be derived. As a consequence we adopt a different approach in the modelling that follows. The basis of this approach is that instead of looking at the growth path from an arbitrary starting point we instead focus on balanced growth paths. Along a balanced growth path all real variables grow at the same rate, so it can be interpreted as describing the process of growth in the long-run.

We model the consumer as choosing a balanced growth path given the path of tax rates announced by the government. The government then chooses the path of tax rates to maximize consumer welfare. If the tax is distortionary the resulting growth rate will not be first-best optimal. We see this analysis as the dynamic equivalent of maximizing welfare in a standard static Diamond-Mirrlees type framework. In characterizing the equilibrium we exploit two equivalences. The first equivalence is that between the market equilibrium and the outcome when the consumer chooses the path of capital directly. This is a standard result that has been widely exploited to simplify the derivation of the path of capital accumulation in growth models. The second is that, in the long-run, the outcome with the consumer choosing the path for capital is equivalent to the consumer directly choosing the rate of growth of the capital stock on the balanced growth path. The equivalence holds provided the economy always tends to a balanced growth path, a property that we assume is applies to the economies we study.

We now make two changes to the specification of the Barro model to demonstrate this methodology. First, we assume that government spending is funded from a tax levied on the private capital input. Second, we assume that public infrastructure and private capital depreciate in use at rates $\delta_G \geq 0$ and $\delta_K \geq 0$ respectively. Under these assumptions the budget constraint of the government, or the law of motion for public infrastructure, at time *t* is

$$G_t = [1-\delta_G]G_{t-1} + \tau_t K_t. \tag{9}$$

The firm belongs to a representative infinitely-lived household whose preferences are from this point described by an instantaneous utility function, $U_t = \ln C_t$. The household maximizes the infinite discounted stream of utility

$$\max U = \sum_{t=0}^{\infty} \beta^t \ln C_t, \tag{10}$$

subject to the sequence of intertemporal budget constraints,

$$Y_t = C_t + K_{t+1} - [1-\delta_K - \tau_t]K_t, \tag{11}$$

and with the sequence of taxes and government infrastructure taken as given.

We focus on balanced growth path equilibria, along which the tax rate is constant and all real variables grow at the same constant rate. The first step is to show that when K_t grows at a

constant rate γ and taxes are constant the law of motion for G_t also converges to growth at the same constant rate. Assume that the private capital stock grows at rate γ from time 0 with capital stock K_0. Recursive substitution into (9) gives

$$\begin{aligned} G_{t+1} &= [1-\delta_G]G_t + \tau K_{t+1} \\ &= [1-\delta_G]^{t+1} G_0 + \sum_{i=0}^{t} [1-\delta_G]^i \tau K_{t+1-i}\,. \end{aligned} \tag{12}$$

From the relation

$$K_{t+1-i} = [1+\gamma]^{t+1-i} K_0\,, \tag{13}$$

it follows that

$$\begin{aligned} \sum_{i=0}^{t} [1-\delta_G]^i \tau K_{t+1-i} &= \tau K_0 [1+\gamma]^{t+1} \sum_{i=0}^{t} \left[\frac{1-\delta_G}{1+\gamma}\right] \\ &= \tau K_0 \frac{1+\gamma}{\gamma+\delta_G} \left[[1+\gamma]^{t+1} - [1-\delta_G]^{t+1}\right]. \end{aligned} \tag{14}$$

Hence,

$$\begin{aligned} G_{t+1} &= [1-\delta_G]^{t+1} G_0 + \tau K_0 \frac{1+\gamma}{\gamma+\delta_G} \left[[1+\gamma]^{t+1} - [1-\delta_G]^{t+1}\right] \\ &= [1-\delta_G]^{t+1} \left[G_0 - \tau K_0 \frac{1+\gamma}{\gamma+\delta_G}\right] + \tau K_{t+1} \frac{1+\gamma}{\gamma+\delta_G}\,. \end{aligned} \tag{15}$$

From (15) it can be seen that the effect of the initial levels disappears with time, and for *t* large enough

$$\frac{G_t}{K_t} \cong \tau \frac{1+\gamma}{\gamma+\delta_G}\,. \tag{16}$$

In particular, this result is consistent with the static balanced budget constraint $G_t = \tau K_t$ if $\delta_G = 1$. When the economy is on the balanced growth path at time 0 it must be the case that

$$G_0 = \tau K_0 \frac{1+\gamma}{\gamma+\delta_G}\,. \tag{17}$$

The level of consumption at time *t* if the balanced growth path is achieved with capital K_0 is

$$C_t = [1+\gamma]^t \left[A K_0^{\alpha} G_0^{1-\alpha} - K_0[\gamma+\delta_K+\tau]\right]. \tag{18}$$

This gives the objective of the household as

$$\max_{\{\gamma\}} \sum_{t=0}^{\infty} \beta^t \ln\left([1+\gamma]^t \left[A K_0^{\alpha} G_0^{1-\alpha} - K_0[\gamma+\delta_K+\tau]\right]\right). \tag{19}$$

The household takes government actions as given when optimizing so the values of τ and G_0 are treated as fixed in the choice of the balanced growth path. The objective function can be rearranged as

$$\max_{\{\gamma\}} \sum_{t=0}^{\infty} \beta^t \ln\left([1+\gamma]^t\right) + \sum_{t=0}^{\infty} \beta^t \ln\left(AK_0^{\alpha} G_0^{1-\alpha} - K_0[\gamma + \delta_K + \tau]\right)$$

$$= \frac{\beta}{[1-\beta]^2} \ln(1+\gamma) + \frac{1}{[1-\beta]} \ln\left(AK_0^{\alpha} G_0^{1-\alpha} - K_0[\gamma + \delta_K + \tau]\right). \quad (20)$$

Assuming an interior solution exists, the necessary condition for the choice of γ is

$$\frac{\beta}{[1+\gamma][1-\beta]} - \frac{K_0}{AK_0^{\alpha} G_0^{1-\alpha} - K_0[\gamma + \delta_K + \tau]} = 0. \quad (21)$$

Solving this gives

$$1 + \gamma = \beta\left[A\left[\frac{G_0}{K_0}\right]^{1-\alpha} + 1 - \delta_K - \tau \right]. \quad (22)$$

The expression in (22) determines the balanced growth path chosen by the household in response to the tax rate and level of public infrastructure selected by the government. This equation summarizes the behaviour of the private sector in the model.

There are two alternatives ways of modelling the choice problem of the government. Either the government can choose τ to maximize γ, or it can choose τ to maximize U taking into account the effect of τ on γ. In both cases the chosen value of τ and the level of government infrastructure are related by (22). It is now shown that these two options are, in fact, equivalent. Rearrangement of the objective function with further substitution from (22) gives

$$U = \frac{\beta}{[1-\beta]^2} \ln(1+\gamma) + \frac{1}{[1-\beta]}\left[\ln(K_0) + \ln\left(A\left[\frac{G_0}{K_0}\right]^{1-\alpha} - \gamma - \delta_K - \tau \right)\right]$$

$$= \frac{1}{[1-\beta]^2} \ln(1+\gamma) + \frac{1}{[1-\beta]}\left[\ln(K_0) + \ln\left(\frac{1-\beta}{\beta}\right)\right]. \quad (23)$$

Since only the first term depends upon policy instruments and is itself an increasing function of γ, it follows that maximizing γ is equivalent to maximizing U.

Using (22) and (17) the growth-maximizing tax rate solves

$$A[1-\alpha]\left[\beta\left[A\frac{\alpha}{1-\alpha}\tau + 1 - \delta_K\right]\right]^{1-\alpha} = \tau^{\alpha}\left[\beta\left[A\frac{\alpha}{1-\alpha}\tau + 1 - \delta_K\right] - 1 + \delta_G\right]^{1-\alpha}. \quad (24)$$

One special case can be explicitly solved. With full depreciation of private and public capital,

$$\tau = [A[1-\alpha]]^{1/\alpha}, \quad (25)$$

so the optimal tax rate increases as the elasticity of output with respect to public infrastructure increases. For the general result it can be seen that the optimal tax rate is decreasing in δ_G,

increasing in δ_K, and decreasing in β. Hence, the more patient is the household the lower should be the optimal tax rate supporting public infrastructure.

This model of public infrastructure illustrates a sense in which there can be an optimal level of government expenditure in an endogenous growth model. The analysis shows how a study of the optimal tax rate can be undertaken by considering choice over different balanced growth paths. We now develop this technique in the context of a world economy with infrastructural externalities between countries.

4 Infrastructural spill-over

This section analyzes a model that incorporates infrastructural spill-overs between countries. The results show that uncoordinated optimization by countries will lead to under-investment in infrastructure. This provides a role for a supra-national body to coordinate the decisions of individual countries so as to secure an increase in the growth rate. We develop these results by retaining the focus upon the comparison of balanced growth paths.

The model of the previous section is extended to a multi-country setting in which production benefits from positive externalities created by global infrastructure. For country i at time t the level of output is given by

$$Y_{it} = AK_{it}^{\alpha}\left[G_{it}^{1-\rho}\Gamma_t^{\rho}\right]^{1-\alpha}. \tag{26}$$

The measure of global infrastructure at time t, Γ_t, is defined as the total public investment in infrastructure, $\Gamma_t = G_{it} + \overline{G}_{it}$, where $\overline{G}_{it}$ is the public investment in infrastructure in all countries other than i. The infrastructural externality is generated by the term $\overline{G}_{it}$ appearing here. The interpretation is that both infrastructure within a country (the term involving G_{it} in (26)) and the total level of infrastructure (the term involving Γ_t) are relevant.

We focus on balanced growth paths along which all real variables in all countries grow at the same rate and the tax rates are constant over time. The equality of the growth rates across countries here is imposed, since the law of motion of the public capital in one country only ensures that the growth rates of the stock of public and private capital are equal in that country, but there is no reason of why the growth rates should be equal across countries. If we did not impose this assumption then the output of one country would eventually become arbitrarily small relative to the output of the other. An extension to the model that ensures the endogenous equalization of the growth rates is presented in the next section.

When the growth rates in the countries are equal, along the balanced growth path Γ_t grows at the same constant rate as all other real variables, so that at any time t

$$G_{it}^{1-\rho}\Gamma_t^{\rho} = G_{it}\left[\frac{\Gamma_t}{G_{it}}\right]^{\rho} = G_0\left[1+\gamma\right]^{t}\left[\frac{\Gamma_0}{G_0}\right]^{\rho}. \tag{27}$$

The level of consumption at time t if the balanced growth path is reached with capital stock K_0 is

$$C_{it} = [1+\gamma]^t \left[AK_0^{\alpha} \left[G_0 \left[\frac{\Gamma_0}{G_0} \right]^{\rho} \right]^{1-\alpha} - K_0[\gamma + \delta_K + \tau] \right]. \tag{28}$$

This gives the objective of the household as

$$\max_{\{\gamma\}} \sum_{t=0}^{\infty} \beta^t \ln \left([1+\gamma]^t \left[AK_0^{\alpha} \left[G_0 \left[\frac{\Gamma_0}{G_0} \right]^{\rho} \right]^{1-\alpha} - K_0[\gamma + \delta_K + \tau] \right] \right), \tag{29}$$

which is the same as in the closed economy case, with total factor productivity now augmented by the factor $[\Gamma_0 / G_0]^{\rho[1-\alpha]}$. Therefore, we immediately obtain the expression for the chosen growth rate in the open economy with externalities,

$$1+\gamma = \beta \left[A \left[\frac{\Gamma_0}{G_0} \right]^{\rho[1-\alpha]} \left[\frac{G_0}{K_0} \right]^{[1-\alpha]} + 1 - \delta_K - \tau \right], \tag{30}$$

where G_0 is related to K_0 through (17), and $\Gamma_0 = G_0 + \overline{G}_0$. Using this expression we obtain for the lifetime utility function

$$U = \sum_{t=0}^{\infty} \beta^t \ln \left([1+\gamma]^t \left[AK_0^{\alpha} \left[G_0 \left[\frac{\Gamma_0}{G_0} \right]^{\rho} \right]^{[1-\alpha]} - K_0[\gamma + \delta_K + \tau] \right] \right)$$

$$= \frac{1}{[1-\beta]^2} \ln(1+\gamma) + \frac{1}{[1-\beta]} \left[\ln(K_0) + \ln\left(\frac{1-\beta}{\beta} \right) \right], \tag{31}$$

as in the closed economy case. Thus, for the government maximizing the welfare of the representative household is equivalent to maximizing the growth rate.

4.1 Independent choice

A government that does not internalize the externality chooses τ to maximize γ, taking K_0 and $\overline{G}_0$ as given. The growth-maximizing tax rate is determined implicitly by the solution to the pair of equations

$$\tau = [1-\alpha] \left[\frac{1+\gamma}{\beta} - 1 + \delta_K + \tau \right] \left[1 - \rho \frac{\overline{G}_0 / K_0}{\varphi(\gamma,\tau) + \overline{G}_0 / K_0} \right], \tag{32}$$

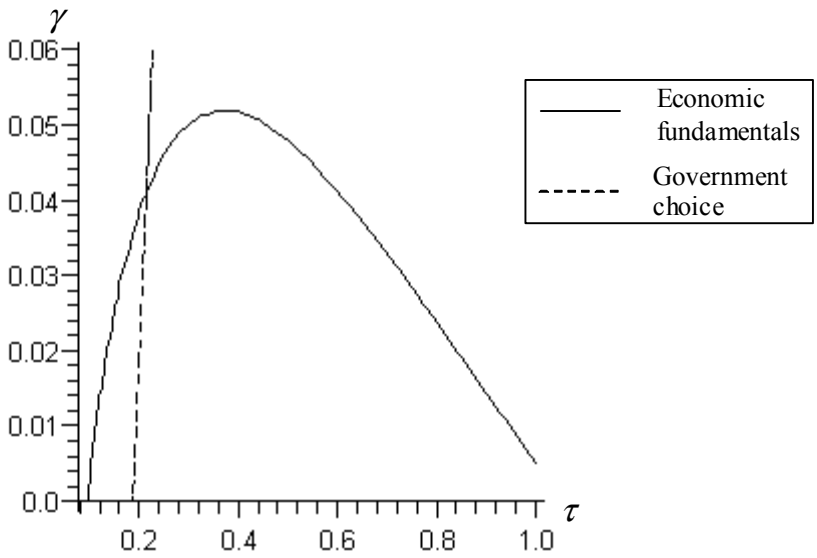
$$\gamma = \beta \left[A \left[1 + \frac{\overline{G}_0 / K_0}{\varphi(\gamma,\tau)} \right]^{\rho[1-\alpha]} \varphi(\gamma,\tau)^{1-\alpha} + 1 - \delta_K - \tau \right] - 1, \tag{33}$$

where $\varphi(\gamma,\tau) = \tau \dfrac{1+\gamma}{\gamma + \delta_G}$.

From this point we assume that the world consists of two countries. Along the balanced growth path all real variables in both countries grow at the same constant rate, γ. The governments do not coordinate their choice of taxes, so each government maximizes only the welfare of its representative household. We assume that the discount rates and depreciation rates are equal across the countries. Furthermore, we assume that the technologies and the endowments in two countries are such that both countries have the same rate of growth. The latter assumption only holds if the technologies and the endowments in two countries satisfy a certain relationship. This relationship is met if we assume symmetry between the countries

In Figure 6 a symmetric equilibrium without coordination between countries is illustrated. Denote the technology levels in the two countries by A and $\overline{A}$, and the initial capital stocks when the balanced growth path is achieved by K_0 and $\overline{K}_0$. The values of the parameters used for the simulation are: $\beta = 0.9$, $\rho = 0.5$, $\alpha = 0.5$, $\delta_K = \delta_G = 0.2$, $A = \overline{A} = 0.5$, $K_0 = \overline{K}_0 = 2$. The solid curve depicts the utility-maximizing growth rate (the optimal choice of the private sector) given the tax rate and level of public infrastructure and is, therefore, determined by the fundamentals of the economy -- endowments, preferences, and the production technology. The dashed curve describes the optimal choice of the tax rate by the government. The equilibrium occurs at the intersection of these two curves. One can see that the equilibrium tax rate is too low: with a higher tax rate higher growth, and, hence, higher welfare can be achieved. This is a consequence of the externality created by the infrastructural spill-over.

Figure 6. Optimal tax rate without coordination
$\tau = \overline{\tau} = 0.21$, $\gamma = \overline{\gamma} = 0.042$.



4.2 Coordination between two countries

We showed in the previous section that without coordination the equilibrium growth rate is below the efficient level: when choosing the tax rate, and hence when choosing the level of public investment, each government ignores the positive externality of the investment in its own country upon the productivity and growth in the other country. In this section we show that the efficient rate of growth can be achieved via coordination.

Assume that the two governments coordinate their policies by choosing simultaneously their tax rates to maximize the sum of the welfare of the representative households. This optimization can be written as the following:

$$\max_{\{\tau,\bar{\tau}\}} U(\gamma)+U(\bar{\gamma}) \text{ s.t. } \gamma=\bar{\gamma}. \tag{34}$$

where γ and $\bar{\gamma}$ are implicitly defined by

$$\gamma=\beta\left[A\left[1+\frac{\bar{\tau}\bar{K}_0}{\tau K_0}\right]^{\rho[1-\alpha]}\left[\tau\frac{1+\gamma}{\gamma+\delta_G}\right]^{[1-\alpha]}+1-\delta_K-\tau\right]-1, \tag{35}$$

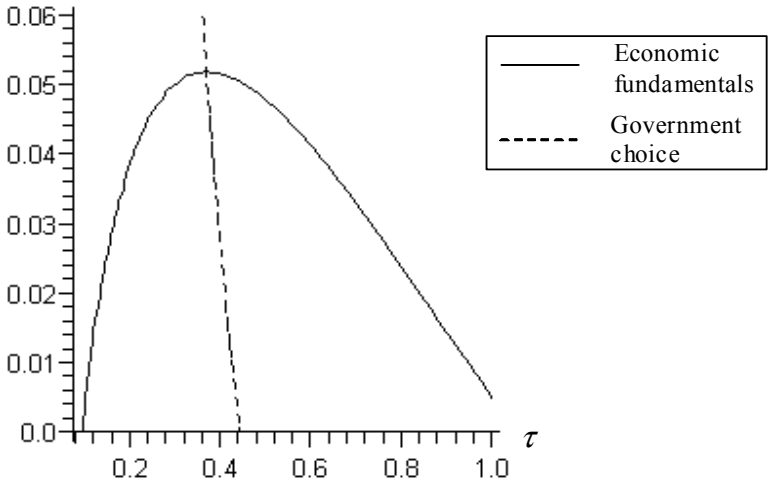
$$\bar{\gamma}=\beta\left[\bar{A}\left[1+\frac{\tau K_0}{\bar{\tau}\bar{K}_0}\right]^{\rho[1-\alpha]}\left[\bar{\tau}\frac{1+\bar{\gamma}}{\bar{\gamma}+\delta_G}\right]^{[1-\alpha]}+1-\delta_K-\bar{\tau}\right]-1. \tag{36}$$

The optimization can be stated equivalently as $\max_{\{\tau,\bar{\tau}\}}\gamma$, with $\gamma=\bar{\gamma}$. When the two countries are identical the necessary condition for τ simplifies to

$$\tau=A2^{\rho[1-\alpha]}[1-\alpha]\left[\tau\frac{1+\gamma}{\gamma+\delta_G}\right]^{[1-\alpha]}. \tag{37}$$

Plotting (37) along with the equation for γ produces Figure 7, which uses the same values for the model parameters as for Figure 6. It can be seen that the coordinated tax rate is higher than in the case without coordination, and the growth rate is the highest that can be achieved in the economy with the given fundamentals. As expected, coordination achieves the efficient outcome.

Figure 7. Coordinated choice of optimal tax rate
$\tau=\bar{\tau}=0.37$, $\gamma=\bar{\gamma}=0.052$.



4.3 Redistribution

In this section we consider the possibility of intervention by a supra-national body that collects and redistributes tax revenues between the countries. The interaction between the central body and the national government is modelled as the following multi-stage game. At the first stage the supra-national body announces what share of the tax revenues will be collected from each national government for a centralized fund. At the second stage the national governments choose optimal tax rates. At the third stage the supra-national body announces how the centralized fund will be divided between the two countries. Finally, the investments are made and production takes place. There is no coordination between the two national governments at any stage.

We assume that a fraction θ of the tax revenue is collected by the supra-national body from the first country (and a fraction $\bar{\theta}$ from the second country), and a fraction μ ($1-\mu$ for the second country) of the total amount collected is returned to the national government. Thus, the law of motion of the public capital is

$$G_{t+1} = [1-\delta_G]G_t + [1-\theta]\tau_{t+1}K_{t+1} + \mu\Omega_{t+1}, \tag{38}$$

where $\Omega_{t+1} = \theta\tau_{t+1}K_{t+1} + \bar{\theta}\bar{\tau}_{t+1}\bar{K}_{t+1}$. Thus, if the balanced growth path is achieved from $t = 0$

$$G_0 = \frac{1+\gamma}{\gamma+\delta_G}\left[[1-\theta+\theta\mu]\tau K_0 + \bar{\theta}\mu\bar{\tau}\bar{K}_0\right]. \tag{39}$$

Since the households take the public capital investment into production as given, the optimization problem for each household is the same as in the case without redistribution solved in the previous section. Thus, the welfare-maximizing growth rate is determined by

$$\gamma = \beta\left[A\left[\frac{\Gamma_0}{G_0}\right]^{\rho[1-\alpha]}\left[\frac{G_0}{K_0}\right]^{[1-\alpha]} + 1 - \delta_K - \tau\right] - 1, \tag{40}$$

where now G_0 is defined by (39), and

$$\Gamma_0 = G_0 + \bar{G}_0 = \tau K_0 + \bar{\tau}\bar{K}_0. \tag{41}$$

We assume that the redistribution is costless, so that the total public investment is not changed.

Maximization of welfare by the government leads to the implicit solution for the optimal tax rate,

$$\tau = [1-\alpha]\left[\frac{1+\gamma}{\beta} - 1 + \delta_K + \tau\right]\left[1 - \rho\frac{\bar{\tau}\bar{K}_0}{\tau K_0 + \bar{\tau}\bar{K}_0}\right] - \bar{\tau}\frac{\bar{\theta}\mu}{1-\theta+\theta\mu}\frac{\bar{K}_0}{K_0}. \tag{42}$$

Similarly, the second country's optimal tax rate is

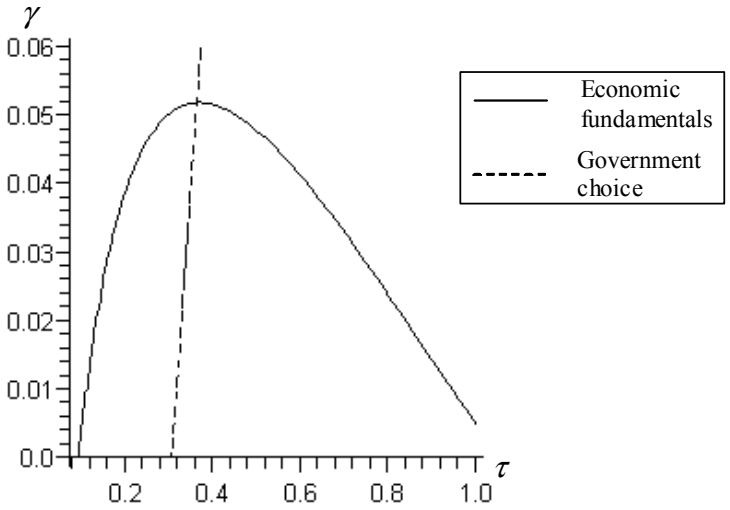
$$\bar{\tau} = [1-\alpha]\left[\frac{1+\gamma}{\beta} - 1 + \delta_K + \tau\right]\left[1 - \rho\frac{\tau K_0}{\tau K_0 + \bar{\tau}\bar{K}_0}\right] - \tau\frac{\theta[1-\mu]}{1-\bar{\theta}+\bar{\theta}[1-\mu]}\frac{K_0}{\bar{K}_0}. \tag{43}$$

It can be seen from (42) and (43) that by correctly choosing $(\theta, \bar{\theta}, \mu)$ it is possible to induce the efficient levels of the national tax rates when there is no cooperation between the governments.

This is illustrated in Figure 8. A comparison with the no coordination case shows that the redistribution results in a shift of the curve describing the optimal choice of the government, and this shift can be adjusted so that the resulting equilibrium is the one with the highest growth rate, *i.e.* the same outcome as with coordination. Note that to achieve this θ and $\bar{\theta}$ must be negative: the central body announces subsidies to public investment in infrastructure. Such a policy is typical for correction of inefficiency in the presence of positive externalities.

Figure 8. Equilibrium with redistribution

$\theta = \bar{\theta} = -0.65$, $\mu = 0.5$.



5 Capital mobility

A limitation of the analysis in the previous section was the assumption that both countries would be on the same balanced growth path. This assumption was required because the model lacked a mechanism that would guarantee the equalization of growth rates. Any asymmetry between the countries would imply that the GDP per capita of one country would eventually become insignificant relative to the other. This is unsatisfactory since growth paths are similar in practice so the model needs an endogenous mechanism that ensures the equality of the growth rates.

The process we use to ensure the equality of balanced growth paths is to allow capital to be mobile between countries. As the investors relocate capital to seek the highest after-tax return the outcome will ensure that the growth rates in the two countries are the same. If the growth rates are equalized then the countries impose an additional dynamic externality on each: if one country raises its tax rate it will affect the growth rates of all countries.

In this section the model is extended to allow the consumers in the two countries to relocate capital costlessly. Let k_t ($\bar{k}_t$) denote the stock of capital owned by the "domestic" ("foreign") consumer. With perfect capital mobility each consumer will choose to invest in the country where the after-tax return on investment is higher. We assume that the tax on capital is collected at the destination, and the output produced in each country is divided between the two investors proportionally to their capital investments.

Let $\lambda_t \in [0,1]$ denote the fraction of k_t invested in the home country and $1-\bar{\lambda}_t \in [0,1]$ denote the fraction of $\bar{k}_t$ invested there. Then

$$K_t = \lambda_t k_t + [1-\bar{\lambda}_t]\bar{k}_t . \tag{44}$$

Similarly, for the foreign country

$$\bar{K}_t = [1-\lambda_t]k_t + \bar{\lambda}_t \bar{k}_t . \tag{45}$$

Razin and Yuen (1997) hypothesized that capital mobility across countries ensures equalization of the growth rates along the balanced growth path, and illustrated this result in a two-country framework of endogenous growth with a human capital input. In what follows we show that a similar result holds in our model. The law of motion of the public capital in the foreign country is

$$\bar{G}_{t+1} = [1-\delta_G]\bar{G}_t + \bar{\tau}[[1-\lambda_t]k_{t+1} + \bar{\lambda}_t \bar{k}_{t+1}]. \tag{46}$$

Let the capital stock owned by domestic investors, k_t, grow at a constant rate γ, and that owned by foreign investors, $\bar{k}_t$, grows at rate $\bar{\gamma}$. Assuming the tax rate and the share of domestic investment are constant, and iterating in (46), we obtain the following:

$$\begin{aligned}
\bar{G}_{t+1} &= [1-\delta_G][[1-\delta_G]\bar{G}_{t-1} + \bar{\tau}[[1-\lambda]k_t + \bar{\lambda}\bar{k}_t]] + \bar{\tau}[[1-\lambda]k_{t+1} + \bar{\lambda}\bar{k}_{t+1}] \\
&= [1-\delta_G]^{t+1}\left[\bar{G}_0 - \bar{\tau}\left[\frac{1+\gamma}{\gamma+\delta_G}[1-\lambda]k_0 + \frac{1+\bar{\gamma}}{\bar{\gamma}+\delta_G}\bar{\lambda}\bar{k}_0\right]\right] \\
&+ \bar{\tau}\left[\frac{1+\gamma}{\gamma+\delta_G}[1-\lambda]k_0[1+\gamma]^{t+1} + \frac{1+\bar{\gamma}}{\bar{\gamma}+\delta_G}\bar{\lambda}\bar{k}_0[1+\bar{\gamma}]^{t+1}\right].
\end{aligned} \tag{47}$$

Dividing both sides by $\bar{k}_{t+1}$,

$$\begin{aligned}
\frac{\bar{G}_{t+1}}{\bar{k}_{t+1}} &= \left[\frac{1-\delta_G}{1+\bar{\gamma}}\right]^{t+1}\frac{1}{\bar{k}_0}\left[G_0 - \bar{\tau}\left[\frac{1+\gamma}{\gamma+\delta_G}[1-\lambda]k_0 - \frac{1+\bar{\gamma}}{\bar{\gamma}+\delta_G}\bar{\lambda}\bar{k}_0\right]\right] \\
&+ \bar{\tau}\left[[1-\lambda]\frac{1+\gamma}{\gamma+\delta_G}\frac{k_0}{\bar{k}_0}\left[\frac{1+\gamma}{1+\bar{\gamma}}\right]^{t+1} + \frac{1+\bar{\gamma}}{\bar{\gamma}+\delta_G}\bar{\lambda}\right].
\end{aligned} \tag{48}$$

It can be seen that in the long run the first term converges to zero and the second term is constant if and only if $\gamma = \bar{\gamma}$. Thus, in the balanced growth path equilibrium the long-run growth rates for the two countries must be equal. Also, if the balanced growth path is achieved at $t = 0$ then

$$\bar{G}_0 = \bar{\tau}\frac{1+\gamma}{\gamma+\delta_G}[[1-\lambda]k_0 + \bar{\lambda}\bar{k}_0]. \tag{49}$$

Similarly, for the home country it must be the case that

$$G_0 = \tau \frac{1+\gamma}{\gamma+\delta_G}\left[\lambda k_0 + \left[1-\bar{\lambda}\right]\bar{k}_0\right]. \tag{50}$$

The allocation of capital across the countries is chosen by each consumer to maximize their utility. An interior solution for λ corresponds to equalized net returns, so

$$\frac{\alpha\lambda k_0 + \left[1-\bar{\lambda}\right]\bar{k}_0}{\lambda k_0 + \left[1-\bar{\lambda}\right]\bar{k}_0}\frac{Y_0}{K_0} - \tau = \frac{\bar{\lambda}\bar{k}_0 + \alpha\left[1-\lambda\right]k_0}{\bar{\lambda}\bar{k}_0 + \alpha\left[1-\lambda\right]k_0}\frac{\bar{Y}_0}{\bar{K}_0} - \bar{\tau}\,. \tag{51}$$

If the tax rates and the fundamentals are such that the left-hand side of (51) is greater than the right-hand side, *i.e.* the domestic net return to domestically-owned capital is higher that the foreign net return, then $\lambda = 1$, the home consumer invests all his capital at home. Conversely, if this left-hand side is less, *i.e.* the foreign net returns are higher than the domestic ones then $\lambda = 0$, and the home consumer invests all his capital abroad. The solution for the foreign consumer's optimization problem is similar. Note that in every case we consider each consumer chooses the allocation of capital between countries taking the decision of other consumer, as well as the tax rates and public capital inputs in both countries, as given.

5.1 Non-cooperative equilibrium

When the two governments do not cooperate they simultaneously choose the tax rates to maximize the welfare of their own consumers, or, equivalently, the growth rates of their economies. Consider the decision of the domestic government, assuming that the optimal allocation of capital by the domestic investor is in the interior. The government does not internalize the externality and chooses τ to maximize γ, taking k_0, $\bar{k}_0$, $\bar{\tau}$, and $\bar{G}_0$ as given. However, each government realizes that its choice of tax will affect the capital allocation decisions of investors in both countries.

Thus, the home government's objective is to maximize γ implicitly defined by

$$\begin{aligned}\gamma = -1 + \beta\Bigg[& \lambda A\left[1 + \frac{\bar{G}_0}{\varphi(\gamma,\tau)\left[\lambda k_0 + \left[1-\bar{\lambda}\right]\bar{k}_0\right]}\right]^{\rho[1-\alpha]}\varphi(\gamma,\tau)^{1-\alpha} \\ & + \left[1-\delta_K\right] - \tau\lambda - \bar{\tau}\left[1-\lambda\right] \\ & + \left[1-\lambda\right]\bar{A}\left[1 + \frac{\varphi(\gamma,\tau)\left[\lambda k_0 + \left[1-\bar{\lambda}\right]\bar{k}_0\right]}{\bar{G}_0}\right]^{\rho[1-\alpha]}\left[\frac{\bar{G}_0}{\bar{\lambda}\bar{k}_0 + \left[1-\lambda\right]k_0}\right]^{1-\alpha}\Bigg],\end{aligned} \tag{52}$$

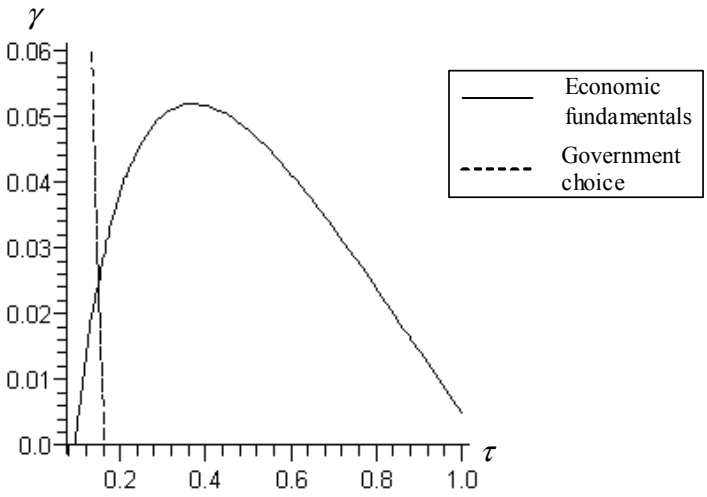
where $\varphi(\gamma,\tau) \equiv \tau\frac{1+\gamma}{\gamma+\delta_G}$, and λ and $\bar{\lambda}$ solve (51) and the counterpart of the latter for the foreign investor.

There is no need to impose the equality of the growth rates: in equilibrium this is ensured by the optimal choice of capital allocation by the consumers. However, the equilibrium growth rate, in general, is not efficient because the externalities are not internalized even with mobile capital.

In Figure 9 the completely symmetric equilibrium with mobile capital when the governments do not coordinate their tax choice is illustrated for the same values of the model parameters as in

the previous numerical examples. One can see that the equilibrium tax rates are even lower than in the no-coordination case with immobile capital, because of the tax competition effect: each government cuts their tax rate in order to attract capital from abroad. Thus, capital mobility in the absence of coordination exacerbates the inefficiency caused by the externality.

Figure 9. Optimal tax rate without coordination, with mobile capital
$\tau = \bar{\tau} = 0.1487$, $\gamma = \bar{\gamma} = 0.0259$.



5.2 Cooperative equilibrium

If the two governments cooperate in choosing taxes the equilibrium outcome can be improved. The efficient equilibrium growth rate is achieved when the externalities are internalized, *i.e.* the two governments choose their tax rates simultaneously to maximize the sum of the two welfare functions.

This is equivalent to solving

$$\max_{\{\tau,\bar{\tau}\}} \gamma, \tag{53}$$

where γ is implicitly defined by

$$\begin{aligned}\gamma = \beta\Bigg[& \lambda A\left[1+\frac{\bar{\tau}\left[\bar{\lambda}\bar{k}_0+\left[1-\lambda\right]k_0\right]}{\tau\left[\lambda k_0+\left[1-\bar{\lambda}\right]\bar{k}_0\right]}\right]^{\rho[1-\alpha]}\left[\tau\frac{1+\gamma}{\gamma+\delta_G}\right]^{1-\alpha} \\ & +\left[1-\delta_K\right]-\tau\lambda-\bar{\tau}\left[1-\lambda\right] \\ & +\left[1-\lambda\right]\bar{A}\left[1+\frac{\tau\left[\lambda k_0+\left[1-\bar{\lambda}\right]\bar{k}_0\right]}{\bar{\tau}\left[\bar{\lambda}\bar{k}_0+\left[1-\lambda\right]k_0\right]}\right]^{\rho[1-\alpha]}\left[\bar{\tau}\frac{1+\gamma}{\gamma+\delta_G}\right]^{1-\alpha}\Bigg]+1,\end{aligned} \tag{54}$$

5.3 Non-cooperative equilibrium with redistribution

As in the case of immobile capital considered in the previous section, a policy of intervention by a supra-national government can achieve the first-best outcome through correction of the externality. The intervention is again modelled as a multi-stage game. Since the households take the public capital investment into production as given, the optimization problem for the household is the same as in the case without redistribution. We assume that the central body runs a balanced budget.

Under the redistribution scheme along the balanced growth path

$$G_0 = \frac{1+\gamma}{\gamma+\delta_G}\left[\left[1-\theta+\theta\mu\right]\tau K_0 + \bar{\theta}\mu\bar{\tau}\bar{K}_0\right], \tag{55}$$

$$\bar{G}_0 = \frac{1+\gamma}{\gamma+\delta_G}\left[\left[1-\bar{\theta}+\theta[1-\mu]\right]\tau K_0 + \theta[1-\mu]\bar{\tau}\bar{K}_0\right], \tag{56}$$

where

$$K_0 = \lambda k_0 + \left[1-\bar{\lambda}\right]\bar{k}_0, \tag{57}$$

and

$$\bar{K}_0 = \bar{\lambda}\bar{k}_0 + \left[1-\lambda\right]k_0. \tag{58}$$

The domestic government chooses τ to maximize γ implicitly defined by

$$\begin{aligned}\gamma = -1 + \beta\Bigg[& \lambda A\left[1+\frac{\bar{G}_0}{\tilde{\varphi}(\gamma,\tau)\left[\lambda k_0 + \left[1-\bar{\lambda}\right]\bar{k}_0\right]}\right]^{\rho[1-\alpha]}\tilde{\varphi}(\gamma,\tau)^{1-\alpha} \\ & + \left[1-\delta_K\right] - \tau\lambda - \bar{\tau}\left[1-\lambda\right] \\ & + \left[1-\lambda\right]\bar{A}\left[1+\frac{\tilde{\varphi}(\gamma,\tau)\left[\lambda k_0 + \left[1-\bar{\lambda}\right]\bar{k}_0\right]}{\bar{G}_0}\right]^{\rho[1-\alpha]}\left[\frac{\bar{G}_0}{\bar{\lambda}\bar{k}_0 + \left[1-\lambda\right]k_0}\right]^{1-\alpha}\Bigg].\end{aligned} \tag{59}$$

where

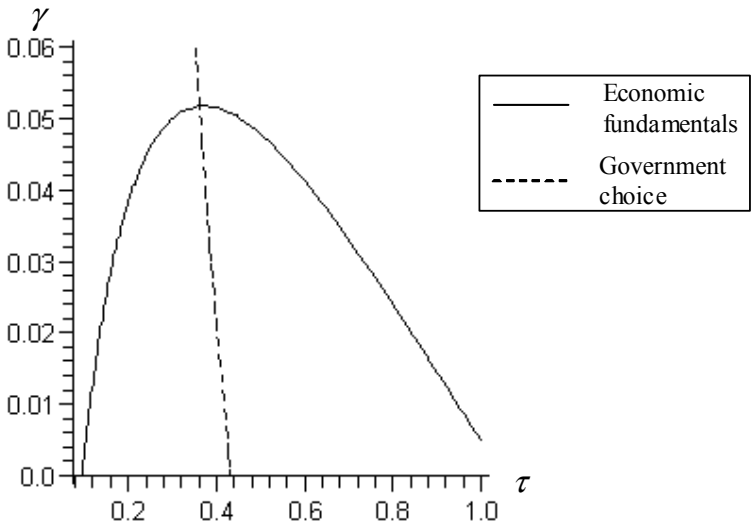
$$\tilde{\varphi}(\gamma,\tau) = \frac{1+\gamma}{\gamma+\delta_G}\left[\left[1-\theta+\theta\mu\right]\tau + \bar{\theta}\mu\bar{\tau}\frac{\bar{K}_0}{K_0}\right]. \tag{60}$$

The foreign government faces a similar optimization.

By choosing $\{\theta, \bar{\theta}, \mu\}$ the supra-national body can shift the reaction functions of the two governments so that the equilibrium choice of taxes coincides with the first-best outcome. There is no closed-form solution, but we can characterize it qualitatively. Since the externality from public investment is positive, in the non-cooperative equilibrium the taxes will be set too low. In addition, capital mobility will cause tax competition between the governments, which will result in even lower taxes. To achieve efficiency the supra-national body needs to encourage higher taxes, which requires θ and $\bar{\theta}$ to be negative. Once the supra-national body announces that it will subsidize public investment in each country, the governments set higher taxes. After that

the subsidies are claimed back. Figure 10 demonstrates that the maximum growth rate can be achieved by this process.

Figure 10. Effect of central body, with mobile capital
$\tau = \bar{\tau} = 0.361$, $\theta = \bar{\theta} = -1.27$.



6 Conclusions

There is no convincing empirical evidence of a relationship between taxation and economic growth in cross-country data. We have argued that the lack of a relationship is not inconsistent with the growth rate being increased by additional public sector expenditure. The explanation offered to resolve this apparent contradiction is that public sector expenditure is productive, that there are spill-overs of the benefits of public infrastructure between countries, and that capital is internationally mobile. These mechanisms make it possible for an increase in taxation in one country to raise the growth rate in all countries. This effect will not be apparent in cross-country comparisons taken at one point.

This argument is reflected in the summary of results presented in Table 2. This reports the growth rate for the two models of immobile capital and mobile capital for a range of values of the fraction θ of the tax revenue collected by the supra-national body. The first observation is that with no intervention ($\theta = 0$) the growth rate is below the maximum level. With immobile capital this reflects the inefficiency resulting from the spill-over of infrastructure. The growth rate with no intervention is even lower when capital is mobile because this creates an additional externality. The rate of growth is increased when θ becomes negative since this provides an incentive for the countries to increase their tax rates.

Table 2: Growth rate and intervention

θ	-1.4	-1.2	-1.0	-0.8	-0.6	-0.4	-0.2	0	0.2	0.4
Immobile	0.039	0.045	0.049	0.051	0.052	0.050	0.047	0.042	0.034	0.025
Mobile	0.052	0.052	0.051	0.048	0.045	0.042	0.034	0.026	0.017	0.006

The policy implications of our analysis are that although public expenditure can assist growth there is no guarantee that the optimal level of growth will be achieved. The design of public expenditure has to take into account the infrastructure externalities and the capital flows. If the choices of individual countries are not coordinated then the outcome will be inefficient and growth will not be welfare-maximizing. A coordinating body, such as the European Commission, has a role to play in attaining an efficient level of expenditure on public infrastructure. This role involves supporting the expenditure decisions of individual countries to raise the overall level of expenditure.

Appendix

The Appendix provides the derivation of the results used in the main text.

A4.1 Independent choice

A government that does not internalize the externality chooses τ to maximize γ, taking K_0 and $\overline{G}_0$ as given. The resulting value of γ is given by

$$\gamma = \beta\left[A\left[1+\frac{\overline{G}_0/K_0}{\varphi(\gamma,\tau)}\right]^{\rho[1-\alpha]}\left[\varphi(\gamma,\tau)^{1-\alpha}+1-\delta_K-\tau\right]\right]-1, \tag{A1}$$

where $\varphi(\gamma,\tau)=\tau\dfrac{1+\gamma}{\gamma+\delta_G}$. Total differentiation gives

$$\frac{1}{\beta}d\gamma = A\left[1+\frac{\overline{G}_0/K_0}{\varphi(\gamma,\tau)}\right]^{\rho[1-\alpha]}\varphi(\gamma,\tau)^{1-\alpha}$$

$$\times\left[-\frac{\rho[1-\alpha]}{1+\dfrac{\overline{G}_0/K_0}{\varphi(\gamma,\tau)}}\frac{\overline{G}_0}{K_0}\frac{d\varphi}{\varphi^2}+[1-\alpha]\frac{d\varphi}{\varphi}\right]-d\tau. \tag{A2}$$

Using (A1) this can be re-written as the following:

$$\left[\frac{1}{\beta}+\frac{[1-\delta_G][1-\alpha]\left[\dfrac{1+\gamma}{\beta}-1+\delta_K+\tau\right]}{[1+\gamma][\gamma+\delta_G]}\left[1-\rho\frac{\overline{G}_0/K_0}{\varphi(\gamma,\tau)+\overline{G}_0/K_0}\right]\right]d\gamma$$

$$=[1-\alpha]\left[\left[\frac{1+\gamma}{\beta}-1+\delta_K+\tau\right]\left[1-\rho\frac{\overline{G}_0/K_0}{\varphi(\gamma,\tau)+\overline{G}_0/K_0}\right]-\tau\right]\frac{d\tau}{\tau}. \tag{A3}$$

Thus, the growth-maximizing tax rate is determined implicitly by the solution to the pair of equations

$$\tau=[1-\alpha]\left[\frac{1+\gamma}{\beta}-1+\delta_K+\tau\right]\left[1-\rho\frac{\overline{G}_0/K_0}{\varphi(\gamma,\tau)+\overline{G}_0/K_0}\right], \tag{A4}$$

$$\gamma=\beta\left[A\left[1+\frac{\overline{G}_0/K_0}{\varphi(\gamma,\tau)}\right]^{\rho[1-\alpha]}\varphi(\gamma,\tau)^{1-\alpha}+1-\delta_K-\tau\right]-1. \tag{A5}$$

If the world consists of two countries the equilibrium tax rates and the growth rate solve the following system of equations (assuming the discount rates and depreciation rates are equal across the countries):

$$\tau = [1-\alpha]\left[\frac{1+\gamma}{\beta} - 1 + \delta_K + \tau\right]\left[1 - \rho\frac{\bar{\tau}\bar{K}_0}{\tau K_0 + \bar{\tau}\bar{K}_0}\right], \tag{A6}$$

$$\bar{\tau} = [1-\alpha]\left[\frac{1+\gamma}{\beta} - 1 + \delta_K + \bar{\tau}\right]\left[1 - \rho\frac{\tau K_0}{\tau K_0 + \bar{\tau}\bar{K}_0}\right], \tag{A7}$$

$$\gamma = \beta\left[A\left[1+\frac{\bar{\tau}\bar{K}_0}{\tau K_0}\right]^{\rho[1-\alpha]}\left[\tau\frac{1+\gamma}{\gamma+\delta_G}\right] + 1 - \delta_K - \tau\right] - 1, \tag{A8}$$

and

$$A\left[1+\frac{\bar{\tau}\bar{K}_0}{\tau K_0}\right]^{\rho[1-\alpha]}\left[\tau\frac{1+\gamma}{\gamma+\delta_G}\right]^{[1-\alpha]} - \tau = \bar{A}\left[1+\frac{\tau K_0}{\bar{\tau}\bar{K}_0}\right]^{\rho[1-\alpha]}\left[\bar{\tau}\frac{1+\gamma}{\gamma+\delta_G}\right]^{[1-\alpha]} - \bar{\tau}. \tag{A9}$$

The last equality is obtained from the equality of the two growth rates. This implies an additional restriction on the fundamentals, $\{A, \bar{A}, K_0, \bar{K}_0\}$. In other words, to achieve the balanced growth path a certain relationship between the technologies and the endowments in two countries must hold. These conditions are met if we assume symmetry between the countries in the sense that $A = \bar{A}$, and $K_0 = \bar{K}_0$.

A4.2 Coordination between countries

Assuming symmetry with $A = \bar{A}$, $\tau = \bar{\tau}$ and $K_0 = \bar{K}_0$, the optimization simplifies to

$$\max_{\{\tau\}} = \beta\left[A2^{\rho[1-\alpha]}\left[\tau\frac{1+\gamma}{\gamma+\delta_G}\right]^{[1-\alpha]} + 1 - \delta_K - \tau\right] - 1. \tag{A10}$$

This gives the necessary condition for τ as

$$\tau = A2^{\rho[1-\alpha]}[1-\alpha]\left[\tau\frac{1+\gamma}{\gamma+\delta_G}\right]^{[1-\alpha]}. \tag{A11}$$

A4.3 Redistribution

The law of motion of the public capital is

$$G_{t+1} = [1-\delta_G]G_t + [1-\theta]\tau_{t+1}K_{t+1} + \mu\Omega_{t+1}, \tag{A12}$$

where $\Omega_{t+1} = \theta\tau_{t+1}K_{t+1} + \bar{\theta}\bar{\tau}_{t+1}\bar{K}_{t+1}$. Iterating with respect to t yields

$$G_{t+1} = [1-\delta_G]^{t+1}G_0 + \sum_{i=0}^{t}[1-\delta_G]^i[[1-\theta]\tau_{t+1}K_{t+1-i} + \mu\Omega_{t+1-i}], \tag{A13}$$

and if the capital stock grows at a constant rate γ in both countries, whereas the tax rates and redistribution rates are constant,

$$G_{t+1} = [1-\delta_G]^{t+1}G_0 + \sum_{i=0}^{t}[1-\delta_G]^i[[1-\theta]\tau K_0 + \mu\Omega_0][1+\gamma]^{t+1-i}$$

$$= [1-\delta_G]^{t+1}\left[G_0 - \frac{1+\gamma}{\gamma+\delta_G}[[1-\theta+\theta\mu]\tau K_0 + \theta[1-\mu]\bar{\tau}\bar{K}_0]\right]$$

$$+[1+\gamma]^{t+1}\frac{1+\gamma}{\gamma+\delta_G}\left[[1-\theta+\theta\mu]\tau K_0+\bar{\theta}\mu\bar{\tau}\bar{K}_0\right]. \tag{A14}$$

Thus, if the balanced growth path is achieved from $t = 0$

$$G_0=\frac{1+\gamma}{\gamma+\delta_G}\left[[1-\theta+\theta\mu]\tau K_0+\bar{\theta}\mu\bar{\tau}\bar{K}_0\right]. \tag{A15}$$

Since the households take the public capital investment into production as given, the optimization problem for the household is the same as in the case without redistribution. Thus, the welfare-maximizing growth rate is determined by

$$\gamma=\beta\left[A\left[\frac{\Gamma_0}{G_0}\right]^{\rho[1-\alpha]}\left[\frac{G_0}{K_0}\right]^{[1-\alpha]}+1-\delta_K-\tau\right]-1, \tag{A16}$$

where

$$\Gamma_0=G_0+\bar{G}_0=\tau K_0+\bar{\tau}\bar{K}_0. \tag{A17}$$

A government that does not internalize the externality chooses τ to maximize γ, taking K_0 and $\bar{G}_0$ as given. Now

$$\gamma=\beta\left[A\left[1+\frac{\bar{G}_0/K_0}{\tilde{\varphi}(\gamma,\tau)}\right]^{\rho[1-\alpha]}\varphi(\gamma,\tau)^{1-\alpha}+1-\delta_K-\tau\right]-1, \tag{A18}$$

where

$$\tilde{\varphi}(\gamma,\tau)=\frac{G_0}{K_0}=\frac{1+\gamma}{\gamma+\delta_G}\left[[1-\theta+\theta\mu]\tau+\bar{\theta}\mu\bar{\tau}\frac{\bar{K}_0}{K_0}\right]. \tag{A19}$$

Total differentiation gives

$$\frac{1}{\beta}d\gamma=A\left[1+\frac{\bar{G}_0/K_0}{\tilde{\varphi}(\gamma,\tau)}\right]^{\rho[1-\alpha]}\tilde{\varphi}(\gamma,\tau)^{1-\alpha}\left[-\frac{\rho[1-\alpha]}{1+\dfrac{\bar{G}_0/K_0}{\tilde{\varphi}(\gamma,\tau)}}\frac{\bar{G}_0}{K_0}\frac{d\tilde{\varphi}}{\tilde{\varphi}^2}+[1-\alpha]\frac{d\tilde{\varphi}}{\tilde{\varphi}}\right]-d\tau$$

$$=[1-\alpha]A\left[1+\frac{\bar{G}_0/K_0}{\tilde{\varphi}(\gamma,\tau)}\right]^{\rho[1-\alpha]}\tilde{\varphi}(\gamma,\tau)^{1-\alpha}\left[1-\rho\frac{\bar{G}_0/K_0}{\tilde{\varphi}(\gamma,\tau)+\bar{G}_0/K_0}\right]$$

$$\times\left[d\tau\frac{1-\theta+\theta\mu}{[1-\theta+\theta\mu]\tau+\bar{\theta}\mu\bar{\tau}\dfrac{\bar{K}_0}{K_0}}-d\lambda\frac{1-\delta_G}{[1+\gamma][\gamma+\delta_G]}\right]-d\tau. \tag{A20}$$

We therefore obtain the implicit solution for the optimal tax rate,

$$\tau=[1-\alpha]\left[\frac{1+\gamma}{\beta}-1+\delta_K+\tau\right]\left[1-\rho\frac{\bar{\tau}\bar{K}_0}{\tau K_0+\bar{\tau}\bar{K}_0}\right]-\bar{\tau}\frac{\bar{\theta}\mu}{1-\theta+\theta\mu}\frac{\bar{K}_0}{K_0}. \tag{A21}$$

Similarly, the second country's optimal tax rate is

$$\bar{\tau} = [1-\alpha]\left[\frac{1+\gamma}{\beta} - 1 + \delta_K + \tau\right]\left[1 - \rho\frac{\tau K_0}{\tau K_0 + \bar{\tau}\bar{K}_0}\right] - \tau\frac{\theta[1-\mu]}{1-\bar{\theta}+\bar{\theta}[1-\mu]}\frac{K_0}{\bar{K}_0}. \quad \text{(A22)}$$

A5. Capital mobility

The law of motion of the public capital in the foreign country is

$$\bar{G}_{t+1} = [1-\delta_G]\bar{G}_t + \bar{\tau}\left[[1-\lambda_t]k_{t+1} + \bar{\lambda}_t\bar{k}_{t+1}\right]. \quad \text{(A23)}$$

Let the capital stock owned by domestic investors, k_t, grow at a constant rate γ, and that owned by foreign investors, $\bar{k}_t$, growth at rate $\bar{\gamma}$. Assuming the tax rate and the share of domestic investment are constant, and iterating in (A23), we obtain the following:

$$\begin{aligned}\bar{G}_{t+1} &= [1-\delta_G]\left[[1-\delta_G]\bar{G}_{t-1} + \bar{\tau}\left[[1-\lambda]k_t + \bar{\lambda}\bar{k}_t\right]\right] + \bar{\tau}\left[[1-\lambda]k_{t+1} + \bar{\lambda}\bar{k}_{t+1}\right] \\ &= [1-\delta_G]^{t+1}\left[\bar{G}_0 - \bar{\tau}\left[\frac{1+\gamma}{\gamma+\delta_G}[1-\lambda]k_0 + \frac{1+\bar{\gamma}}{\bar{\gamma}+\delta_G}\bar{\lambda}\bar{k}_0\right]\right] \\ &+ \bar{\tau}\left[\frac{1+\gamma}{\gamma+\delta_G}[1-\lambda]k_0[1+\gamma]^{t+1} + \frac{1+\bar{\gamma}}{\bar{\gamma}+\delta_G}\bar{\lambda}\bar{k}_0[1+\bar{\gamma}]^{t+1}\right]. \quad \text{(A24)}\end{aligned}$$

Dividing both sides by $\bar{k}_{t+1}$,

$$\begin{aligned}\frac{\bar{G}_{t+1}}{\bar{k}_{t+1}} &= \left[\frac{1-\delta_G}{1+\bar{\gamma}}\right]^{t+1}\frac{1}{\bar{k}_0}\left[G_0 - \bar{\tau}\left[\frac{1+\gamma}{\gamma+\delta_G}[1-\lambda]k_0 - \frac{1+\bar{\gamma}}{\bar{\gamma}+\delta_G}\bar{\lambda}\bar{k}_0\right]\right] \\ &+ \bar{\tau}\left[[1-\lambda]\frac{1+\gamma}{\gamma+\delta_G}\frac{k_0}{\bar{k}_0}\left[\frac{1+\gamma}{1+\bar{\gamma}}\right]^{t+1} + \frac{1+\bar{\gamma}}{\bar{\gamma}+\delta_G}\bar{\lambda}\right]. \quad \text{(A25)}\end{aligned}$$

The first term converges to zero and the second term is constant if and only if $\gamma = \bar{\gamma}$. If the balanced growth path is achieved at $t = 0$

$$\bar{G}_0 = \bar{\tau}\frac{1+\gamma}{\gamma+\delta_G}\left[[1-\lambda]k_0 + \bar{\lambda}\bar{k}_0\right]. \quad \text{(A26)}$$

Similarly, for the home country it must be the case that

$$G_0 = \tau\frac{1+\gamma}{\gamma+\delta_G}\left[\lambda k_0 + [1-\bar{\lambda}]\bar{k}_0\right]. \quad \text{(A27)}$$

With capital flows the budget constraint of the domestic consumer becomes

$$C_t = \frac{\lambda k_t}{K_t}Y_t + \frac{[1-\lambda]k_t}{\bar{K}_t}\bar{Y}_t + [1-\delta_K]k_t - \tau\lambda k_t - \bar{\tau}[1-\lambda]k_t - k_{t+1}, \quad \text{(A28)}$$

and along the balanced growth path

$$C_t = [1+\gamma]^t\left[\frac{\lambda k_0}{K_0}Y_0 + \frac{[1-\lambda]k_0}{\bar{K}_0}\bar{Y}_0 + [1-\delta_K]k_0 - \tau\lambda k_0 - \bar{\tau}[1-\lambda]k_0 - [1+\gamma]k_0\right]$$

$$= [1+\gamma]^t C_0, \tag{A29}$$

where

$$C_0 = \left[\lambda \frac{Y_0}{K_0} + [1-\lambda]\frac{\overline{Y}_0}{\overline{K}_0} + [1-\delta_K] - \tau\lambda - \overline{\tau}[1-\lambda] - [1+\gamma] \right] k_0, \tag{A30}$$

and

$$\frac{Y_0}{K_0} = \left[\frac{G_0}{\lambda k_0 + [1-\overline{\lambda}]\overline{k}_0} \left[\frac{\Gamma_0}{G_0} \right]^{\rho} \right]^{1-\alpha}, \tag{A31}$$

$$\frac{\overline{Y}_0}{\overline{K}_0} = \left[\frac{\overline{G}_0}{\overline{\lambda}\overline{k}_0 + [1-\lambda]k_0} \left[\frac{\Gamma_0}{\overline{G}_0} \right]^{\rho} \right]^{1-\alpha}. \tag{A32}$$

The lifetime utility of the home consumer is

$$U = \sum_{t=0}^{\infty} \beta^t \ln(C_t) = \frac{1}{1-\beta}\ln(C_0) + \frac{\beta}{[1-\beta]^2}\ln(1+\gamma). \tag{A33}$$

Assume that two consumers simultaneously choose the allocation of capital and after that simultaneously choose the optimal growth rate. Solving backwards we first solve the first-order condition for γ. For the home consumer we have

$$\frac{\partial U}{\partial \gamma} = \frac{1}{1-\beta}\frac{1}{C_0}\frac{\partial C_0}{\partial \gamma} + \frac{\beta}{[1-\beta]^2}\frac{1}{1+\gamma},$$

$$C_0 = -\frac{\partial C_0}{\partial \gamma}\frac{1-\beta}{\beta}[1+\gamma] = \frac{1-\beta}{\beta}[1+\gamma]k_0, \tag{A34}$$

and, substituting this back into the utility function,

$$U(\gamma(\lambda)) = \frac{1}{1-\beta}\ln\left(\frac{1-\beta}{\beta}\right) + \frac{1}{1-\beta}\ln(k_0) + \frac{1}{[1-\beta]^2}\ln(1+\gamma(\lambda)). \tag{A35}$$

Now differentiation with respect to λ gives

$$\frac{dU}{d\lambda} = \frac{1}{[1-\beta]^2}\frac{1}{1+\gamma}\frac{d\gamma}{d\lambda}. \tag{A36}$$

For the interior solution this is equal to zero. From (A34)

$$\frac{1-\beta}{\beta}[1+\gamma] = \frac{C_0}{k_0}$$

$$= \lambda\frac{Y_0}{K_0} + [1-\lambda]\frac{\overline{Y}_0}{\overline{K}_0} + [1-\delta_K] - \tau\lambda - \overline{\tau}[1-\lambda] - [1+\gamma], \tag{A37}$$

so that

$$\frac{1}{\beta}[1+\gamma] = \lambda\frac{Y_0}{K_0} + [1-\lambda]\frac{\overline{Y}_0}{\overline{K}_0} + [1-\delta_K] - \tau\lambda - \overline{\tau}[1-\lambda]. \tag{A38}$$

Differentiation gives

$$\frac{1}{\beta}\frac{d\gamma}{d\lambda} = \frac{Y_0}{K_0} - \frac{\overline{Y}_0}{\overline{K}_0} - \tau + \overline{\tau} - \lambda\frac{Y_0}{K_0}\frac{[1-\alpha]k_0}{K_0} + [1-\lambda]\frac{\overline{Y}_0}{\overline{K}_0}\frac{[1-\alpha]k_0}{K_0}$$

$$= \frac{\alpha\lambda k_0 + [1-\overline{\lambda}]\overline{k}_0}{\lambda k_0 + [1-\overline{\lambda}]\overline{k}_0}\frac{Y_0}{K_0} - \tau - \left[\frac{\overline{\lambda}\overline{k}_0 + \alpha[1-\lambda]k_0}{\overline{\lambda}\overline{k}_0 + \alpha[1-\lambda]k_0}\frac{\overline{Y}_0}{\overline{K}_0} - \overline{\tau}\right]. \qquad \text{(A39)}$$

This equation is expressed as the difference in net returns. Thus, an interior solution for λ corresponds to the equalized net returns. If the tax rates and the fundamentals are such that this difference is positive, *i.e.* domestic net returns to domestically-owned capital then $\lambda = 1$, the home consumer invests all his capital at home. Conversely, if this difference is negative, *i.e.* the foreign net returns are higher than the domestic ones then $\lambda = 0$, and the home consumer invests all his capital abroad.

The solution for the foreign consumer is similar:

$$\frac{1}{\beta}\frac{d\gamma}{d\overline{\lambda}} = \frac{\alpha\overline{\lambda}\overline{k}_0 + [1-\lambda]k_0}{\overline{\lambda}\overline{k}_0 + [1-\lambda]k_0}\frac{\overline{Y}_0}{\overline{K}_0} - \overline{\tau} - \left[\frac{\lambda k_0 + \alpha[1-\overline{\lambda}]k_0}{\lambda k_0 + [1-\overline{\lambda}]k_0}\frac{Y_0}{K_0} - \tau\right], \qquad \text{(A40)}$$

so that $\overline{\lambda} = 1$ when the difference is positive, $\overline{\lambda} = 0$ when the difference is negative, and $\overline{\lambda}$ is between zero and one when the two net returns are equalized. Note that each consumer chooses his capital allocation taking the decision of other consumer, as well as the tax rates and public capital inputs in both countries as given. Thus, in (A39) and (A40)

$$\frac{Y_0}{K_0} = A\left[\frac{G_0}{\lambda k_0 + \alpha[1-\overline{\lambda}]k_0}\left[\frac{\Gamma_0}{G_0}\right]^{\rho}\right]^{1-\alpha}, \qquad \text{(A41)}$$

$$\frac{\overline{Y}_0}{\overline{K}_0} = \overline{A}\left[\frac{\overline{G}_0}{\overline{\lambda}\overline{k}_0 + [1-\lambda]k_0}\left[\frac{\Gamma_0}{\overline{G}_0}\right]^{\rho}\right]^{1-\alpha}. \qquad \text{(A42)}$$

Suppose, λ is in the interior. Then one can see from (A41) and (A42) that $\overline{\lambda}$ is also in the interior i.f.f. $Y_0 / K_0 = \overline{Y}_0 / \overline{K}_0$. Therefore, interior solutions for both λ and $\overline{\lambda}$ may exist for a particular combination of endowments and productivities. If the optimal choice of $\overline{\lambda}$ is zero, then it must be the case that in equilibrium $Y_0 / K_0 < \overline{Y}_0 / \overline{K}_0$. Conversely, if the optimal choice of $\overline{\lambda}$ is one it must be the case that in equilibrium $Y_0 / K_0 > \overline{Y}_0 / \overline{K}_0$.

A5.1 Non-cooperative equilibrium

The domestic government's objective is to maximize γ implicitly defined by

$$\gamma = -1 + \beta\left[\lambda A\left[1 + \frac{\overline{G}_0}{\varphi(\gamma,\tau)[\lambda k_0 + [1-\overline{\lambda}]\overline{k}_0]}\right]^{\rho[1-\alpha]}\varphi(\gamma,\tau)^{1-\alpha}\right.$$

$$+ [1-\delta_K] - \tau\lambda - \overline{\tau}[1-\lambda]$$

$$\left. + [1-\lambda]\overline{A}\left[1 + \frac{\varphi(\gamma,\tau)[\lambda k_0 + [1-\overline{\lambda}]\overline{k}_0]}{\overline{G}_0}\right]^{\rho[1-\alpha]}\left[\frac{\overline{G}_0}{\overline{\lambda}\overline{k}_0 + [1-\lambda]k_0}\right]^{1-\alpha}\right], \qquad \text{(A43)}$$

where $\varphi(\gamma,\tau)\equiv\tau\dfrac{1+\gamma}{\gamma+\delta_G}$, and λ and $\bar{\lambda}$ solve

$$\frac{\alpha\lambda k_0+[1-\bar{\lambda}]\bar{k}_0}{\lambda k_0+[1-\bar{\lambda}]\bar{k}_0}\frac{Y_0}{K_0}-\tau=\frac{\bar{\lambda}\bar{k}_0+\alpha[1-\lambda]k_0}{\bar{\lambda}\bar{k}_0+\alpha[1-\lambda]k_0}\frac{\bar{Y}_0}{\bar{K}_0}-\bar{\tau}\,, \tag{A44}$$

and

$$\left\{\frac{\alpha\lambda k_0+[1-\bar{\lambda}]\bar{k}_0}{\lambda k_0+[1-\bar{\lambda}]\bar{k}_0}\frac{Y_0}{K_0}-\tau=\frac{\bar{\lambda}\bar{k}_0+\alpha[1-\lambda]k_0}{\bar{\lambda}\bar{k}_0+\alpha[1-\lambda]k_0}\frac{\bar{Y}_0}{\bar{K}_0}-\bar{\tau}\vee\frac{Y_0}{K_0}=\frac{\bar{Y}_0}{\bar{K}_0}\right\}, \tag{A45}$$

or

$$\left\{\bar{\lambda}=0\vee\frac{Y_0}{K_0}>\frac{\bar{Y}_0}{\bar{K}_0}\right\},\ \text{or}\ \left\{\bar{\lambda}=1\vee\frac{Y_0}{K_0}<\frac{\bar{Y}_0}{\bar{K}_0}\right\}. \tag{A46}$$

Here, from the viewpoint of the domestic government,

$$\frac{Y_0}{K_0}=A\left[\varphi(\gamma,\tau)\left[1+\frac{\bar{G}_0}{\varphi(\gamma,\tau)[\lambda k_0+[1-\bar{\lambda}]\bar{k}_0]}\right]^{\rho}\right]^{1-\alpha}, \tag{A47}$$

$$\frac{\bar{Y}_0}{\bar{K}_0}=\bar{A}\left[\frac{\bar{G}_0}{\bar{\lambda}\bar{k}_0+[1-\lambda]k_0}\left[1+\frac{\varphi(\gamma,\tau)[\lambda k_0+[1-\bar{\lambda}]\bar{k}_0]}{\bar{G}_0}\right]^{\rho}\right]^{1-\alpha}. \tag{A48}$$

The foreign government chooses τ to maximize γ defined implicitly by

$$\begin{aligned}\gamma=-1+\beta\Bigg[&\bar{\lambda}\bar{A}\left[1+\frac{G_0}{\varphi(\gamma,\bar{\tau})[\bar{\lambda}\bar{k}_0+[1-\lambda]k_0]}\right]^{\rho[1-\alpha]}\varphi(\gamma,\bar{\tau})^{1-\alpha}\\&+[1-\delta_K]-\bar{\tau}\bar{\lambda}-\tau[1-\bar{\lambda}]\\&+[1-\bar{\lambda}]A\left[1+\frac{\varphi(\gamma,\tau)[\bar{\lambda}\bar{k}_0+[1-\lambda]k_0]}{G_0}\right]^{\rho[1-\alpha]}\left[\frac{G_0}{\lambda k_0+[1-\bar{\lambda}]\bar{k}_0}\right]^{1-\alpha}\Bigg],\end{aligned} \tag{A49}$$

but, since it takes G_0 as given, from the viewpoint of the foreign government

$$\frac{Y_0}{K_0}=A\left[\frac{G_0}{\lambda k_0+[1-\bar{\lambda}]\bar{k}_0}\left[1+\frac{\varphi(\gamma,\bar{\tau})[\bar{\lambda}\bar{k}_0+[1-\lambda]k_0]}{G_0}\right]^{\rho}\right]^{1-\alpha}, \tag{A50}$$

$$\frac{\bar{Y}_0}{\bar{K}_0}=\bar{A}\left[\varphi(\gamma,\bar{\tau})\left[1+\frac{G_0}{\varphi(\gamma,\bar{\tau})[\bar{\lambda}\bar{k}_0+[1-\lambda]k_0]}\right]^{\rho}\right]^{1-\alpha}. \tag{A51}$$

There is no need to impose the equality of the growth rates: in equilibrium this is ensured by the optimal choice of capital allocation by the consumers. However, the equilibrium growth rate, in general, is not efficient because the externalities are not internalized even with mobile capital.

A5.1.1 Symmetric case: identical endowments and productivities

Consider the case where $A = \bar{A}$ and $k_0 = \bar{k}_0$. The choice of the domestic and the foreign investors, λ and $\bar{\lambda}$, solve

$$\frac{\alpha\lambda + [1-\bar{\lambda}]}{\lambda + [1-\bar{\lambda}]}\frac{Y_0}{K_0} - \tau = \frac{\bar{\lambda} + \alpha[1-\lambda]}{\bar{\lambda} + [1-\lambda]}\frac{\bar{Y}_0}{\bar{K}_0} - \bar{\tau}, \tag{A52}$$

and

$$\left\{\frac{\alpha\lambda + [1-\bar{\lambda}]}{\lambda + [1-\bar{\lambda}]}\frac{Y_0}{K_0} - \tau = \frac{\bar{\lambda} + \alpha[1-\lambda]}{\bar{\lambda} + \alpha[1-\lambda]}\frac{\bar{Y}_0}{\bar{K}_0} - \bar{\tau} \vee \frac{Y_0}{K_0} = \frac{\bar{Y}_0}{\bar{K}_0}\right\}, \tag{A53}$$

or

$$\left\{\bar{\lambda} = 0 \vee \frac{Y_0}{K_0} > \frac{\bar{Y}_0}{\bar{K}_0}\right\}, \text{ or } \left\{\bar{\lambda} = 1 \vee \frac{Y_0}{K_0} < \frac{\bar{Y}_0}{\bar{K}_0}\right\}. \tag{A54}$$

Here

$$\frac{Y_0}{K_0} = \frac{A}{k_0^{1-\alpha}}\left[\frac{G_0}{\lambda + [1-\bar{\lambda}]}\left[\frac{\Gamma_0}{G_0}\right]^{\rho}\right]^{1-\alpha}, \tag{A55}$$

$$\frac{\bar{Y}_0}{\bar{K}_0} = \frac{\bar{A}}{k_0^{1-\alpha}}\left[\frac{\bar{G}_0}{\bar{\lambda} + [1-\lambda]}\left[\frac{\Gamma_0}{\bar{G}_0}\right]^{\rho}\right]^{1-\alpha}. \tag{A56}$$

In equilibrium $\frac{G_0}{\bar{G}_0} = \frac{\tau}{\bar{\tau}}$, so $\frac{Y_0}{K_0} < \frac{\bar{Y}_0}{\bar{K}_0}$ i.f.f. $\frac{\tau}{\lambda + [1-\bar{\lambda}]} < \frac{\bar{\tau}}{\bar{\lambda} + [1-\lambda]}$. Thus, there exists a completely symmetric equilibrium with $\tau = \bar{\tau}$ and $\lambda = \bar{\lambda} = 1/2$. For the equilibrium with interior λ and $\bar{\lambda} = 1$ it must be the case that $\frac{\tau}{\lambda} < \frac{\bar{\tau}}{2-\lambda}$, and for the equilibrium with interior λ and $\bar{\lambda} = 0$ it must be the case that $\frac{\tau}{1+\lambda} > \frac{\bar{\tau}}{1-\lambda}$.

The growth rate in the domestic country is determined by

$$\frac{1}{\beta}[1+\gamma] = \lambda\frac{Y_0}{K_0} + [1-\bar{\lambda}]\frac{\bar{Y}_0}{\bar{K}_0} + [1-\delta_K] - \tau\lambda - \bar{\tau}[1-\bar{\lambda}], \tag{A57}$$

and in the foreign country by

$$\frac{1}{\beta}[1+\bar{\gamma}] = \bar{\lambda}\frac{\bar{Y}_0}{\bar{K}_0} + [1-\lambda]\frac{Y_0}{K_0} + [1-\delta_K] - \bar{\tau}\bar{\lambda} - \tau[1-\lambda]. \tag{A58}$$

Clearly, the completely symmetric equilibrium is consistent with $\gamma = \bar{\gamma}$.

A5.2 Cooperative equilibrium

Here γ is implicitly defined by

$$\gamma = -1 + \beta\left[\lambda A\left[1+\frac{\bar{\tau}\left[\bar{\lambda}\bar{k}_0+\left[1-\lambda\right]k_0\right]}{\tau\left[\lambda k_0+\left[1-\bar{\lambda}\right]\bar{k}_0\right]}\right]^{\rho[1-\alpha]}\left[\tau\frac{1+\gamma}{\gamma+\delta_G}\right]^{1-\alpha}\right.$$
$$+\left[1-\delta_K\right]-\tau\lambda-\bar{\tau}\left[1-\lambda\right]$$
$$\left.+\left[1-\lambda\right]\bar{A}\left[1+\frac{\tau\left[\lambda k_0+\left[1-\bar{\lambda}\right]\bar{k}_0\right]}{\bar{\tau}\left[\bar{\lambda}\bar{k}_0+\left[1-\lambda\right]k_0\right]}\right]^{\rho[1-\alpha]}\left[\bar{\tau}\frac{1+\gamma}{\gamma+\delta_G}\right]^{1-\alpha}\right], \qquad \text{(A59)}$$

and

$$\frac{Y_0}{K_0} = A\left[\tau\frac{1+\gamma}{\gamma+\delta_G}\left[1+\frac{\bar{\tau}\left[\bar{\lambda}\bar{k}_0+\left[1-\lambda\right]k_0\right]}{\tau\left[\lambda k_0+\left[1-\bar{\lambda}\right]\bar{k}_0\right]}\right]^{\rho}\right]^{1-\alpha}, \qquad \text{(A60)}$$

$$\frac{\bar{Y}_0}{\bar{K}_0} = \bar{A}\left[\bar{\tau}\frac{1+\gamma}{\gamma+\delta_G}\left[1+\frac{\tau\left[\lambda k_0+\left[1-\bar{\lambda}\right]\bar{k}_0\right]}{\bar{\tau}\left[\bar{\lambda}\bar{k}_0+\left[1-\lambda\right]k_0\right]}\right]^{\rho}\right]^{1-\alpha}. \qquad \text{(A61)}$$

A5.3 Non-cooperative equilibrium with redistribution

The domestic government chooses τ to maximize γ implicitly defined by

$$\gamma = -1 + \beta\left[\lambda A\left[1+\frac{\bar{G}_0}{\tilde{\varphi}(\gamma,\tau)\left[\lambda k_0+\left[1-\bar{\lambda}\right]\bar{k}_0\right]}\right]^{\rho[1-\alpha]}\tilde{\varphi}(\gamma,\tau)^{1-\alpha}\right.$$
$$+\left[1-\delta_K\right]-\tau\lambda-\bar{\tau}\left[1-\lambda\right]$$
$$\left.+\left[1-\lambda\right]\bar{A}\left[1+\frac{\tilde{\varphi}(\gamma,\tau)\left[\lambda k_0+\left[1-\bar{\lambda}\right]\bar{k}_0\right]}{\bar{G}_0}\right]^{\rho[1-\alpha]}\left[\frac{\bar{G}_0}{\bar{\lambda}\bar{k}_0+\left[1-\lambda\right]k_0}\right]^{1-\alpha}\right]. \qquad \text{(A62)}$$

where

$$\tilde{\varphi}(\gamma,\tau) = \frac{1+\gamma}{\gamma+\delta_G}\left[\left[1-\theta+\theta\mu\right]\tau+\bar{\theta}\mu\bar{\tau}\frac{\bar{K}_0}{K_0}\right], \qquad \text{(A63)}$$

$$\frac{Y_0}{K_0} = A\left[\tilde{\varphi}(\gamma,\tau)\left[1+\frac{\bar{G}_0}{\tilde{\varphi}(\gamma,\tau)\left[\lambda k_0+\left[1-\bar{\lambda}\right]\bar{k}_0\right]}\right]^{\rho}\right]^{1-\alpha}, \qquad \text{(A64)}$$

$$\frac{\bar{Y}_0}{\bar{K}_0} = \bar{A}\left[\frac{\bar{G}_0}{\bar{\lambda}\bar{k}_0+\left[1-\lambda\right]k_0}\left[1+\frac{\tilde{\varphi}(\gamma,\tau)\left[\lambda k_0+\left[1-\bar{\lambda}\right]\bar{k}_0\right]}{\bar{G}_0}\right]^{\rho}\right]^{1-\alpha}. \qquad \text{(A65)}$$

The foreign government chooses $\bar{\tau}$ to maximize γ implicitly defined by

$$\gamma = -1 + \beta\left[\bar{\lambda}\bar{A}\left[1 + \frac{G_0}{\hat{\varphi}(\gamma,\bar{\tau})\left[\bar{\lambda}\bar{k}_0 + [1-\lambda]k_0\right]}\right]^{\rho[1-\alpha]}\hat{\varphi}(\gamma,\bar{\tau})^{1-\alpha}\right.$$
$$+ [1-\delta_K] - \bar{\tau}\bar{\lambda} - \tau[1-\bar{\lambda}]$$
$$\left. + [1-\bar{\lambda}]A\left[1 + \frac{\hat{\varphi}(\gamma,\bar{\tau})\left[\bar{\lambda}\bar{k}_0 + [1-\lambda]k_0\right]}{G_0}\right]^{\rho[1-\alpha]}\left[\frac{G_0}{\lambda k_0 + [1-\bar{\lambda}]\bar{k}_0}\right]^{1-\alpha}\right]. \quad \text{(A66)}$$

where

$$\hat{\varphi}(\gamma,\bar{\tau}) = \frac{1+\gamma}{\gamma+\delta_G}\left[\left[1 - \bar{\theta} + \bar{\theta}[1-\mu]\bar{\tau} + \theta[1-\mu]\tau\frac{\bar{K}_0}{K_0}\right]\right], \quad \text{(A67)}$$

where now

$$\frac{Y_0}{K_0} = A\left[\frac{G_0}{\lambda k_0 + [1-\bar{\lambda}]\bar{k}_0}\left[1 + \frac{\hat{\varphi}(\gamma,\bar{\tau})\left[\lambda\bar{k}_0 + [1-\lambda]k_0\right]}{G_0}\right]^{\rho}\right]^{1-\alpha}, \quad \text{(A68)}$$

$$\frac{\bar{Y}_0}{\bar{K}_0} = \bar{A}\left[\hat{\varphi}(\gamma,\bar{\tau})\left[1 + \frac{G_0}{\hat{\varphi}(\gamma,\bar{\tau})\left[\bar{\lambda}\bar{k}_0 + [1-\lambda]k_0\right]}\right]^{\rho}\right]^{1-\alpha}. \quad \text{(A69)}$$

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Macro Policy and Industry Growth: The Effect of Counter-Cyclical Fiscal Policy*

By

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Abstract:

This paper evaluates whether the cyclical pattern of fiscal policy can affect growth. We first build a simple endogenous growth model where entrepreneurs face a tighter borrowing constraint when they invest in more risky yet more productive projects. In this framework, a counter-cyclical fiscal policy prompts entrepreneurs to take more risky bets because it dampens the negative impact of more risky investments on the access to external finance. A stabilizing fiscal policy is therefore growth enhancing. Secondly the paper takes this prediction to the data following the Rajan-Zingales (1998) methodology. Empirical evidence shows that (i) value added and productivity growth,measured at the industry level, is larger when fiscal policy, measured at the country level, is more counter-cyclical, (ii) the positive growth effect of fiscal policy counter-cyclicality is larger in industries with heavier reliance on external finance.

Keywords: growth, financial dependence, fiscal policy, counter-cyclicality

JEL Classification: E32, E62

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1 Introduction

Standard macroeconomic textbooks generally present macroeconomics in two separate bodies: in the long term an economy's performance is essentially influenced by structural characteristics, such as education, R&D, openness to trade, competition or financial development. In the short term however, the economy is essentially influenced by the shocks it undergoes and stabilization policies undertaken (fiscal and monetary policy). These two approaches have been considered for long as separate and distinct bodies of research. Stabilization policies for instance are considered to have no significant impact on the long run performance of an economy. The point of this paper is to investigate (the relevance of) this dichotomy focusing on the impact, if any, of cyclical fiscal policy on growth. To answer this question, we take a two step approach. First we build a simple model to illustrate how the cyclical component of fiscal policy can affect growth. Second we take the theoretical predictions to the data and provide empirical evidence of a statistically and economically significant impact of stabilizing fiscal policy on growth.

The theoretical part of the paper is based on a model with risk neutral entrepreneurs and lenders. Entrepreneurs can choose a project to invest in among a set of existing projects, the more productive being also the more risky. When states of nature are non verifiable -or alternatively if verifiability is sufficiently costly- then entrepreneurs who invest in more productive projects also face a tighter borrowing constraint because higher average productivity implies lower output in bad states and hence a lower ability to pay back liabilities. To put it in a nutshell, when states of nature are non verifiable, pledgeable income is negatively related to average productivity which creates a trade-off for entrepreneurs in their technological choice. The government can then alter this trade-off by imposing state contingent taxes. Namely a pro-cyclical fiscal policy, i.e. high taxes in bad states and low taxes in good states, tends to amplify the negative effect of more risky investments on the ability to borrow. As consequence, entrepreneurs optimally choose less risky and less productive projects. On the contrary a counter-cyclical fiscal policy, i.e. low taxes in bad states and high taxes in good states, tends to dampen the negative effect of more risky investments on the ability to borrow which prompts entrepreneurs to take more risky bets. Moreover the positive effect of counter-cyclical fiscal policy on productivity growth increases with the share of investment financed through external capital but decreases with income pledgeability. The second part of the paper is devoted to test empirically these three predictions: (i) counter-cyclical fiscal policy is growth enhancing, (ii) the growth enhancing impact of counter-cyclical fiscal policy should increase with the share of investment financed through external capital, (iii) but decrease with income pledgeability.

A simple approach to assessing the impact of counter-cyclical economic policies on growth consists in running a regression with a growth indicator (output or labour productivity) as a dependent variable and an indicator of counter-cyclicality in economic policies as an explanatory variable. Every thing else equal, this framework can tell whether the cyclical properties of macro policy do affect growth significantly and in case they do, how much growth increase can be expected from a change in macro policy, for instance moving from a procyclical to an acyclical policy. However there are three important issues that preclude a proper interpretation of this type of straightforward exercise. First cyclicality in economic policies (by now, we will only focus on fiscal policy) is generally captured through a unique time-invariant parameter which only varies in the country dimension. As a result, standard cross-country panel regression cannot be used to assess to the effect of the cyclical pattern of fiscal policy on growth in as much as the former is perfectly collinear to the fixed effect that is traditionally introduced to control for unobserved cross-country heterogeneity. To solve this issue, Aghion and Marinescu (2007) introduce time-varying estimates of fiscal policy cyclicality.[1] While this is a step forward in the effort to capturing the growth effect of fiscal policy cyclicality —while at

1 Time varying estimates of cyclicality can be obtained with a number of non parametric methods.

the same time controlling for unobserved heterogeneity-, this is at the cost of loosing precision in the estimates of fiscal policy cyclicality. Secondly the causality issue -namely does fiscal policy cyclicality affect growth or does growth modify the cyclical pattern of fiscal policy- cannot be properly addressed with a macro level analysis. This question is fundamental to derive the policy implications of the empirical exercise. In particular estimating the growth gain/cost to a change in the cyclical pattern of fiscal policy highly depends on whether the causality issue has been properly addressed. One particular reason is that fiscal policy cyclicality is used in growth regressions as a right hand side variable while the estimation of time-varying fiscal policy cyclicality requires using the full data sample. In these circumstances, instrumental variable cannot be of any help.[2] A final concern is identification. A macro level analysis cannot help testing the theoretical mechanism underlying the relationship if any between cyclical fiscal policy and growth. let alone the problem of control variables —the econometrics must be robust to the inclusion of a number of control variables representing other standard theoretical models-. Hence even if the argument -that the cyclical pattern of fiscal policy is important for growth- is empirically verified, the channel through which this conclusion works remains uncovered with a macro level analysis.

The approach we provide in this paper proposes a possible remedy for each of these issues. Based on the theoretical predictions developed above, we apply the methodology provided by Rajan and Zingales (1998) in their seminal paper and draw a relationship between growth at the industry level to fiscal policy cyclicality at the macro level. Moreover as predicted by our model, fiscal policy cyclicality is interacted by industry level external financial dependence to test whether industries which rely more heavily on external finance benefit more from counter-cyclical fiscal policy. This approach proves to be useful in solving the issues stated above. First, because we use a country - industry panel dataset, we can estimate counter-cyclicality in fiscal policy based on a time-invariant parameter. As previously fiscal policy counter-cyclicality is collinear to country fixed effects. However we test the conclusion that the growth effect of fiscal policy counter-cyclicality is larger for industries that rely more on external finance. Hence the interaction between a country level and an industry level variable solves the collinearity issue. Second the interaction term helps solve the identification issue because it shows that the effect of fiscal policy counter-cyclicality goes through the financial structure of the firm — or the industry- hence validating the theoretical framework described above. Finally and most importantly, this approach is a step forward in dealing with the causality issue. Because macro policy can affect industry level growth while the opposite - industry level growth affecting macro policy- is much less likely, this approach can be useful to assess whether the cyclical pattern of fiscal policy has a causal impact on growth.[3] There is however a downside to the industry level investigation.

The difference in difference approach has nothing to say about the magnitude of the macroeconomic growth gain/loss to different patterns of cyclicality in fiscal policy. The empirical estimates of the industry level growth gain due to a change in the cyclical pattern of fiscal policy are, above all, qualitative evidence of the growth effect of counter-cyclical fiscal

2 IV regressions usually use internal instruments, i.e. lagged values of right hand side variables. In the case of time-varying estimates of fiscal policy cyclicality, that boils down to using forward information as instruments, in which case instruments cannot be exogenous.

3 Fiscal policy cyclicality could be endogenous to the industry level composition of total output if for example industries that benefit more from fiscal policy counter-cyclicality do lobby more for counter-cyclical fiscal policy. However to the extent that there are decreasing returns to scale (which is plausible given that we focus here on manufacturing industries and happens to be empirically verified), that should rather imply a downward bias in our estimates of the positive impact of fiscal policy counter- cyclicality on growth. Hence controlling for this possible endogeneity relationship, in case it is first order, would probably reinforce the results we obtain here by reducing this downward bias.

policy. Results detailed below cannot be used to derive directly the growth implications of different fiscal policies.[4]

The empirical results of the paper can be divided into three main parts. First fiscal policy counter-cyclicality - measured as the sensitivity to the output gap of total or primary fiscal balance to GDP - has a positive significant and robust impact on industry growth, larger reliance on external finance amplifying this effect. This property holds both for real value added as well as for labour productivity growth. Based on these results, the magnitude of the diff-in-diff effect is derived, i.e. how much extra growth following an increase in fiscal policy counter-cyclicality and financial dependence. Figures happen to be relatively large, especially when compared to those obtained from similar investigations (especially those in Rajan and Zingales, 1998), hence suggesting that the effect of counter-cyclical fiscal policy is both statically and economically significant. Second we go through a number of robustness checks by introducing a number of control variables. We show that the impact of counter-cyclical fiscal policy on growth is indeed robust to the inclusion of other growth determinants. Third, we provide different partitions of fiscal policy (expenditures, revenues, consumption, investment, etc. ..) and look at which component is indeed driving the positive growth effect of counter-cyclical fiscal policy. We uncover two unexpected results. First counter-cyclicality in government consumption affects significantly indsutry growth while counter-cyclicality in government investment does not. Second counter-cyclicality in government receipts has no significant effect on industry growth but counter-cyclicality in government expenditures does have a significant positive impact on industry growth. Finally an instrumental variable estimation is carried out whose results are very close to those obtained in the very first regressions, thus confirming both qualitatively and quantitatively the first results of the paper.

The rest of the paper is organized as follows. The next section lays down the theoretical model and derives the main predictions to be tested empirically. Section 3 details the econometric methodology and presents the data used in estimations. The basic as well as the more elaborate specifications are tested in section 4. In particular we check if the growth impact of counter-cyclical fiscal policy is robust to the inclusions of structural characteristics. We also investigate which part of fiscal policy is indeed important for growth through its counter-cyclicality (expenditures, revenues, consumption, investment, etc...). Conclusions are eventually drawn in section 5.

2 Cyclical fiscal policy and growth: a toy model

2.1 Timing and technology

We consider an economy with a continuum of mass one of risk neutral agents and a single good. Agents live for one period. Each agent owns a unitary initial capital endowment. A proportion e of agents are entrepreneurs, a proportion 1 — e are lenders. At the beginning of life, entrepreneurs choose a production technology among technologies with different average productivities. A technology is characterized by a pair {A_hjAl} where A_s is productivity in state *s*. A more productive technology on average is more volatile. Denoting τη = $^h2$ the average productivity and σ = ġ the standard deviation in productivity, associated with a technology *{Ah, A_l},* we assume for simplicity that *m* is linear in σ

4 A further limit to a direct interpretation of our results relates to our focus on growth for manufacturing industries while the total share of manufacturing industries in total value added in about one third not more. Deriving the global macroeconomic effect of fiscal policy cyclicality would require an assessment of the impact on the service sector.

$$m = a_0 + a_1\sigma \tag{1}$$

(1) defines the technological frontier for entrepreneurs. To make the problem interesting, we assume that $O_Q > 0$ and $0 < O_\chi < 1$. Once they have selected a technology, entrepreneurs decide how much capital to invest in that technology and therefore how much to borrow from lenders on the capital market. Lenders can lend capital to entrepreneurs, which they do inelastically to simplify. There are two equiprobable states of nature, high s = h and low s = l and one of them realizes in the middle of the period

$$\Pr(s = h) = \Pr(s = l) = 1/2 \tag{2}$$

The technology delivers output at the end of the period which is produced according to the AK technology

$$Y_s^t = T^t A_s K \tag{3}$$

where K is the total capital invested at the beginning of the period, s is the state of nature that realizes over the period, and T^t is the stock of knowledge at the beginning of period t. Let

$$y_s^t = \frac{Y_s^t}{T^t} \tag{4}$$

denote the knowledge adjusted final output at date t. Following Aghion Angeletos, Banerjee and Manova (2005), knowledge grows between two successive periods at a rate which is proportional (for simplicity, equal) to aggregate production last period:

$$T_{t+1} - T_t = Y^t \tag{5}$$

so that the growth rate of knowledge is simply equal to y_s^t. Finally there is a government which can levy taxes. To simplify the analysis, we assume that the government makes no expenditures.

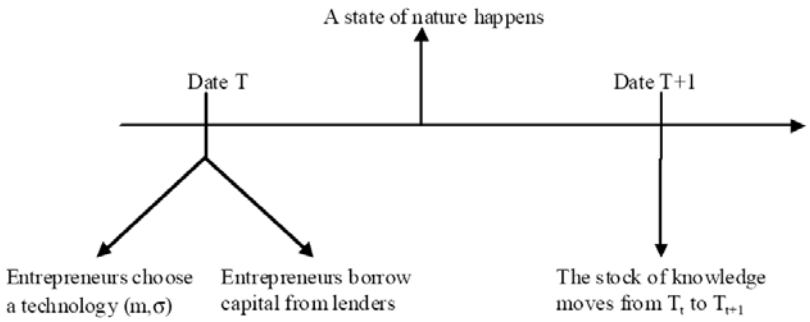


Figure 1: Timing of the model

2.2 Borrowing and technology choice by entrepreneurs

We shall solve the model by backward induction. For given choice of the technology, consider an entrepreneur *i* with unitary initial capital endowment who borrows d_i units of capital from lenders. If the government imposes in state *s* taxes on entrepreneurs τ_s q_i where q_i is entrepreneur *i* total investment, then the knowledge adjusted expected profits at the end of period *t* of entrepreneur *i* write as:

$$E\pi_s^t = \frac{A_l - \tau_l + A_h - \tau_h}{2}(1+d_i) - (1+r)d_i \qquad (6)$$

where r is the equilibrium interest rate which we shall derive below. Let us now introduce capital market imperfections. Capital market imperfections result from an ex post enforceability problem (see Aghion-Banerjee-Piketty (1999)) which prevents the lender from extracting more than μ times her post-tax income, in other words:

$$(1+r)d_i \le \mu(A_s - \tau_s)(1+d_i) \qquad (7)$$

Hence the government can enforce contingent repayments whereas private agents (lenders here) cannot. Thus entrepreneur *i* will choose her borrowing d_i to

$$\max_{d_i} E\pi_s^t(d_i) = \frac{1}{2}\left[A_l - \tau_l + A_h - \tau_h\right](1+d_i) - (1+r)d_i$$
$$\text{s.t. } (1+r)d_i \le \mu(A_s - \tau_s)(1+d_i), s = \{l,h\} \qquad (8)$$

We shall restrict attention to the case where $A_l - \tau_l + A_h - \tau_h > 2(1+r)$, so that the borrowing constraint is binding in equilibrium, and where $A_l - \tau_l < A_h - \tau_h$, so that the borrowing constraint is binding in the bad state of nature. The maximum expected profit of entrepreneur *i* for given technology $\{A_h, A_l\}$ is then equal to:

$$E\pi_s^t = \frac{\frac{1}{2}\left[A_l - \tau_l + A_h - \tau_h\right] - \mu(A_l - \tau_l)}{(1+r) - \mu(A_l - \tau_l)}(1+r) \qquad (9)$$

Now let us move back one step and consider the entrepreneur's optimal choice of technology. Writing $Al = m - \sigma$ and $Ah = m + \sigma$, entrepreneur *i* will choose the technology (m, σ) that maximizes ex ante expected profits

$$\max_{\sigma} E\pi_s^t(m,\sigma) - \frac{m - r - \mu(m - \sigma - \tau_l)}{(1+r) - \mu(m - \sigma - \tau_l)}(1+r) \qquad (10)$$
$$\text{s.t } m \le a_0 + a_1\sigma$$

where τ is the average tax rate; $\tau = \frac{\tau_l + \tau_h}{2}$. The corresponding first order condition writes as

$$\frac{1+r}{\mu} = \frac{a_0 - a_1\tau_l - \tau(1-a_1)}{a_1 + \mu(1-a_1)} \qquad (11)$$

2.3 Equilibrium of the capital market

Given that the borrowing constraint (7) must hold for any state of nature, the individual demand for capital solves

$$(1 + r)\, d_i = \mu\, (A_1 - \tau_l)\, (1 + d_i) \qquad (12)$$

and aggregate demand for capital D is the sum of individual capital demands d_i by all entrepreneurs

$$D = e\frac{\mu(A_l - \tau_l)}{1 + r - \mu(A_l - \tau_l)} \qquad (13)$$

Aggregate capital supply S is simply equal to the sum of capital endowments over all lenders, namely: $S = (1 - e)$. In equilibrium of the capital market we have $D = S$ or equivalently:

$$\frac{1+r}{\mu} = \frac{e}{1-e}(A_l - \tau_l) \qquad (14)$$

Consequently with relations (11) and (14) we can determine the optimal technological choice of entrepreneurs at the equilibrium of the economy.

Proposition 1 *The equilibrium average growth rate of the economy verfies* $m_{eq} = a_0 + a_1\sigma_{eq}$ *with*

$$\sigma_{eq} = \frac{a_0 - \tau_l}{1 - a_1}\left[1 - \lambda(e,\mu)\right] + \lambda(e,\mu)\frac{\tau_h - \tau_l}{2}$$

$$\lambda(e,\mu) = \frac{1-e}{e}\frac{1}{a_1 + \mu(1-a_1)}$$

Proof. The optimal technology chosen by entrepreneurs at the equilibrium of the capital market verifies

$$\frac{e}{1-e}(A_l - \tau_l) = \frac{a_0 - a_1\tau_l - \tau(1-a_1)}{a_1 + \mu(1-a_1)}$$

This relation can then be simplified as

$$\sigma = \frac{a_0 - \tau_l}{1 - a_1}\left[1 - \frac{1-e}{e}\frac{1}{a_1 + \mu(1-a_1)}\right] + \frac{1-e}{e}\frac{1}{a_1 + \mu(1-a_1)}\frac{\tau_h - \tau_l}{2}$$

2.4 Fiscal policy and growth

Fiscal policy has two effects on aggregate productivity and therefore on growth: a pure taxation effect through which larger taxes τ_l reduces productivity and a counter-cyclicality effect through which larger taxes τ_h in good times and lower taxes τ_l in bad times contribute to raise productivity, namely:

$$\sigma_{eq} = \underbrace{[1-\lambda(e,\mu)]\frac{a_0-\tau_l}{1-a_1}}_{pure\ taxation\ effect} + \underbrace{\lambda(e,\mu)\frac{\tau_h-\tau_l}{2}}_{counter-cyclicality\ effect}$$

An increase in government taxes counter-cyclicality, i.e. an increase in τ_h — τ_l, therefore raises every thing else equal, average growth since $\partial\sigma eq/\partial\ (\tau_h$ — $\tau_l) > 0$. Moreover this effect is amplified when there are fewer entrepreneurs, i.e. when the share of investment financed through external funds is larger since $\partial\lambda/\partial e < 0$. On the contrary this effect is dampened when the share of pleadgeable income μ is larger since $\partial\lambda/\partial\mu < 0$. The remaining of the paper is devoted to an empirical investigation of these properties.

3 Data and econometric methodology

The empirical investigation is based on a regression where the dependent variable (henceforth LHS variable) is the average annual growth rate of real value added or alternatively labour productivity in industry *j* in country *k* for a given period of time. Labour productivity is defined as the ratio of real value added to total employment.[5] On the right hand side, industry and country fixed effects *{αj ; βk}* control for unobserved heterogeneity between industries and countries. The variable of interest $(fdj) \times (fpc_k^{t,t+n})$, is the interaction between industry *j* external financial dependence and country *k* fiscal policy cyclicality for the period *[t, t + n]*. Finally, a control for initial conditions is included. When the LHS variable is the growth rate of real value added, the ratio of initial real value added in industry *j* in country *k* to total real value added in the manufacturing sector in country *k* controls for initial conditions. When the LHS variable is labour productivity growth, the ratio of initial labour productivity in industry *j* in country *k* to labour productivity in the manufacturing sector in country *k* is included. Denoting yj_k (resp. *yl,)* real value added or alternatively labour productivity in industry *j* (resp. in manufacturing) in country *k* in year τ and *Sjk* as an error term, the empirical investigation is based on estimating the regression

Following Rajan and Zingales (1998) we measure industry level external financial dependence with firm level data for the US.

$$\frac{1}{n}\left[\ln(y_{jk}^{t+n}) - \ln(y_{jk}^{t})\right] = \alpha_j + \beta_k + \gamma(fd_j)\times(fpc_k^{t,t+n}) - \delta\log\left(\frac{y_{jk}^{t}}{y_k^{t}}\right) + \varepsilon_{jk} \qquad (15)$$

External financial dependence is computed as the ratio of capital expenditures minus cash flow from operations divided by capital expenditures accross all firms in a given industry. Proceeding this way is valid as long as (i) differences in financing across industries are largely driven by differences in technology, (ii) technological differences persist across countries, (iii) countries are relatively similar in terms of overall firm environment. Under these three assumptions, the US based measure of external finance is likely to be a valid measure of external financial

5 Although we also have access to industry level data on hours worked, we prefer to focus on productivity per worker and not productivity per hour because measurement error is more likely to affect the latter than the former.

dependence for countries other than the US.[6] In reality these three conditions are likely to be verified. For instance if pharmaceuticals require proportionally more external finance than textiles in the US, this is likely to be the case in other countries. Moreover given that we focus on a subset of developed OECD countries, cross-industry differences are likely to persist across countries. Finally because the US is one of the most developed capital market in the world, US based measures of external financial dependence are likely to give the least noisy measures of industry level demand for external finance.

The last ingredient needed to estimate (15) is fiscal policy cyclicality. A simple benchmark to begin with consists in estimating fiscal policy cyclicality as the marginal change in fiscal policy following a change in the output gap. Hence country *k* fiscal policy cyclicality $(fpc_k^{t,t+n})$ over the period *[t; t + n]* can be estimated with the following regression

$$de\, f_k^\tau = \eta_k + (fpc_k^{t,t+n}) z_k^\tau + u_k^\tau \qquad (16)$$

where $\tau \in [t; t+n], de\, f_k^\tau$ is a measure of fiscal policy in country *k* in year τ (fiscal balance, primary balance, expenditures, revenues, etc. ..), z_k^τ is a measure of the output gap of the economy in country *k* in year τ, η_k is a constant and u_k^τ is an error term. The output gap is measured as the difference between output and trend output. It therefore represents the position of the economy in the cycle. Equation (16) is estimated for each country. For instance if the LHS is scal balance to GDP, a positive (resp. negative) parameter $(fpc_k^{t,t+n})$ reflects a counter-cyclical (resp. pro-cyclical) fiscal policy as the government fiscal balance is larger (resp. smaller) when economic conditions improve.

While this benchmark equation is extremely simplistic, it must be regarded as a first step. More elaborated fiscal policy specifications can be considered. In particular, following Gali and Perrotti (2003) fiscal policy cyclicality can be measured in a regression including a debt stabilization motive and controlling for fiscal policy persistence. Noting *bl* the ratio of public debt to GDP in country *k* in year r, a more elaborate estimation of fiscal policy cyclicality $(fpc_{2,k}^{t,t+n})$ over the period *[t;t+n]* can be obtained estimating the following equation:[7]

$$de\, f_k^\tau = \alpha_k + (fpc_{2,k}^{t,t+n})\, z_k^\tau + \beta_k b_k^{\tau-1} + \gamma_k de\, f_k^{\tau-1} + \varepsilon_k^\tau \qquad (17)$$

To estimate the basic specification (15) we can rely on a simple OLS procedure which if need be can be corrected for heteroscedasticity bias. The reason why we can proceed this way is that the right hand side variable i.e. the interaction term between industry financial dependence and fiscal policy cyclicality is in theory exogenous to the LHS variable, industry value added growth or industry labour productivity growth. On the one hand financial dependence is measured in the US while industry growth on the LHS is considered for other countries than the US. Hence reverse causality in the sense that industry growth outside the US could affect the industry financing structure in the US seems quite implausible. Moreover in some cases the LHS variable is measured on a post 1990 period while the financial dependence indicator is always measured on a pre 1990 period, hence further reducing the possibility of reverse causality. On the other hand fiscal policy cyclicality is measured at the macro level while the LHS variable is measured at the industry level which in theory precludes any case for reverse causality as long as each sector individually represents a small share of total output in the economy. Moreover as a cross-check of the validity of these arguments, we also carry out instrumental variable

6 Note however that this measure is unlikely to be valid for the US as it likely reflects the equilibrium of supply and demand for capital in the US and is hence endogenous.

7 Results presented in this paper are based on the simple fiscal policy counter-cyclicality specification (16). Using specification (17) does not modify the main conclusions of the paper

regressions where fiscal policy cyclicality is instrumented. We then verify that equations passing over-identification tests confirm our results.[8]

We focus our empirical investigation on the industrialized OECD countries, i.e. we abstract from Central and Eastern European countries (Hungary, Poland, Slovakia, and the Check Republic), and emerging markets (Mexico, Turkey and South Korea). We end up with a panel of seventeen countries which as stated above does not include the US. Data is available from 1980 to 2005. We consider six different time spans 1980-2005, 1980-2000, 1985-2005, 1985-2000, 1990-2005, 1990-2000. The latter cases are useful because Germany can then be included to our sample.[9] Data used come from three different sources. Industry level real value added growth and labour productivity growth data come from EU KLEMS dataset which provides annual industry level data for a large number of indicators.[10] The primary source of data on industry financial dependence is Compustat which gathers balance sheets and income statements for US listed firms. We draw on Rajan and Zingales (1998) and Raddatz (2006) to compute dataset the industry level indicators for financial dependence.[11] Finally macroeconomic fiscal and other control variables come from the OECD Economic Outlook dataset and from the World Bank Financial Development and Structure database.[12]

4 The basic specification

We first estimate the benchmark equation (15) in the case where the LHS variable is real value added growth and fiscal policy cyclicality is measured using equation (16). We consider two different cases; one where the LHS variable of (16) is total fiscal balance to GDP (table 1a) and another where the LHS of (16) is primary fiscal balance to GDP (table 1b).

Table 1a: Real Value Added Growth and Total Fiscal Balance Counter-cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	-0.903*** *(0.242)*	-0.930*** *(0.251)*	-0.648 *(0.374)*	-0.737* *(0.410)*	-0.739 *(0.473)*	-1.124* *(0.550)*
Interaction (External Financial Dependence x Total Fiscal Balance to GDP Counter-Cyclicality)	7.003*** *(1.998)*	6.786*** *(2.294)*	6.393** *(2.551)*	7.375*** *(2.299)*	4.815** *(2.138)*	5.788** *(1.992)*
Observations	574	575	576	577	594	595
R-squared	0.523	0.508	0.507	0.503	0.474	0.451

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the ratio of beginning of period industry real value added to beginning of period total manufacturing real value added. *External financial dependence* is the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. The interaction variable is the product of external financial dependence and total fiscal balance to GDP counter-cyclicality. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1 % (resp. 5%; 10%) level is indicated by *** (resp. **; *).

8 Next tables will show a large degree of similarity between OLS and IV estimations, thus confirming that our empirical strategy properly addresses the reverse causality issue, even in the case of OLS estimation.

9 See appendix for country sample and other details on data.

10 Data is is available at the following address: http://www.euklems.net/data/08i/all_countries_08I.txt

11 Rajan and Zingales data is accessible at the following address: http://faculty.chicagogsb.edu/luigi.zingales/research/financing.htm

12 OECD Economic Outlook dataset is accessible at the following address: http://titania.sourceoecd.org. The World Bank Financial Development and Structure database is accessible at the following address: http://siteresources.worldbank.org

Table 1b: Real Value Added Growth and Total Fiscal Balance Counter-cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	-0.933*** *(0.217)*	-0.925*** *(0.219)*	-0.688* *(0.383)*	-0.721* *(0.407)*	-0.816 *(0.487)*	-1.137* *(0.551)*
Interaction (External Financial Dependence x Primary Fiscal Balance to GDP Counter-Cyclicality)	5.409*** *(1.419)*	5.343*** *(1.786)*	5.330*** *(1.680)*	5.947*** *(1.714)*	4.772** *(2.056)*	5.413** *(1.860)*
Observations	574	575	576	577	594	595
R-squared	0.522	0.508	0.509	0.502	0.478	0.453

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the the ratio of beginning of estimation period real value added at the industry level to total manufacturing beginning of period real value added. *External financial dependence* is the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990. *Primary Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when primary fiscal balance to GDP is regressed on a constant and the output gap. The interaction variable is the product of external financial dependence and net total fiscal balance to GDP counter-cyclicality. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

As detailed above, we consider six different time spans as is shown in each table, fiscal policy cyclicality being measured in each regression on the relevant time period. Empirical results show that real value added growth is significantly and positively affected by the interaction of financial dependence and fiscal policy cyclicality: a larger sensitivity of total fiscal balance -or net primary fiscal balance- to GDP to the output gap raises industry real valued added growth, and the more so for industries with higher external financial dependence. Note that estimated coefficients are highly significant -in spite of the relatively conservative standard errors estimates given clustering at the country level- and relatively stable across periods especially in the case where the fiscal policy indicator is the net primary fiscal balance to GDP. Finally estimated coefficients are usually larger when the fiscal policy indicator is the total fiscal balance to GDP. This sounds natural given that sensitivity to the output gap is likely to be lower for total than for primary fiscal balance (cf. figure 1 and figure 2 in appendix).[13] These results can be extended to the case where labour productivity growth is the LHS variable.

Table 2a: Labor Productivity Growth and Total Fiscal Balance Counter-cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Relative Labor Productivity	-2.096*** *(0.533)*	-2.332*** *(0.516)*	-2.081*** *(0.524)*	-2.475*** *(0.685)*	-2.199*** *(0.487)*	-3.247* *(0.737)*
Interaction (External Financial Dependence x Total Fiscal Balance to GDP Counter-Cyclicality)	**4.479***** *(1.282)*	**4.732***** *(1.002)*	**4.576**** *(1.991)*	**4.829***** *(1.526)*	**3.810*** *(1.849)*	**4.027**** *(1.620)*
Observations	573	573	573	573	586	586
R-squared	0.442	0.412	0.451	0.432	0.414	0.398

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initial Relative Labor Productivity* is the ratio of industry beginning of period labor productivity to total manufacturing beginning of period labor productivity. External Financial Dependence is the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. The interaction variable is the product of external financial dependence and net total fiscal balance to GDP counter-

13 For instance, net primary fiscal balance to GDP is almost always counter-cyclical (positive output gap sensitivity) while total fiscal balance to GDP is pro-cyclical in a number of countries (negative output gap sensitivity).

cyclicality. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *)

Table 2b: Labor Productivity Growth and Primary Fiscal Balance Counter-cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Relative Labor Productivity	-2.127*** *(0.566)*	-2.333*** *(0.527)*	-2.048*** *(0.504)*	-2.474*** *(0.661)*	-2.154*** *(0.495)*	-3.241* *(0.735)*
Interaction (External Financial Dependence x Primary Fiscal Balance to GDP Counter-Cyclicality)	3.575*** *(0.704)*	3.759*** *(0.641)*	4.095*** *(1.229)*	4.160*** *(1.070)*	3.935** *(1.492)*	3.839** *(1.445)*
Observations	573	573	573	573	586	586
R-squared	0.443	0.412	0.455	0.434	0.420	0.400

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initial Relative Labor Productivity* is the ratio of industry beginning of period labor productivity to total manufacturing beginning of period labor productivity. *External Financial Dependence* is the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990. *Primary Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when primary fiscal balance to GDP is regressed on a constant and the output gap. The interaction variable is the product of external financial dependence and net total fiscal balance to GDP counter-cyclicality. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

As is shown in table 2a and 2b, labour productivity growth is significantly affected by the interaction of financial dependence and fiscal policy cyclicality: a larger sensitivity of total fiscal balance -or net primary fiscal balance- to GDP to the output gap raises industry labour productivity growth, and the more so for industries with higher external financial dependence. Hence decomposing real value added growth into labour productivity growth and employment growth, this last set of regressions shows that the growth gain in real value added due to counter-cyclical fiscal policies is indeed driven both by a growth gain in employment and a growth gain in labour productivity growth. Comparing the estimated coefficients in table 1a and table 2a shows that approximately 60 to 80% of the gain in real value added growth due to a more counter-cyclical fiscal policy is attributable to a increase in labour productivity growth while 20 to 40% is due to an increase in employment. Similar -although slightly larger- figures are obtained from comparing table 1b and table 2b (70 to 80% of the gain in real value added growth due to a more counter-cyclical fiscal policy is attributable to a increase in labour productivity growth).

The natural question is then how big are the numbers estimated? To give a sense of the magnitudes involved here, we compute the growth gain for an industry moving from the 25% to the 75% percentile in external financial dependence in a country where fiscal policy counter-cyclicality would also move from the 25% to the 75% percentile, measuring fiscal policy with primary fiscal balance to GDP. The approximate growth gain in terms of real value added is between one and a half and two and a half percentage points per year while the growth gain in terms of productivity growth is around one percentage point per year.

Table 3: Growth gain from a change in financial dependence and fiscal policy cyclicality

Time Period	1980-2000	1980-2005	1985-2000	1985-2005	1990-2005	1990-2000
Table 1b	1,30%	1,29%	1,77%	2,00%	1,73%	2,08%
Table 2b	0,86%	0,91%	1,36%	1,40%	1,43%	1,47%

These numbers are fairly large especially if compared with the original results in Rajan and Zingales (1998). According to their results the real value added growth gain to moving from the 25% to the 75% percentile in terms of financial development and external financial dependence

is roughly about 1% per year. Hence some of our estimates for labour productivity growth are larger than their estimates for real value added growth. On of the main reasons for this difference is that dispersion accross countries in the cylicality of primary fiscal balance is indeed very large. Hence moving from the 25% to the 75% percentile in terms of primary fiscal balance to GDP counter-cyclicality implies a very large change in the design of fiscal policy alon the cycle. Moreover this simple computation does not take into account the possible costs associated with the transition from a steady state with low fiscal policy counter-cyclicality to a steady state with high fiscal policy counter-cyclicality. It is therefore only meant to suggest that differences in fiscal policy counter-cyclicality can be an important driver of differences in value added and productivity growth at the industry level.

Before going into further investigation, it is worth looking at two issues. The first one consists in verifying whether any particular country in the sample is indeed driving the empirical results. To examine this point we withdraw countries one by one and check whether the main results still hold.

Table 4a: Real Value Added Growth and Fiscal Policy Counter-cyclicaity

Estimation Period: 1980-2005 Country withdrawn	**None**	**AUS**	**AUT**	**BEL**	**DEU**	**DNK**	**ESP**	**FIN**	**FRA**
Log of initial share in manufacturing Value Added	**-0.903***** *(0.242)*	**-0.896***** *(0.251)*	**-0.839***** *(0.241)*	**-0.872***** *(0.253)*	**-0.909***** *(0.256)*	**-0.943***** *(0.244)*	**-0.833***** *(0.263)*	**-0.877***** *(0.247)*	**-0.993***** *(0.249)*
Interaction (External Financial dependence x Total Fiscal Balance to GDP Counter-Cyclicality)	**7.003***** *(1.998)*	**7.211***** *(2.081)*	**7.478***** *(2.126)*	**6.712***** *(2.074)*	**7.160***** *(2.046)*	**7.888**** *(2.685)*	**6.580***** *(1.973)*	**6.784***** *(1.955)*	**8.089***** *(1.917)*
Observations	574	542	541	538	543	539	530	543	533
R-squared	0.523	0.522	0.521	0.529	0.521	0.512	0.557	0.514	0.620
Estimation Period: 1980-2005 Country withdrawn	**GBR**	**GRC**	**IRL**	**ITA**	**JPN**	**LUX**	**NLD**	**PRT**	**SWE**
Log of initial share in manufacturing Value Added	**-0.839***** *(0.279)*	**-1.016***** *(0.231)*	**-0.869***** *(0.258)*	**-0.937***** *(0.238)*	**-1.044***** *(0.223)*	**-0.803***** *(0.267)*	**-0.841***** *(0.251)*	**-0.921***** *(0.261)*	**-0.888***** *(0.271)*
Interaction (External Financial dependence x Total Fiscal Balance to GDP Counter-Cyclicality)	**7.078***** *(1.997)*	**5.558***** *(1.565)*	**6.420***** *(1.724)*	**6.831***** *(2.088)*	**7.030***** *(1.965)*	**6.951***** *(2.017)*	**6.882***** *(2.042)*	**7.029***** *(2.166)*	**7.732**** *(2.713)*
Observations	529	541	534	547	536	553	547	546	542
R-squared	0.544	0.523	0.463	0.532	0.522	0.527	0.528	0.527	0.527

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. The country code in each column represents the country withdrawn from sample estimation. *Initial Share in Manufacturing Value Added* is the the ratio of industry beginning of period real value added to total manufacturing beginning of period real value added. *External financial dependence* is the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. The interaction variable is the product of external financial dependence and total fiscal balance to GDP counter-cyclicality. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 3a indeed shows that the interaction of industry level external financial dependence and fiscal policy counter-cyclicality is always a significant determinant of industry real value added growth. Moreover estimated coefficients are relatively stable, which confirms that none of the countries in the sample is driving by itself the result that fiscal policy counter-cyclicality is

growth enhancing neither in terms of statistical significance nor in terms economic magnitude. This is somewaht unsurprinsing given the relatively homogenous set of coutries we focus on. Table 4a shows that this also applies to labour productivity: no single country in the sample is responsible for the positive effect of fiscal policy counter-cyclicality on labour productivity.

Table 5a: Labor Productivity Growth and Fiscal Policy Counter-cyclicality

Estimation Period: 1980-2005 Country withdrawn	**None**	**AUS**	**AUT**	**BEL**	**DEU**	**DNK**	**ESP**	**FIN**	**FRA**
Log of initial Relative Productivity	**-2.127*** ***(0.566)***	**-2.101*** ***(0.580)***	**-1.953*** ***(0.592)***	**-2.093*** ***(0.561)***	**-2.091*** ***(0.571)***	**-2.039*** ***(0.604)***	**-2.049*** ***(0.563)***	**-2.102*** ***(0.593)***	**-2.416*** ***(0.621)***
Interaction (External Financial dependence x Primary Fiscal Balance to GDP Counter-Cyclicality)	**3.575*** ***(0.704)***	**3.665*** ***(0.679)***	**3.645*** ***(0.719)***	**3.497*** ***(0.744)***	**3.615*** ***(0.715)***	**3.590*** ***(1.071)***	**3.645*** ***(0.662)***	**3.633*** ***(0.714)***	**3.943*** ***(0.599)***
Observations	573	542	540	537	546	537	529	541	532
R-squared	0.443	0.442	0.444	0.446	0.442	0.432	0.460	0.433	0.573
Estimation Period: 1980-2005 Country withdrawn	**GBR**	**GRC**	**IRL**	**ITA**	**JPN**	**LUX**	**NLD**	**PRT**	**SWE**
Log of initial Relative Productivity	**-2.089*** ***(0.567)***	**-2.060*** ***(0.654)***	**-1.727** ***(0.632)***	**-2.161*** ***(0.551)***	**-2.517*** ***(0.425)***	**-2.285*** ***(0.536)***	**-2.114*** ***(0.576)***	**-2.188*** ***(0.633)***	**-2.141*** ***(0.602)***
Interaction (External Financial dependence x Primary Fiscal Balance to GDP Counter-Cyclicality)	**3.613*** ***(0.691)***	**3.223*** ***(1.065)***	**3.876*** ***(0.691)***	**3.411*** ***(0.743)***	**3.619*** ***(0.674)***	**3.457*** ***(0.712)***	**3.568*** ***(0.702)***	**3.649*** ***(0.730)***	**3.004*** ***(0.778)***
Observations	529	540	533	546	532	552	547	544	541
R-squared	0.451	0.430	0.379	0.446	0.486	0.453	0.451	0.444	0.438

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. The country code in each column represents the country withdrawn from sample estimation. *Initial Relative Labor Productivity* is the ratio of industry beginning of period labor productivity to total manufacturing beginning of period labor productivity. *External financial dependence* is the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. The interaction variable is the product of external financial dependence and total fiscal balance to GDP counter-cyclicality. All estimated coefficient are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1 % (resp. 5%; 10%) level is indicated by *** (resp. **; *).

The second issue that devotes some attention is related to the existence of some industries with negative external financial dependence. These are industries for which capital expenditures have been lower than internally generated funds over the 1980-1990 period in the US. For such industries, a more counter-cyclical fiscal policy in the sense of a larger sensitivity of fiscal balance to the output gap translates into a lower (more negative) interaction term. A positive coefficient of the interaction term would then imply that a countercyclical fiscal policy is indeed growth reducing and not growth enhancing. To check the validity of this point, we separate the interaction term in two variables: an interaction between external financial dependence and fiscal policy counter-cyclicality for industries with positive external financial dependence and an interaction term for industries with negative external financial dependence. If counter-cyclical fiscal policy is indeed growth enhancing we should obtain a positive coefficient when financial dependence is positive but a negative coefficient when financial dependence is positive.

Table 6a and table 6b essentially show that splitting the interaction term into two components depending on whether external financial dependence is positive or negative tends to confirm the

result that fiscal policy counter-cyclicality enhances real value added growth since the coefficient of the interaction term is positive only when external financial dependence is positive. Hence for industries with negative external financial dependence, moving from a pro to a counter-cyclical fiscal policy moves the interaction term from a positive to a negative figure which raises growth given the negative estimated coefficient. Note however that magnitude and statistical significance of the estimated coefficient is larger for the positive component of the interaction term while the negative component is not always significant. This is not surprising given that industries with a negative external financial dependence represent a small share of the sample.

Table 6a: Real Value Added Growth and Total Fiscal Balance Counter-cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	**-0.959*** ***(0.245)***	**-0.969*** ***(0.256)***	**-0.715*** ***(0.366)***	**-0.782*** ***(0.420)***	**-0.837*** ***(0.477)***	**-1.232**** ***(0.554)***
(Positive External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**9.009*** ***(2.542)***	**8.308*** ***(2.642)***	**8.809*** ***(2.869)***	**9.113*** ***(2.504)***	**7.571**** ***(2.694)***	**8.570*** ***(2.078)***
(Negative External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**-6.459** ***(3.895)***	**-2.973** ***(5.303)***	**-10.58**** ***(4.463)***	**-4.268** ***(6.099)***	**-14.19*** ***(3.896)***	**-13.05*** ***(6.768)***
Observations	574	575	576	577	594	595
R-squared	0.526	0.510	0.512	0.505	0.484	0.459

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the ratio of beginning of period real value added at the industry level to total manufacturing beginning of period real value added. *Positive* (resp. *Negative) External Financial Dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when net total fiscal balance to GDP is regressed on a constant and the output gap. The interaction variable is the product of positive or negative external financial dependence and total fiscal balance to GDP counter-cyclicality. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1 % (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 6b: Real Value Added Growth and Primary Fiscal Balance Counter-cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	**-0.971*** ***(0.214)***	**-0.951*** ***(0.218)***	**-0.736*** ***(0.381)***	**-0.752*** ***(0.414)***	**-0.890*** ***(0.502)***	**-1.209**** ***(0.551)***
(Positive External Financial Dependence) x (Primary Fiscal Balance to GDP Counter-Cyclicality)	**6.756*** ***(1.753)***	**6.376*** ***(1.886)***	**7.007*** ***(1.979)***	**7.175*** ***(1.819)***	**7.069**** ***(2.573)***	**7.532*** ***(1.919)***
(Negative External Financial Dependence) x (Primary Fiscal Balance to GDP Counter-Cyclicality)	**-3.076** ***(2.022)***	**-1.091** ***(3.816)***	**-5.582*** ***(2.734)***	**-2.025** ***(4.082)***	**-11.47*** ***(3.830)***	**-9.709** ***(6.288)***
Observations	574	575	576	577	594	595
R-squared	0.524	0.509	0.512	0.503	0.487	0.459

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the ratio of beginning of period real value added at the industry level to total manufacturing beginning of period real value added. *Positive* (resp. *Negative) External financial dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Primary Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when primary fiscal balance to GDP is regressed on a constant and the output gap. The interaction variable is the product of positive or negative external financial dependence and primary fiscal balance to GDP counter-cyclicality. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1 % (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Finally as is shown in table 7a and 7b, this result holds both for real value added as well as for labour productivity growth.

Table 7a: Labor Productivity Growth and Total Fiscal Balance Counter-cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Relative Labour Productivity	**2.105*** ***(0.518)***	**-2.317*** ***(0.527)***	**-2.182*** ***(0.488)***	**-2.524*** ***(0.684)***	**-2.480*** ***(0.385)***	**-3.552*** ***(0.638)***
(Positive External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**7.493*** ***(1.464)***	**7.303*** ***(1.370)***	**8.659*** ***(2.093)***	**7.859*** ***(1427)***	**7.652*** ***(2.213)***	**7.664*** ***(1.511)***
(Negative External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**-15.89*** ***(5.222)***	**-12.40*** ***(3.941)***	**-24.05*** ***(5.199)***	**-16.01** ***(6.937)***	**-23.83*** ***(4.347)***	**-22.26*** ***(4.829)***
Observations	573	573	573	573	586	586
R-squared	0.453	0.419	0.472	0.443	0.445	0.425

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initial Relative Labor Productivity* is the ratio of beginning of period labor productivity at the industry level to total manufacturing beginning of period labor productivity. *Positive* (resp. *Negative) External financial dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. The interaction variable is the product of positive or negative external financial dependence and total fiscal balance to GDP counter-cyclicality. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 7b: Labor Productivity Growth and Primary Fiscal Balance Counter-cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Relative Labour Productivity	**-2.140*** ***(0.555)***	**-2.319*** ***(0.537)***	**-2.127*** ***(0.479)***	**-2.506*** ***(0.665)***	**-2.445*** ***(0.390)***	**-3.539*** ***(0.645)***
(Positive External Financial Dependence) x (Primary Fiscal Balance to GDP Counter-Cyclicality)	**5.805*** ***(0.839)***	**5.678*** ***(0.772)***	**7.062*** ***(1.340)***	**6.511*** ***(0.962)***	**7.349*** ***(1.756)***	**6.854*** ***(1.341)***
(Negative External Financial Dependence) x (Primary Fiscal Balance to GDP Counter-Cyclicality)	**-10.81*** ***(3.565)***	**-8.592*** ***(2.666)***	**-15.69*** ***(4.175)***	**-11.45** ***(5.105)***	**-21.00*** ***(4.121)***	**-18.83*** ***(4.737)***
Observations	573	573	573	573	586	586
R-squared	0.452	0.418	0.472	0.443	0.451	0.424

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initial Relative Labor Productivity* is the ratio of industry beginning of period labor productivity to total manufacturing beginning of period labor productivity. *Positive* (resp. *Negative) External Financial Dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Net Primary Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when net primary fiscal balance to GDP is regressed on a constant and the output gap. The interaction variable is the product of positive or negative external financial dependence and net total fiscal balance to GDP counter-cyclicality. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

4.1 Opening the fiscal policy box

If fiscal policy, understood as fiscal balance, counter-cyclicality promotes growth in terms of value added and labour productivity, one is inclined to ask which component of fiscal policy is

growth enhancing when counter-cyclical and which item of fiscal policy has no effect on growth through its counter-cyclicality. To provide a possible answer to this question, we examine two different decompositions. First we split fiscal policy into receipts and expenditures and ask counter-cyclicality in which component is (more) important for growth. Second, we divide fiscal expenditures between government consumption and government investment and ask a similar question.

Table 8a: Real Value Added Growth and Government Receipts to GDP Counter-Cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	**-0.682**** *(0.269)*	**-0.686**** *(0.260)*	**-0.365** *(0.392)*	**-0.421** *(0.339)*	**-0.396** *(0.490)*	**-0.778** (0.535)
(Positive External Financial Dependence) x (Government Receipts to GDP Counter-Cyclicality)	**1.248** *(4.525)*	**2.398** *(4.005)*	**2.423** (5.756)	**4.677** (5.044)	**1.613** (4.522)	**7.489** *(4.638)*
(Negative External Financial Dependence) x (Government Receipts to GDP Counter-	**0.742** (3.986)	**0.280** *(3.931)*	**-5.473** (6.696)	**-3.591** (6.750)	**-16.38**** (6.522)	**-21.37*** *(10.43)*
Observations	574	575	576	577	594	595
R-squared	0.503	0.492	0.491	0.485	0.462	0.441

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the ratio of beginning of period real value added at the industry level to total manufacturing beginning of period real value added. *Positive* (resp. *Negative) External Financial Dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Government Receipts to GDP Counter-Cyclicality* is the regression coefficient of the output gap when government receipts to GDP is regressed on a constant and the output gap. The interaction variable is the product of positive or negative external financial dependence and government receipts to GDP counter-cyclicality. All estimated coefficient are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 8b: Labor Productivity Growth and Government Receipts to GDP Counter-Cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	**-2.212***** *(0.572)*	**-2.404***** *(0.539)*	**-2.254***** *(0.518)*	**-2.637***** *(0.676)*	**-2.366***** *(0.440)*	**-3.489***** *(0.658)*
(Positive External Financial Dependence) x (Government Receipts to GDP Counter-Cyclicality)	**1.356** *(2.919)*	**2.311** *(2.632)*	**3.872** *(3.886)*	**6.087*** (3.029,)	**3.285** *(3.412)*	**9.185***** *(3.017)*
(Negative External Financial Dependence) x (Government Receipts to GDP Counter-Cyclicality)	**-1.155** *(5.722)*	**-3.208** *(3.956)*	**-9.719** *(9.249)*	**-12.56*** *(6.100)*	**-20.71**** *(9.482)*	**-33.10***** *(8.388)*
Observations	573	573	573	573	586	586
R-squared	0.431	0.402	0.443	0.429	0.407	0.410

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initiai Relative Labor Productivity* is the ratio of industry beginning of period labor productivity to total manufacturing beginning of period labor productivity. *Positive* (resp. *Negative) External Financial Dependence* is the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Government Receipts to GDP Counter-Cyclicality* is the regression coefficient of the output gap when government receipts to GDP is regressed on a constant and the output gap. The interaction variable is the product of positive or negative external financial dependence and government receipts to GDP counter-cyclicality. All estimated coefficient are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Empirical evidence shows that counter-cyclicality in government receipts does not seem to play a significant role neither for real value added growth nor for labour productivity growth. This would suggest that the positive effect on growth of fiscal balance counter-cyclicality is mainly coming from counter-cyclicality in expenditures. Indeed the interaction term between external financial dependence and counter-cyclicality in government expenditures to GDP is a significant determinant of industry growth both for real value added and labour productivity.

Table 9a: Real Value Added Growth and Government Spending to GDP Counter-Cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	-0.770** *(0.349)*	**-0.770*** *(0.416)*	**-0.523** *(0.458)*	**-0.545** *(0.537)*	**-0.880*** *(0.468)*	**-1.304***** *(0.562)*
(Positive External Financial Dependence) x (Government Spending to GDP Pro-Cyclicality)	**4.490**** *(1.960*	**-3.785** *(2.574)*	**-5.756**** *(2.331)*	**-5.670** *(3.557)*	**-10.09***** *(2.431)*	**-13.51***** *(2.587)*
(Negative External Financial Dependence) x (Government Spending to GDP Pro-Cyclicality)	**4.642** *(3.553)*	**2.203** *(4.485)*	**5.943** *(4.572)*	**1.906** *(6.396)*	**10.53** *(5.217)*	**11.03** *(11.27)*
Observations	574	575	576	577	594	595
R-squared	0.511	0.495	0.501	0.489	0.491	0.460

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the ratio of beginning of period real value added at the industry level to total manufacturing beginning of period real value added. *Positive* (resp. *Negative) External Financial Dependence* is the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Government Spending to GDP Pro-Cyclicality* is the regression coefficient of the output gap when government spending to GDP is regressed on a constant and the output gap. The interaction variable is the product of positive or negative external financial dependence and total government spending to GDP pro-cyclicality. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 9b: Labor Productivity Growth and Government Spending to GDP Counter-Cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Relative Labor Productivity	**-2.143***** *(0.553)*	**-2.394***** *(0.563)*	**-2.224***** *(0.553)*	**-2.672***** *(0.764)*	**-2.413***** *(0.443)*	**-3.507***** *(0.666)*
(Positive External Financial Dependence) x (Government Spending to GDP Pro-Cyclicality)	**-3.688***** *(1.157)*	**-3.434**** *(1.349)*	**-4.927**** *(2.244)*	**-3.624*** *(2.101)*	**-9.233***** *(1.613)*	**-9.823***** *(2.632)*
(Negative External Financial Dependence) x (Government Spending to GDP Pro-Cyclicality)	**9.668**** *(3.648)*	**6.825** *(4.134)*	**14.40**** *(5.936)*	**7.439** *(5.608)*	**22.42***** *(7.357)*	**22.02**** *(8.376)*
Observations	573	573	573	573	586	586
R-squared	0.431	0.402	0.443	0.429	0.407	0.410

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initial Relative Labor Productivity* is the ratio of industry beginning of period labor productivity to total manufacturing beginning of period labor productivity. *Positive* (resp. *Negative) External Financial Dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Government Spending to GDP Pro-Cyclicality* is the regression coefficient of the output gap when government spending to GDP is regressed on a constant and the output gap. The interaction variable is the product of positive or negative external financial dependence and government spending to GDP pro-cyclicality. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by*** (resp. **; *).

This brings two remarks. First it seems that the the positive impact of fiscal policy counter-cyclicality on growth deos not stem from the simple effect of automatic stabilizers since the latter is presumably more relevant for government receipts than for government expenditures. Put differently, the positive effect of counter-cyclical fiscal policy goes beyond the simple effect of automatic stabilizers. Second the result that counter-cyclicality in government expenditures is growth enhancing suggests that fiscal policy affects growth through a demand channel. If a countercyclical fiscal policy raises productivity growth by smoothing the aggregate demand, then it is natural that government expenditures are more important for stabilization than government receipts. In the model developed above, counter-cyclical government expenditures typically raise aggregate demand and hence the value of collateral in downturns which raises entrepreneurs' ability to invest in more productive, yet more risky projects. On the contrary counter-cyclical government receipts can do the same only as long as the effect of a reduction in taxes is not offset by the drop in aggregate demand. Next we focus on government expenditures and ask which type of expenditure is growth enhancing through its counter-cyclicality? To do so we focus on the impact of government consumption and government investment on real value added growth.

Table 10a: Real Value Added Growth and Government Investment to GDP Counter-Cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	**-0.867***** *(0.257)*	**-0.947***** *(0.289)*	**-0.594*** *(0.309)*	**-0.607*** *(0.349)*	**-0.643*** *(0.376)*	**-1.055**** *(0.504)*
(Positive External Financial Dependence) x (Government Spending to GDP Pro-Cyclicality)	**2.918** *(12.50)*	**-8.423** *(10.23)*	**27.79*** *(14.54)*	**4.272** *(13.27)*	**-1.880** *(14.36)*	**-18.76** *(11.78)*
(Negative External Financial Dependence) x (Government Spending to GDP Pro-Cyclicality)	**2.431** *(31.67)*	**0.342** *(28.19)*	**-32.57** *(30.61)*	**-20.21** *(34.46)*	**45.13** *(32.35)*	**50.97** *(38.52)*
Observations	541	542	543	544	561	562
R-squared	0.511	0.499	0.505	0.487	0.468	0.444

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the ratio of beginning of period real value added at the industry level to total manufacturing beginning of period real value added. *Positive* (resp. *Negative) External Financial Dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Government Investment to GDP Pro-Cyclicality* is the regression coefficient of the output gap when government investment to GDP is regressed on a constant and the output gap. The interaction variable is the product of positive or negative external financial dependence and government investment to GDP pro-cyclicality. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 10b: Labor Productivity Growth and Government Investment to GDP Counter-

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Relative Labor Productivity	**-2.019*** ***(0.535)***	**-2.182*** ***(0.580)***	**-1.962*** ***(0.553)***	**-2.283*** ***(0.646)***	**-2.238*** ***(0.532)***	**-3.285*** ***(0.686)***
(Positive External Financial Dependence) x (Government Spending to GDP Pro-Cyclicality)	**-7.242** ***(11.39)***	**-9.828** ***(9.479)***	**20.50*** ***(11.80)***	**5.261** ***(10.53)***	**-9.561** ***(12.33)***	**-15.54*** ***(9.098)***
(Negative External Financial Dependence) x (Government Spending to GDP Pro-Cyclicality)	**21.39** ***(33.38)***	**21.02** ***(32.02)***	**-26.59** ***(30.75)***	**-17.25** (33.29,)	**61.87*** ***(32.47)***	**46.20** (36.32,)
Observations	540	540	540	540	553	553
R-squared	0.423	0.381	0.444	0.402	0.421	0.390

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initial Relative Labor Productivity* is the ratio of industry beginning of period labor productivity to total manufacturing beginning of period labor productivity. *Positive* (resp. *Negative) External Financial Dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Government Investment to GDP Pm-Cyclicality* is the regression coefficient of the output gap when government investment to GDP is regressed on a constant and the output gap. The interaction variable is the product of variables in parentheses. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

In this case, empirical evidence seems to point out that counter-cyclical fiscal policy is growth enhancing mainly through government consumption not government investment since the former is significant while the latter is not. There may be several reasons that can account for this result. First government consumption counter-cyclicality is likely to exhibit larger variation across countries than government investment counter-cyclicality because in most countries government investment is planned over long time horizons so that countries end up being relatively similar in terms of government investment counter-cyclicality. On the contrary, government consumption counter-cyclicality displays much larger dispersion. As a matter of fact in our sample, dispersion across countries in government consumption counter-cyclicality σ_c is about two times larger than dispersion in government investment counter-cyclicality σ_i. Second, the volume of government investment is relatively small compared to the volume of government consumption. Indeed in our sample, average government consumption to GDP across countries m_c is more than six times larger than average government investment to GDP m_i.

Table 11: Dispersion in government consumption relative to government investment

Time Period	1980-2000	1980-2005	1985-2000	1985-2005	1990-2005	1990-2000
σ_c/σ_i	2,17	2,59	1,84	2,34	2,08	1,37
m_c/m_i	6,21	6,40	6,42	6,62	6,78	6,57

As a consequence the effect of government investment counter-cyclicality is likely to be of second order importance compared to the effect of government consumption counter-cyclicality. The empirical analysis for labour productivity growth delivers essentially a similar result. As in the case of real value added growth, counter-cyclicality in government consumption is a significant growth predictor while counter-cyclicality in government investment is not.

Table 12a: Real Value Added Growth and Government Consumption to GDP Counter-Cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	**-1.212*** ***(0.243)***	**-1.191*** ***(0.324)***	**-0.761** ***(0.318)***	**-0.682*** ***(0.372)***	**-1.059*** ***(0.509)***	**-1.586** ***(0.555)***
(Positive External Financial Dependence) x (Government Consumption to GDP Pro-Cyclicality)	**-19.98*** ***(5.354)***	**-19.02*** ***(4.567)***	**-19.20*** ***(6.167)***	**-15.44** ***(6.764)***	**-21.70*** ***(5.969)***	**-31.77*** ***(5.854)***
(Negative External Financial Dependence) x (Government Consumption to GDP Pro-Cyclicality)	**13.75** ***(11.86)***	**7.092** ***(12.27)***	**14.89** ***(13.65)***	**-2.531** ***(16.14)***	**25.71** ***(20.30)***	**37.20** ***(35.05)***
Observations	510	511	512	513	530	531
R-squared	0.529	0.512	0.515	0.501	0.491	0.472

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the ratio of beginning of period real value added at the industry level to total manufacturing beginning of period real value added. *Positive* (resp. *Negative) External Financial Dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Government Consumption to GDP Pro-Cyclicality* is the regression coefficient of the output gap when government consumption to GDP is regressed on a constant and the output gap. The interaction variable is the product of variables in parentheses. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 12b: Labor Productivity Growth and Government Consumption to GDP Counter-Cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Relative Labor Productivity	**-1.989*** ***(0.585)***	**-2.132*** ***(0.607)***	**-1.893*** ***(0.600)***	**-2.176** ***(0.844)***	**-2.459*** ***(0.485)***	**-3.512*** ***(0.697)***
(Positive External Financial Dependence) x (Government Consumption to GDP Pro-Cyclicality)	**-11.87** ***(4.050)***	**-13.82*** ***(4.207)***	**-16.16*** ***(8.646)***	**-8.892** ***(6.145)***	**-18.90*** ***(3.051)***	**-20.59*** ***(4.127)***
(Negative External Financial Dependence) x (Government Consumption to GDP Pro-Cyclicality)	**24.90** ***(9.517)***	**22.44** ***(12.97)***	**28.53** ***(17.33)***	**4.595** ***(10.41)***	**29.27** ***(22.33)***	**34.39** ***(33.99)***
Observations	513	513	513	513	526	526
R-squared	0.431	0.390	0.458	0.412	0.451	0.423

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initial Relative Labor Productivity* is the ratio of industry beginning of period labor productivity to total manufacturing beginning of period labor productivity. *Positive (resp. Negative) External Financial Dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Government Consumption to GDP Pro-Cyclicality* is the regression coefficient of the output gap when government consumption to GDP is regressed on a constant and the output gap. The interaction variable is the product of variables in parentheses. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Hence the traditional distinction between government consumption -usually regarded as unproductive spending-and government investment -regarded as (more) productive spending- does not apply here. One reason for this result is possibly that countries where government consumption is more counter-cyclical are also countries where government consumption is more productive in the sense that it is more efficiently used as a substitute to private demand, especially in downturns.

4.2 Counter-cyclicality and competing stories

Up to now we have provided evidence that countercyclical fiscal policy has a significant positive impact on industry real value added and labour productivity growth. In this section, we challenge this result by looking at how its significance changes when it competes with standard factors that are know to affect growth at the industry level. Put differently, how robust is the effect of counter-cyclical fiscal policy on growth? To what extent are we picking up other stories? While an exhaustive study to determine how the story related stabilizing fiscal policy compares with alternative explanations would be very long, we propose to focus on a limited but insightful number of them. First if industries differ mainly in the split between internal and external funds to finance investment, then it seems natural that industries located in countries which have been borrowing from abroad, i.e. running current account deficits, should be growing faster because a current account deficit implies that the country as a whole is importing capital. On the contrary industries located in current account surplus countries should be growing slower, everything else equal.

Table 13a: Real Value Added Growth, Total Fiscal Balance Counter-Cyclicality and Current Account Balance

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	**-1.053*** ***(0.205)***	**-1.043*** ***(0.227)***	**-0.840** ***(0.358)***	**-0.886** ***(0.408)***	**-1.020** ***(0.454)***	**-1.364** ***(0.548)***
(Positive External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**8.926*** ***(2.526)***	**8.402*** ***(2.626)***	**8.197*** ***(2.332)***	**8.857*** ***(2.257)***	**7.452*** ***(2.372)***	**8.622*** ***(1.900)***
(Negative External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**-8.834** ***(4.109)***	***-AMI*** ***(4.736)***	**-14.87*** ***(4.419)***	**-7.760** ***(6.702)***	**-14.42*** ***(3.772)***	**-14.24** ***(5.608)***
(Positive External Financial Dependence) x (Average Current Account Balance to GDP)	**0.314** ***(0.455)***	**0.210** ***(0.566)***	**0.622** ***(0.584)***	**0.606** ***(0.794)***	**0.625** ***(0.434)***	**0.544** ***(0.531)***
(Negative External Financial Dependence) x (Average Current Account Balance to GDP)	**1.453*** ***(0.807)***	**2.034** ***(1.222)***	**1.297** ***(1.070)***	**1.753** ***(1.892)***	**0.354** ***(0.931)***	**2.184** ***(1.579)***
Observations	574	575	576	577	594	595
R-squared	0.529	0.512	0.519	0.510	0.491	0.466

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the ratio of beginning of period real value added at the industry level to total manufacturing beginning of period real value added. *Positive* (resp. *Negative) External Financial Dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. *Average Current Account Balance to GDP* is the simple mean of current account balance to GDP. The interaction variables are the product of variables in parentheses. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and industry dummies. Significance at the 1 % (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Empirical evidence shows however that this is not the case: the interaction of current account balance and external financial dependence has no significant impact neither on real value added growth nor on labour productivity growth while the impact of the interaction between external financial dependence and stabilizing fiscal policy is still significant. Moreover the magnitude of estimated coefficients is relatively unchanged while significance is enhanced. Hence the impact on growth of a stabilizing fiscal policy is robust to controlling for the current account balance.

Table 13b: Labor Productivity Growth, Total Fiscal Balance Counter-Cyclicality and Current Account Balance

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Relative Labor Productivity	**-2.097*** ***(0.528)***	**-2.277*** ***(0.548)***	**-2.076*** ***(0.491)***	**-2.378*** ***(0.718)***	**-2.493*** ***(0.390)***	**-3.516*** ***(0.664)***
(Positive External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**7.503*** ***(1.585)***	**7.337*** ***(1.407)***	**7.990*** ***(1.914)***	**7.664*** ***(1.648)***	**7.281*** ***(1.767)***	**7.591*** ***(1.369)***
(Negative External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**-16.13*** ***(5.369)***	**-12.69*** ***(3.795)***	**-25.21*** ***(4.973)***	**-18.41**** ***(6.847)***	**-23.48*** ***(4.045)***	**-23.30*** ***(4.074)***
(Positive External Financial Dependence) x (Average Current Account Balance to GDP)	**-0.007** ***(0.328)***	**-0.194** ***(0.318)***	**0.448** ***(0.510)***	**0.354** ***(0.743)***	**0.615** ***(0.356)***	**0.343** ***(0.450)***
(Negative External Financial Dependence) x (Average Current Account Balance to GDP)	**0.225** ***(0.807)***	**1.186** ***(1.222)***	**0.511** ***(1.070)***	**1.795** ***(1.892)***	**-0.687** ***(0.931)***	**1.835** ***(1.579)***
Observations	573	573	573	573	586	586
R-squared	0.453	0.420	0.476	0.448	0.452	0.430

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initial Relative Labor Productivity* is the ratio of industry beginning of period labor productivity to total manufacturing beginning of period labor productivity. *Positive (resp. Negative) External Financial Dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. *Average Current Account Balance to GDP* is the simple mean of current account balance to GDP. The interaction variables are the product of variables in parentheses. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Next we look at the impact of inflation. In theory one of the negative effects of inflation relates to its impact on the allocative efficiency of capital. When inflation is higher, the financial system allocates less efficiently capital. As a consequence, this negative effect is more likely to verified for industries with high reliance on external finance because investors will face more difficulties to identify the high productivity projects which will translate into more capital allocated to low productivity projects. On the contrary, for industries with no external financial dependence, this negative effect does not apply by definition. Hence the negative impact of inflation should be dampened.

Empirical evidence provides two results: First inflation does exert a significant negative impact on industry growth which amplifies for industries with larger reliance on external capital. But this effect is robust only when real value added growth is on the LHS. Significance is lower or even absent when labour productivity growth is the dependent variable. What this means is that inflation is costly not necessarily because it reduces productivity growth but more likely because it reduces employment growth, firms adjusting their labour demand to cope with the misallocation of capital. This way, value added growth is hurt but productivity growth is not. Second, the effect of counter-cyclical fiscal policy is both significant and robust to the inclusion of inflation as a control variable. Put differently, the positive effect on growth of a stabilizing

fiscal policy is not related the fact that countries in which fiscal policy is more counter-cyclical would be countries with lower average inflation and hence higher allocative efficiency.

Table 14a: Real Value Added Growth,Total Fiscal Balance Counter-Cyclicality and Inflation

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	**-1.155*** ***(0.197)***	**-1.167*** ***(0.218)***	**-0.917** ***(0.336)***	**-0.949** ***(0.387)***	**-1.105** ***(0.486)***	**-1.425** ***(0.540)***
(Positive External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**7.877*** ***(2.050)***	**6.937*** ***(1.963)***	**6.176** ***(2.154)***	**6.276*** ***(1.916)***	**5.889** ***(2.576)***	**6.506*** ***(2.212)***
(Negative External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**-9.646*** ***(4.607)***	**-5.951** ***(4.749)***	**-17.27*** ***(5.705)***	**-10.43** ***(5.988)***	**-17.40*** ***(4.812)***	**-17.27** ***(5.987)***
(Overall External Financial Dependence) x (Average CPI Inflation)	**-0.890** ***(0.307)***	**-0.841*** ***(0.267)***	**-1.555*** ***(0.453)***	**-1.309*** ***(0.397)***	**-1.984*** ***(0.602)***	**-1.633*** ***(0.548)***
Observations	574	575	576	*511*	594	595
R-squared	0.536	0.520	0.527	0.517	0.498	0.468

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the ratio of industry beginning of period real value added to total manufacturing beginning of period real value added. *Positive* (resp. *Negative) External Financial Dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 if the fraction positive, (resp. negative) and is equal to zero otherwise. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. *Average CPI Inflation* is the simple mean of consumer price index inflation. The interaction variables are the product of variables in parentheses. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 14b: Labor Productivity Growth, Total Fiscal Balance Counter-Cyclicality and Inflation

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Relative Labor Productivity	**-2.079*** ***(0.517)***	**-2.271*** ***(0.518)***	**-1.960*** ***(0.507)***	**-2.272*** ***(0.719)***	**-2.377*** ***(0.396)***	**-3.466*** ***(0.652)***
(Positive External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**7 212*** ***(1.507)***	**6.905*** ***(1.254)***	**6.809*** ***(2.305)***	**5.815*** ***(1.927)***	**6.318** ***(2.277)***	**6.003*** ***(1.721)***
(Negative External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**-16.38*** ***(5.545)***	**-13.11*** ***(3.890)***	**.27.22*** ***(5.994)***	**-19.71*** ***(6.703)***	**-25.71*** ***(5.189)***	**-25.10*** ***(4.433)***
(External Financial Dependence) x (Average Private Credit to GDP)	**-0.169** ***(0.238)***	**-0.217** ***(0.166)***	**-0.950*** ***(0.516)***	**-0.897*** ***(0.459)***	**-1.277** ***(0.517)***	**-1.164** ***(0.469)***
Observations	573	573	573	573	586	586
R-squared	0.453	0.420	0.480	0.451	0.453	0.432

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initial Relative Labor Productivity* is the ratio of industry beginning of period labor productivity to total manufacturing beginning of period labor productivity. *Positive (resp. Negative) External financial dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. *Average CPI Inflation* is the simple mean of consumer price index inflation. The interaction variables are the product of variables in parentheses. All estimated coefficient are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Thirdly, we look at financial development. A large part of the growth literature stresses the impact of financial constraints on growth. Indeed industries with larger financial dependence are reasonably expected to grow faster if tey can access external fund more easily, at a cheaper cost. Hence, it seems natural to confront our results to the possibility that fiscal policy counter-cyclicality is simply a proxy for financial development, which could be a very natural outcome given the existence of a positive relationship between fiscal policy counter-cyclicality and financial development (cf. Aghion and Marisnecu (2007)). In the two next tables, we test how the effect of fiscal policy counter-cyclicality on growth compares with the effect of financial development.

Table 15a: Real Value Added Growth,Total Fiscal Balance Counter-Cyclicality and Private Credit

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	**-1.094*** ***(0.215)***	**-1.153*** ***(0.216)***	**-0.862**** ***(0.323)***	**-1.005**** ***(0.348)***	**-0.856*** ***(0.468)***	**-1.255**** ***(0.567)***
(Positive External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**9.079*** ***(2.429)***	**8.716*** ***(2.571)***	**8.102*** ***(2.699)***	**8.681*** ***(2.368)***	**7.337**** ***(2.619)***	**8.248*** ***(1.904)***
(Negative External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**-7.015** ***(4.458)***	**-2.263** ***(4.948)***	**-12.57**** ***(4.987)***	**-5.210** ***(5.828)***	**-14.46*** ***(4.253)***	**-13.35*** ***(6.736)***
(External Financial Dependence) x (Average Private Credit to GDP)	**5.191*** ***(2.571)***	**5.745**** ***(2.167)***	**6.001** ***(3.472)***	**6.629**** ***(2.370)***	**1.217** ***(3.455)***	**1.243** ***(1.800)***
Observations	574	575	576	577	594	595
R-squared	0.531	0.516	0.519	0.515	0.485	0.460

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the the ratio of beginning of period real value added at the industry level to total manufacturing beginning of period real value added. *Positive (resp. Negative) External financial dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. *Average private credit to GDP* is the simple mean private credit to GDP. The interaction variables are the product of variables in parentheses. All estimated coefficient are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 15b: Labor Productivity Growth, Total Fiscal Balance Counter-Cyclicality and Private Credit

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Relative Labor Productivity	**-2.115*** ***(0.502)***	**-2.318*** ***(0.516)***	**-2.071*** ***(0.539)***	**-2.361*** ***(0.742)***	**-2.462*** ***(0.398)***	**-3.541*** ***(0.648)***
(Positive External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**7.520*** ***(1.476)***	**7.302*** ***(1.398)***	**7.913*** ***(1.961)***	**7.333*** ***(1.577)***	**7.216*** ***(2.153)***	**6.678*** ***(1.468)***
(Negative External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**-15.91*** ***(5.176)***	**-12.40*** ***(3.992)***	**-24.60*** ***(5.142)***	**-16.32**** ***(6.605)***	**-24.31*** ***(4.586)***	**-23.29*** ***(4.769)***
(External Financial Dependence) x(Average CPI Inflation)	**-0.630** ***(1.596)***	**-0.0125** ***(1.196)***	**4.165** ***(2.994)***	**5.161**** ***(2.249)***	**2.010** ***(2.590)***	**3.505*** ***(0.949)***
Observations	573	573	573	573	586	586
R-squared	0.453	0.419	0.476	0.452	0.446	0.429

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initial Relative Labor Productivity* is the the ratio of industry beginning of period labor productivity to total manufacturing beginning of period labor productivity. *Positive (resp. negative) External financial dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. *Average CPI Inflation* is the simple mean of consumer price index inflation. The interaction variables are the product of variables in parentheses. All estimated coefficient are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Finally if the cyclical component of fiscal policy does significantly affect real value added an labour productivity growth, it is also likely that the structural component of fiscal policy plays a similar role. Indeed counter-cyclical fiscal policy may be growth enhancing not because counter-cyclicality is valuable on its own but because counter-cyclicality in fiscal policy reflects better designed fiscal policy. higher efficiency. For instance if differences in fiscal balance counter-cyclicality systematically vary with differences in average fiscal balance across countries, then it could be that more counter-cyclical fiscal policy reflects higher fiscal discipline in which we could mistakenly attribute to fiscal counter-cyclicality what in reality is a result of fiscal discipline. To study this question, we run a horse race regression with counter-cyclicality in total fiscal balance (resp. primary fiscal balance) to GDP on the one hand and the average fiscal balance (resp. average primary balance) to GDP on the other hand.

Table 16a shows that the average level of the total fiscal balance to GDP ratio does not in general embed significant explanatory power to account for real value added growth. On the contrary the effect of countercyclical fiscal balance is still significant which implies that the effect of counter-cyclical fiscal policy on growth does no go through the structural component of fiscal policy. There are however some estimations where the average fiscal balance to GDP does play a significant positive impact, a lower average fiscal deficit to GDP raising industry value added growth (cf. column (i) and (iii)). Now when we turn to labour productivity growth on the LHS (table 16b), the average fiscal balance to GDP has so significant effect whatsoever, while counter-cyclicality in fiscal balance is still significant. The positive effect of a stabilizing fiscal policy on labour productivity growth is hence robust to controlling for the average fiscal policy balance and therefore does not proxy for the effectof average fiscal policy. However this does not necessarily imply that fiscal discipline in the sense of a moderate average fiscal deficit has no implications for growth. In particular fiscal discipline is likely to be a prerequisite for stabilizing fiscal policies in as much as a large average fiscal deficit would preclude any

government from stabilizing the economy in downturns if the government, as any other agent faces a borrowing constraint.

Table 16a: Real Value Added Growth, Total Fiscal Balance Counter-Cyclicality and Average Total Fiscal Balance

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	**-0.945*** ***(0.236)***	**-1.009*** ***(0.253)***	**-0.681*** ***(0.365)***	**-0.816*** ***(0.416)***	**-0.882*** ***(0.449)***	**-1.300**** ***(0.514)***
Interaction (Positive External Financial Dependence x Total Fiscal Balance to GDP Counter-Cyclicality)	**6.845**** ***(2.809)***	**7.221**** ***(3.068)***	**5.810** ***(3.536)***	**6.404** ***(3.881)***	**7.102**** ***(2.816)***	**7.750**** ***(2.913)***
Interaction (Negative External Financial Dependence x Total Fiscal Balance to GDP Counter-Cyclicality)	**-9.688** ***(5.751)***	**-7.879** ***(6.446)***	**-17.62**** ***(6.842)***	**-12.96** ***(11.19)***	**-15.33***** ***(4.140)***	**-18.77***** ***(6.423)***
Interaction (Positive External Financial Dependence x Average Total Fiscal Balance to GDP)	**0.960*** ***(0.526)***	**0.598** ***(0.606)***	**1.237*** ***(0.664)***	**1.139** ***(0.937)***	**0.862** ***(0.846)***	**0.987** ***(1.449)***
Interaction (Negative External Financial Dependence x Average Total Fiscal Balance to GDP)	**1.254** ***(1.599)***	**1.876** ***(1.638)***	**2.520** ***(1.699)***	**2.799** (2.709,)	**0.945** ***(1.358)***	**3.804** ***(3.003)***
Observations	574	575	576	577	594	595
R-squared	0.534	0.516	0.524	0.515	0.489	0.467

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the the ratio of beginning of period real value added at the industry level to total manufacturing beginning of period real value added. *Positive (resp. Negative) External financial dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. *Average total fiscal balance to GDP* is the simple mean of total fiscal balance to GDP. The interaction variables are the product of variables in parentheses. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 16b: Labor Productivity Growth, Total Fiscal Balance Counter-Cyclicality and Average Total Fiscal Balance

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Relative Labor Productivity	**-2.055***** ***(0.529)***	**-2.313***** ***(0.529)***	**-2 11 y***** ***(0.448)***	**-2.459***** ***(0.676)***	**-2.443***** ***(0.392)***	**-3.575***** ***(0.639)***
Interaction (Positive External Financial Dependence x Total Fiscal Balance to GDP Counter-Cyclicality)	**6.345***** ***(2.076)***	**7.502***** ***(1.870)***	**7.349**** ***(3.163)***	**7.107*** ***(3.418)***	**7.376***** ***(2.262)***	**7.952***** ***(1.983)***
Interaction (Negative External Financial Dependence x Total Fiscal Balance to GDP Counter-Cyclicality)	**-13.63*** ***(7.530)***	**-15.91**** ***(6.148)***	**-25.42**** ***(8.723)***	**-24.15*** ***(12.24)***	**-22.31***** ***(4.400)***	**-27.07***** ***(6.039)***
Interaction (Positive External Financial Dependence x Average Total Fiscal Balance to GDP)	**0.515** ***(0.444)***	**-0.0908** ***(0.407)***	**0.557** ***(0.635)***	**0.329** ***(0.908)***	**0.397** ***(0.620)***	**-0.234** ***(0.853)***
Interaction (Negative External Financial Dependence x Average Total Fiscal Balance to GDP)	**-0.925** ***(1.826)***	**1.462** ***(1.478)***	**0.394** ***(2.639)***	**2.785** ***(2.885)***	**-1.570** ***(1.962)***	**3.429** ***(2.791)***
Observations	573	573	573	573	586	586
R-squared	0.455	0.420	0.475	0.448	0.446	0.427

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initial Relative Labor Productivity* is the the ratio of industry beginning of period labor productivity to total manufacturing beginning of period labor productivity. *Positive (resp. Negative) External*

financial dependence is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. *Average total fiscal balance to GDP* is the simple mean of total fiscal balance to GDP. The interaction variables are the product of variables in parentheses. All estimated coefficient are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by*** (resp. **; *).

4.3 Dampening effects

In the theoretical model described above, the impact of counter-cyclical fiscal policy on growth is amplified when external financial dependence is larger but dampened when the share of pledgeable income is bigger. In this section we test the second prediction, namely whether a larger share of pledgeable income tends to reduce the positive effect of fiscal policy counter—cyclicality on growth. Income pledgeability is captured through the volume of private credit to GDP because when a larger share of income is pledgeable to outside investors, entrepreneurs borrow more capital and the volume of credit is larger. Two additional terms are introduced compared with to the standard specification (15). We first add the interaction of private credit to GDP and external financial dependence and secondly the interaction of private credit to GDP, fiscal policy counter-cyclicality and external financial dependence. The first term controls for the positive effect of private credit on growth while the second term is designed to capture dampening effects of private credit on the impact of fiscal policy counter-cyclicality on growth. Note however that there may be alternative ways to investigate the existence of dampening effects. For instance countries could be divided between those with above and those with below median private credit to GDP. However this last procedure has not proved very successful in identifying dampening of amplifying effects. This is why we use a triple linear interaction.

Table 17a: Real Value Added Growth, Total Fiscal Balance Counter-Cyclicality and Private Credit

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	**-0.995*** ***(0.206)***	**-1.073*** ***(0.221)***	**-0.761** ***(0.329)***	**-0.896** ***(0.349)***	**-0.768** ***(0.451)***	**-1.176** ***(0.544)***
Interaction (External Financial Dependence x Total Fiscal Balance to GDP Counter-Cyclicality)	**14.43*** ***(4.286)***	**11.98** ***(4.109)***	**10.47** ***(4.833)***	**14.64*** ***(2.619)***	**7.722** ***(5.729)***	**9.154*** ***(2.911)***
Interaction (External Financial Dependence x Average Private Credit to GDP)	**10.98** ***(4.666)***	**10.06*** ***(3.233)***	**9.312*** ***(5.141)***	**12.97*** ***(2.695)***	**3.064** ***(5.994)***	**5.039** ***(3.233)***
Interaction (External Financial Dependence x Total Fiscal Balance to GDP Counter-Cyclicality x Average Private Credit to GDP)	**-9.993*** ***(5.224)***	**-7.641** ***(4.847)***	**-6.088** ***(6.864)***	**-11.78*** ***(3.946)***	**-3.099** ***(6.010)***	**-4.267** ***(2.935)***
Observations	574	575	576	577	594	595
R-squared	0.530	0.517	0.515	0.518	0.475	0.453

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the the ratio of beginning of period real value added at the industry level to total manufacturing beginning of period real value added. *Positive (resp. Negative) External financial dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. *Average private credit to GDP* is the simple mean of private credit to GDP. The interaction variables are the product of variables in parentheses. All estimated coefficient are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

We present estimations for real value added and labour productivity growth when the fiscal policy indicator is total fiscal balance to GDP. In this case empirical evidence shows that a larger volume of private credit to GDP effectively tends to dampen the positive effect on growth of fiscal policy counter-cyclicality since the coefficient of the triple interaction term is almost always negative. However this dampening effect is barely statistically significant, especially for labour productivity growth. There are two possible reasons. First it is likely that identifying dampening or amplifying effects through a triple interaction is difficult because the triple interaction term is likely to be collinear with the two simple interaction terms, especially in our case where the number of countries is relatively small. Second private credit to GDP is likely to be a relatively poor proxy for income pledgeability. As a result, these empirical evidence are at best suggestive of the existence of dampening effects. But clearly more investigation is needed with a larger cross-country dimension and/or a better proxy for income pledgeability.

Table 17b: Labor Productivity Growth, Total Fiscal Balance Counter-Cyclicality and Private Credit

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Relative Labor Productivity	**-2.075***** *(0.536)*	**-2.321***** *(0.502)*	**-1.982***** *(0.574)*	**-2.182***** *(0.727)*	**-2.179***** *(0.512)*	**-3.212***** *(0.762)*
Interaction (External Financial Dependence x Total Fiscal Balance to GDP Counter-Cyclicality)	**6.892*** *(3.676)*	**5.327**** *(1.962)*	**3.165** *(3.461)*	**8.454***** *(2.742)*	**4.066** *(4.270)*	**5.663***** *(1.759)*
Interaction (External Financial Dependence x Average Private Credit to GDP)	**1.528** *(3.869)*	**0.620** *(1.973)*	**3.733** *(4.777)*	**8.691**** *(3.225)*	**2.384** *(4.746)*	**6.410**** *(2.742)*
Interaction (External Financial Dependence x Total Fiscal Balance to GDP Counter-Cyclicality x Average Private Credit to GDP)	**-3.211** *(5.788)*	**-0.936** *(2.339)*	**0.839** *(5.650)*	**-6.171** *(4.485)*	**-0.685** *(4.482)*	**-3.126** *(2.136)*
Observations	573	573	573	573	586	586
R-squared	0.443	0.412	0.456	0.443	0.415	0.403

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initial Relative Labor Productivity* is the the ratio of industry beginning of period labor productivity to total manufacturing beginning of period labor productivity. *Positive (resp. Negative) External financial dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. *Average private credit to GDP* is the simple mean of private credit to GDP. The interaction variables are the product of variables in parentheses. All estimated coefficient are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

4.4 Instrumental variable estimation

An important limit to the empirical investigation we carry out in this paper is the fact that counter-cyclicality of macro policy cannot be observed. It can only be inferred through a regression. This can pose a number of problems. Among these problems lies the fact that counter-cyclicality is measured with a standard error. Hence OLS estimation is not consistent as long as we do not observe the "true" value of counter-cyclicality but a "noisy" one. Reducing the impact of this problem on the significance of our results can be done through instrumental variable estimations. Hence we instrument fiscal policy counter-cyclicality with variables which have two characteristics. First, these variables are directly observed, none is inferred from another model. Second they are all predetermined with respect to the counter-cyclicality index we instrument. This means that the period the instruments are observed on is anterior to the period on which counter-cyclicality has been inferred. We use as instruments log of GDP per

worker, imports to GDP, current account balance to GDP, long term interest rate, CPI inflation and private credit to GDP.

Table 18a: Real Value Added Growth, Total Fiscal Balance Counter-Cyclicality and Private Credit

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	**-0.935*** ***(0.308)***	**-1.062*** ***(0.329)***	**-0.713*** ***(0.411)***	**-0.823*** ***(0.453)***	**-0.683** ***(0.472)***	**-1.305** ***(0.541)***
(External Financial Dependence) x (Total Fiscal Balance to GDP Counter-Cyclicality)	**10.54** ***(4.245)***	**9.732*** ***(5.739)***	**11.10*** ***(1.418)***	**10.04*** ***(1.838)***	**5.594*** ***(2.138)***	**7.099*** ***(1.801)***
Hansen J-Stat *p. value*	**6.320** *(0.276)*	**5.592** *(0.348)*	**4.495** *(0.481)*	**4.060** *(0.541)*	**7.549** *(0.183)*	**5.860** *(0.320)*
Observations	522	523	524	525	542	543
R-squared	0.041	0.036	0.015	0.039	0.030	0.038

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the ratio of beginning of period industry real value added to beginning of period total manufacturing real value added. *External financial dependence* is the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. The interaction variable is the product of external financial dependence and total fiscal balance to GDP counter-cyclicality. All regressions are carried out with IV estimations. List of instruments: log of GDP per worker, imports to GDP, current account balance to GDP, long term interest rate, CPI inflation and private credit to GDP. All instruments are beginning of period values. The Hansen J-Stat represents the value of the test statistics associated with the null hypothesis that instruments are all valid. The p. value indicates the probability that rejecting the null hypothesis is wrong. All estimated coefficient are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. The R-squared indicates the percentage of variance explained by non dummy variables. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *)·

Table 18b: Labor Productivity Growth and Total Fiscal Balance Counter-cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Relative Labor Productivity	**-2.158*** ***(0.511)***	**-2.494*** ***(0.423)***	**-2.230*** ***(0.459)***	**-2.846*** ***(0.529)***	**-2.290*** ***(0.446)***	**-3.479*** ***(0.661)***
(External Financial Dependence) x (Net Total Fiscal Balance to GDP Counter-Cyclicality)	**6.666*** ***(2.066)***	**6.691*** ***(1.980)***	**6.117*** ***(1.190)***	**4.968*** ***(1.181)***	**3.910** ***(1.756)***	**4.195*** ***(1.477)***
Hansen J-Stat *p. value*	**4.489** *0.481*	**5.100** *0.404*	**3.980** *0.552*	**3.228** *0.665*	**8.561** *0.128*	**8.568** *0.128*
Observations	525	525	525	525	538	538
R-squared	0.091	0.093	0.087	0.106	0.089	0.138

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initial Relative Labor Productivity* is the ratio of industry beginning of period labor productivity to total manufacturing beginning of period labor productivity. *External Financial Dependence* is the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. The interaction variable is the product of external financial dependence and total fiscal balance to GDP counter-cyclicality. All regressions are carried out with IV estimations. List of instruments: log of GDP per worker, imports to GDP, current account balance to GDP, long term interest rate, CPI inflation and private credit to GDP. All instruments are beginning of period values. The Hansen J-Stat represents the value of the test statistics associated with the null hypothesis that instruments are all valid. The p. value indicates the probability that rejecting the null hypothesis is wrong. All estimated coefficients are in percentage. Standard errors -clustered at the country level-are in parentheses. All estimations include country and sector dummies. The R-squared indicates the percentage of variance explained by non dummy variables. Significance at the 1 % (resp. 5%; 10%) level is indicated by *** (resp. **; *).

The instrumental variable estimations are hence an attempt to determine whether the interaction between financial dependence and fiscal policy counter-cyclicality could be a significant determinant of industry level growth solely because the standard errors around the estimates of fiscal policy counter-cyclicality have not been properly taken into account in the estimations. Table 18a and table 18b provide estimations when total fiscal balance to GDP -the fiscal policy indicator used- is instrumented with variables detailed above. Two main conclusions emerge from these estimations. First the positive effect of counter-cyclical fiscal policy on growth is robust to the instrumental variable estimation. For both value added growth and labour productivity growth, the results show that higher counter-cyclicality in fiscal policy significantly improves industry growth and the more so for industries with larger external financial dependence. The second conclusions that bears attention is that the magnitudes estimated in the IV estimations are either roughly similar to those we first estimated especially in tables 1 and table 2 or larger. Using instruments to estimate the effect of fiscal policy counter-cyclicality does not appear to modify at the first order the estimated differential in real value added and labour productivity growth rates stemming from different cyclicality in fiscal policies. Moreover what these estimations show is that in any case we would be willing to consider differences between IV and OLS estimations that would imply larger rather smaller growth differentials given that the magnitude of coefficients is at least equal and in general larger with IV estimations. Finally as is shown in tables 19a and 19b, considering the case different interactions for positive and negative external financial dependence does not modify the above results: the effect on growth of fiscal policy counter-cyclicality interacted by external financial dependence is robust and in general larger with IV estimations.

Table 19a: Real Value Added Growth and Total Fiscal Balance Counter-cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Share in Manufacturing Value Added	**-1.059***** *(0.349)*	**-1.149***** *(0.371)*	**-0.813**** *(0.410)*	**-0.880*** *(0.469)*	**-0.795*** *(0.482)*	**-1.439***** *(0.542)*
Interaction (Positive External Financial Dependence x Total Fiscal Balance to GDP Counter-Cyclicality)	**14.34***** *(4.948)*	**12.70**** *(6.467)*	**14.22***** *(1.927)*	**12.08***** *(2.208)*	**8.552***** *(2.766)*	**10.28***** *(1.669)*
Interaction (Negative External Financial Dependence x Total Fiscal Balance to GDP Counter-Cyclicality)	**-7.526** *(5.761)*	**-4.876** *(8.175)*	**-8.163**** *(3.317)*	**-2.447** *(4.345)*	**-14.89***** *(4.475)*	**-13.40*** *(7.186)*
Hansen J-Stat *p. value*	**10.86** *0.368*	**9.081** *0.524*	**9.579** *0.478*	**12.97** *0.225*	**10.97** *0.360*	**12.68** *0.242*
Observations	522	523	524	525	542	543
R-squared	0.038	0.033	0.020	0.041	0.049	0.053

Note: The dependent variable is the average annual growth rate in real value added for the period indicated in each column for each ISIC industry in each country. *Initial Share in Manufacturing Value Added* is the ratio of beginning of period industry real value added to beginning of period total manufacturing real value added. *Positive (resp. Negative) External Financial Dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. The interaction variable is the product of positive or negative external financial dependence and total fiscal balance to GDP counter-cyclicality. All regressions are carried out with IV estimations. List of instruments: log of GDP per worker, imports to GDP, current account balance to GDP, long term interest rate, CPI inflation and private credit to GDP. All instruments are beginning of period values. The Hansen J-Stat represents the value of the test statistics associated with the null hypothesis that instruments are all valid. The p. value indicates the probability that rejecting the null hypothesis is wrong. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. The R-squared indicates the percentage of variance explained by non dummy variables. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 19b: Labor Productivity Growth and Total Fiscal Balance Counter-cyclicality

Estimation Period	(i) 1980-2005	(ii) 1980-2000	(iii) 1985-2005	(iv) 1985-2000	(v) 1990-2005	(vi) 1990-2000
Log of Initial Relative Labor Productivity	**-2 122*** ***(0.496)***	**-2.449*** ***(0.437)***	**-2.288*** ***(0.439)***	**-2.857*** ***(0.541)***	**-2.582*** ***(0.351)***	**-3.762*** ***(0.576)***
Interaction (Positive External Financial Dependence x Total Fiscal Balance to GDP Counter-Cyclicality)	**11.94*** ***(2.312)***	**10.35*** ***(1.901)***	**10.51*** ***(1.251)***	**7.623*** ***(1.065)***	**7.868*** ***(2.262)***	**7.760*** ***(1.421)***
Interaction (Negative External Financial Dependence x Total Fiscal Balance to GDP Counter-Cyclicality)	**-19.92*** ***(6.076)***	**-13.80** ***(6.748)***	**-20.61*** ***(2.320)***	**-11.39*** ***(3.852)***	**-24.64*** ***(3.728)***	**-20.59*** ***(4.441)***
Hansen J-Stat *p. value*	**9.883** *0.451*	**9.699** *0.467*	**11.31** *0.334*	**9.561** *0.480*	**12.60** *0.247*	**11.23** *0.340*
Observations	525	525	525	525	538	538
R-squared	0.098	0.097	0.119	0.121	0.140	0.178

Note: The dependent variable is the average annual growth rate in labor productivity for the period indicated in each column for each ISIC industry in each country. *Initial Relative Labor Productivity* is the ratio of industry beginning of period labor productivity to manufacturing beginning of period labor productivity. *Positive* (resp. *Negative) External Financial Dependence* is equal to the fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980-1990 when this fraction is positive (resp. negative) and is equal to zero otherwise. *Total Fiscal Balance to GDP Counter-Cyclicality* is the regression coefficient of the output gap when total fiscal balance to GDP is regressed on a constant and the output gap. The interaction variable is the product of positive or negative external financial dependence and total fiscal balance to GDP counter-cyclicality. All regressions are carried out with IV estimations. List of instruments: log of GDP per worker, imports to GDP, current account balance to GDP, long term interest rate, CPI inflation and private credit to GDP. All instruments are beginning of period values. The Hansen J-Stat represents the value of the test statistics associated with the null hypothesis that instruments are all valid. The p. value indicates the probability that rejecting the null hypothesis is wrong. All estimated coefficients are in percentage. Standard errors -clustered at the country level- are in parentheses. All estimations include country and sector dummies. The R-squared indicates the percentage of variance explained by non dummy variables. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

5 Conclusions

In this paper we have tried to evaluate whether and how the cyclical pattern of macro policy can affect growth, focusing on fiscal policy. Following the Rajan-Zingales (1998) methodology, we have drawn a relationship between fiscal policy counter-cyclicality —measured at the macro level— and growth (both value added and productivity) at the industry level. This simple methodology has the advantage to properly handle the reverse causality issue: namely that within our setup, fiscal policy can affect growth while the opposite is not possible because the former is measured at the macro level while the latter is measured at the industry level. Based on this framework, we have provided evidence that (i) industries have grown faster in economies where fiscal policy has been more counter-cyclical, both in terms of output and productivity (ii) that the positive growth effects of fiscal policy counter-cyclicality have been larger for industries which rely proportionally more on external finance. These two conclusions have been shown to be robust to the inclusion of a large number of structural macroeconomic variables, including financial development, openness to trade or net current account position. Hence, the cyclical pattern of fiscal policy is probably at least as important as can be structural features in their impact on growth.

The results have three different consequences for future research. First they call for a wide renewal of theoretical research on the business cycle and growth to build a proper assessment of the interactions that exist between them especially through the financial channel. Second, a natural question that emerges from this paper is whether and how the results on fiscal policy counter-cyclicality extend to monetary policy counter-cyclicality. This is an important question

as monetary policy can move more easily than fiscal policy, although transmission lags can be larger for the former than the latter. Finally if the conclusion that counter-cyclicality in macro policy contributes to raise growth proves to be relevant, them comes the question of the determinants of counter-cyclicality and especially the institutional arrangements that can foster or prevent counter-cyclicality. This final theme could be of great importance to revisit the debate on growth and institutions.

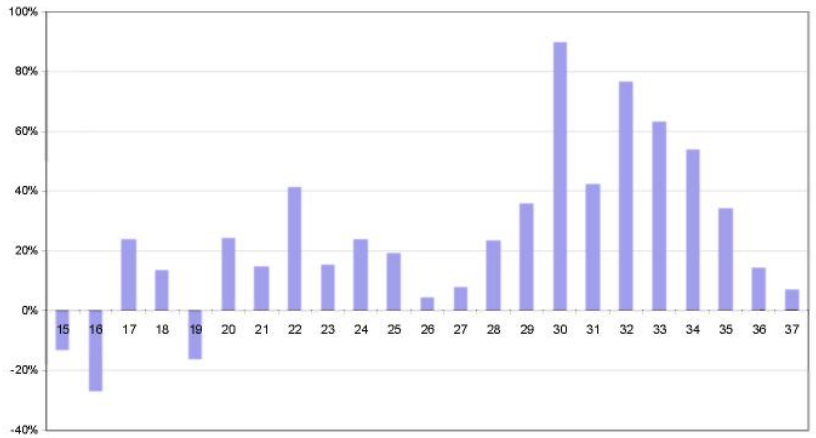
6 Appendix

Countries in the sample	Abbreviations
Australia	AUS
Austria	AUT
Belgium	BEL
Germany	DEU
Denmark	DNK
Spain	ESP
Finland	FIN
France	FRA
Great-Britain	GBR
Greece	GRC
Ireland	IRE
Italy	ITA
Japan	JPN
Luxembourg	LUX
Netherlands	NLD
Portugal	PRT
Sweden	SWE

Description	ISIC rev.3 code
FOOD , BEVERAGES AND TOBACCO	15t16
Food and beverages	15
Tobacco	16
TEXTILES, TEXTILE , LEATHER AND FOOTWEAR	17t19
Textiles and textile	17t18
Textiles	17
Wearing apparel, dressing and dying of fur	18
Leather, leather and footwear	19
WOOD AND OF WOOD AND CORK	20
PULP, PAPER, PAPER , PRINTING AND PUBLISHING	21t22
Pulp, paper and paper	21
Printing, publishing and reproduction	22
Publishing	221
Printing and reproduction	22x
CHEMICAL, RUBBER, PLASTICS AND FUEL	23t25
Coke, refined petroleum and nuclear fuel	23
Chemicals and chemical	24
Pharmaceuticals	244
Chemicals excluding pharmaceuticals	24x
Rubber and plastics	25
OTHER NON-METALLIC MINERAL	26
BASIC METALS AND FABRICATED METAL	27t28
Basic metals	27
Fabricated metal	28
MACHINERY, NEC	29
ELECTRICAL AND OPTICAL EQUIPMENT	30t33
Office, accounting and computing machinery	30
Electrical engineering	31t32
Electrical machinery and apparatus, nec	31
Insulated wire	313
Other electrical machinery and apparatus nec	31x
Radio, television and communication equipment	32
Electronic valves and tubes	321
Telecommunication equipment	322
Radio and television receivers	323
Medical, precision and optical instruments	33
Scientific instruments	331t3
Other instruments	334t5
TRANSPORT EQUIPMENT	34t35
Motor vehicles, trailers and semi-trailers	34
Other transport equipment	35
Building and repairing of ships and boats	351
Aircraft and spacecraft	353
Railroad equipment and transport equipment nec	35x
MANUFACTURING NEC; RECYCLING	36t37
Manufacturing nec	36
Recycling	37

Variable	Data source
Industry Real Value Added	EU KLEMS
Industry Labour Productivity	EU KLEMS
External Financial Dependence	Compustat
Output Gap	OECD Economic Outlook
Total Fiscal Balance	OECD Economic Outlook
Primary Fiscal Balance	OECD Economic Outlook
Government Consumption	OECD Economic Outlook
Government Investment	OECD Economic Outlook
Government Expenditues	OECD Economic Outlook
Government Receipts	OECD Economic Outlook
CPI Inflation	OECD Economic Outlook
Current Account Balance	OECD Economic Outlook
Private Credit	World Bank Financial Structure and Development

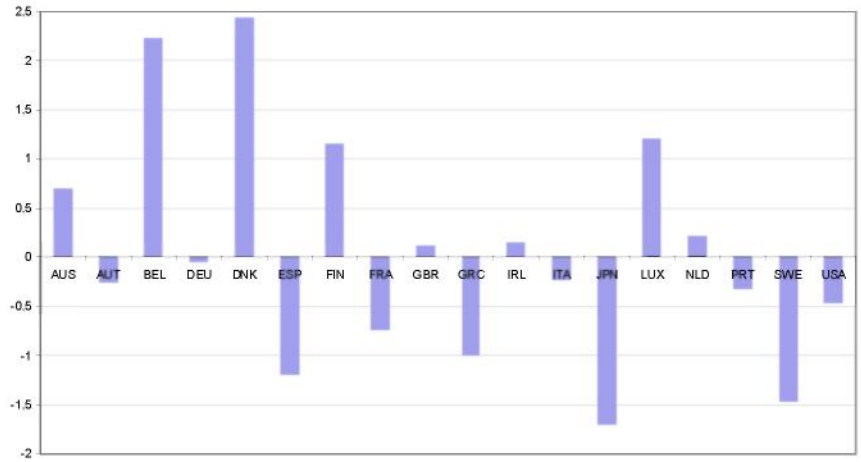
Figure 2: US External Financial Dependence at the two digit level (1980-1990)



Source: Compustat and ISIC Rev. 3.

Figure 3: Average Government Total Deficit (%GDP, 1980-2005)

Figure 4: Average Government Primary Surplus (%GDP, 1980-2005)



Source: OECD economic outlook and authors' computations.

Figure 5: Cyclicality in Government Total Balance to GDP (1980-2005)

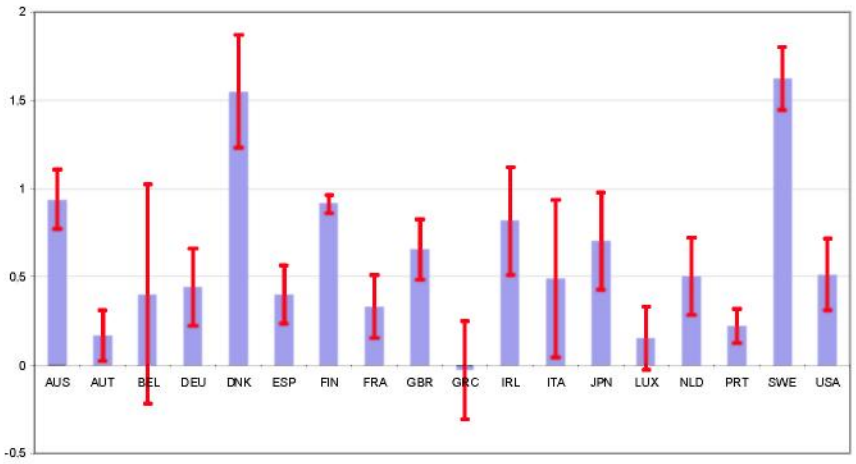
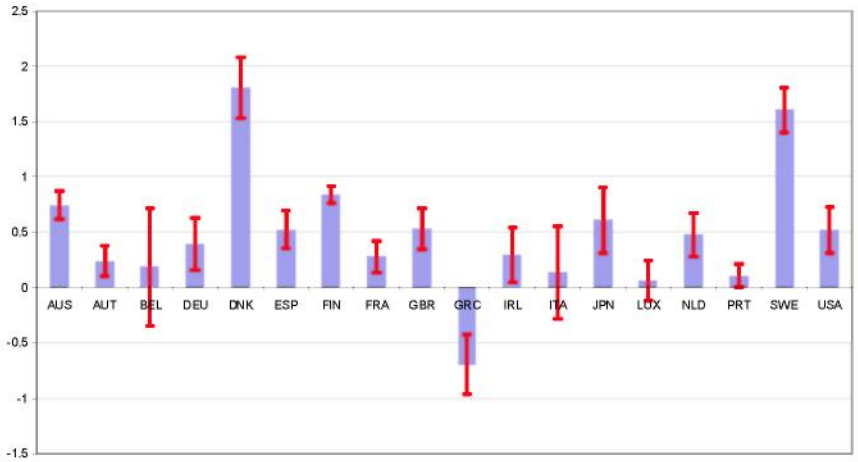


Figure 6: Cyclicality in Government Primary Balance to GDP (1980-2005)



Note: Each bar represents the estimated coefficient αi in the regression: $fb_{it} = \alpha i\ (gapit) + \beta i + \varepsilon it$ where fb_{it} is alternatively government total fiscal balance to GDP (figure 5) or government primary fiscal balance to GDP (figure 6) in country *i* at time *t*, gap_{it} is the output gap in country *i* at time *t*. Each line represents two standard deviations of the estimated coefficient α_i. See below for the list of abbreviations of country names. Source: OECD economic outlook and authors' computations.

Figure 7: Cyclicality of Government Receipts to GDP (1980-2005)

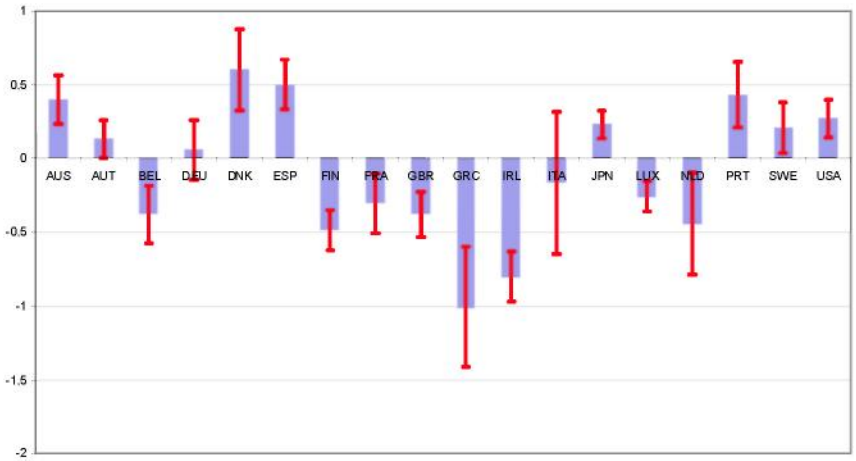
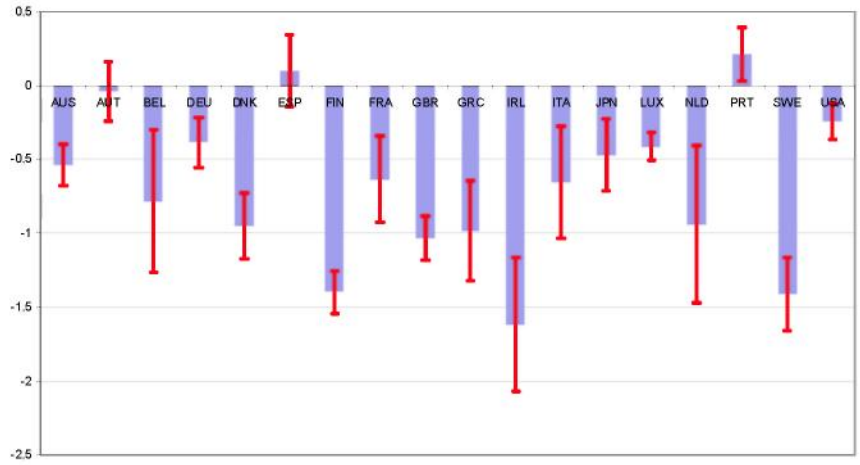


Figure 8: Cyclicality of Government Spending to GDP (1980-2005)



Note: Each bar represents the coefficient αi in the OLS regression: $gy_{it} = \alpha i\ (gap_{it}) + \beta i + \varepsilon it$ where gy_{it} is alternatively government receipts to GDP (figure 7) or government spending to GDP (figure 8) in country *i* at time *t* and gap_{it} is the output gap in country *i* at time *t*. Each line represents two standard deviations of the estimated coefficient α_i. See below for the list of abbreviations of country names. Source: OECD economic outlook and authors' computations.

Figure 9: Cyclicality of Government Consumption as a share of GDP (1980-2005)

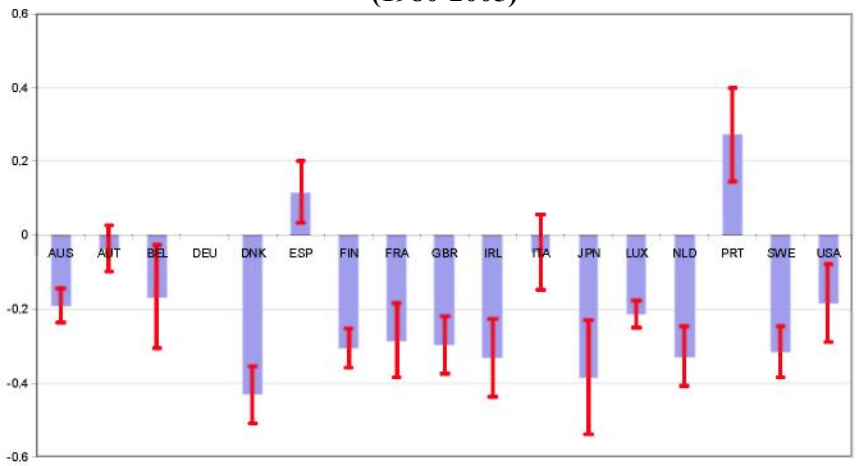
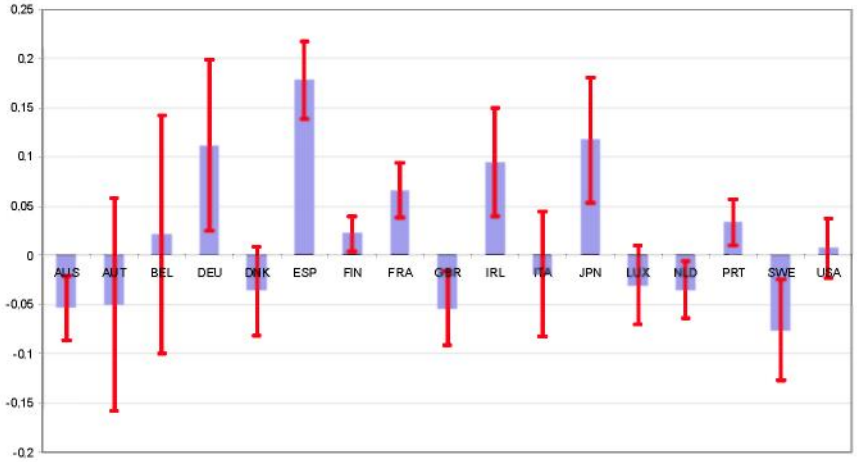
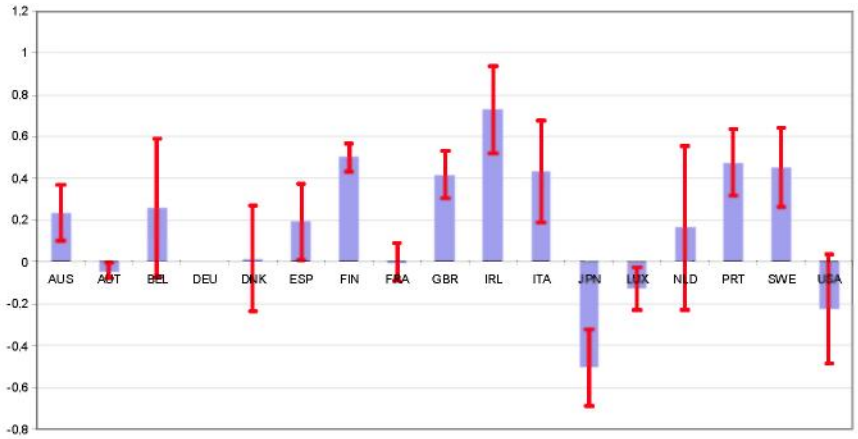


Figure 10: Cyclicality of Government Investment as a share of GDP (1980-2005)



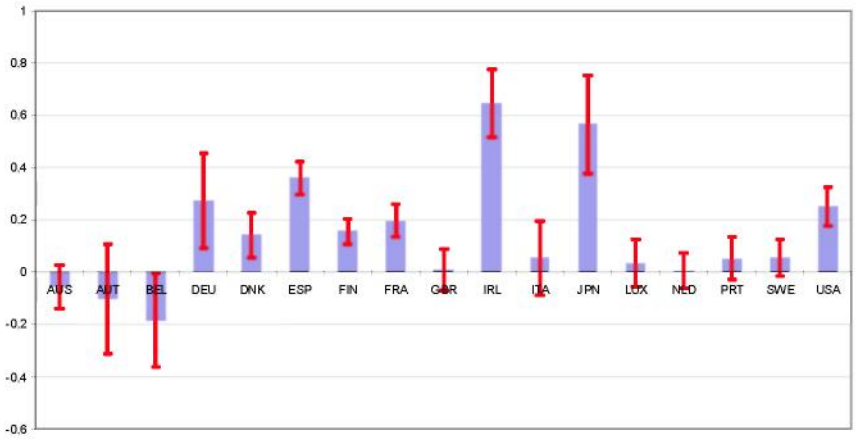
Note: Each bar represents the coefficient α_i in the OLS regression: $gd_{it} = \alpha i\ (gap_{it}) + \beta i + \varepsilon it$ where gc_{it} is alternatively government consumption to GDP (figure 9) or government investment to GDP (figure 10) in country *i* at time *t* and gap_{it} is the output gap in country *i* at time *t.* Each line represents two standard deviations of the estimated coefficient α_i. See below for the list of abbreviations of country names. Source: OECD economic outlook and authors' computations.

Figure 11: Cyclicality of the share of Government Consumption in total Government Spending (1980-2005)



Note: Each bar represents the coefficient αi in the OLS regression: gdsit = αi (gapit) + βi + εit where

Figure 12: Cyclicality of the share of Government Investment in total Government Spending (1980-2005)



gdsit is alternatively the share of government consumption in total government spending (figure 11) or the share of government investment in total government spending (figure 12) in country i at time t and gapit is the output gap in country i at time t. Each line represents two standard deviations of the estimated coefficient αi. See below for the list of abbreviations of country names. Source: OECD economic outlook and authors' computations.

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Public and private inputs in aggregate production and growth: a cross-country efficiency approach*

by

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December 2008

Abstract:

In a cross section of OECD countries we replace the macroeconomic production function by a production possibility frontier, being TFP the composite effect of efficiency scores and possibility frontier changes. We consider, for the periods 1970, 1980, 1990, 2000, one output: GDP per worker; three inputs: human capital, public physical capital per worker and private physical per worker. We use a semi-parametric analysis, computing Malmquist productivity indexes, and we also resort to stochastic frontier analysis. Results show that private capital is more important for growth, although public and human capital also contribute positively. A governance indicator, a non-discretionary input, explains inefficiency. Non-parametric and parametric results coincide rather closely on the countries movements vis-à-vis the possibility frontier, and on their relative distances to the frontier.

JEL: C14, D24, H50, O47
Keywords: economic growth, public spending, efficiency, Malmquist index.

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Non-technical summary

In a cross section of OECD countries we replace the macroeconomic production function by a production possibility frontier, being Total Factor Productivity the composite effect of efficiency scores and possibility frontier changes. We consider, for the periods 1970, 1980, 1990, 2000, one output, GDP per worker, and three inputs, human capital, public physical capital per worker and private physical per worker. We use a semi-parametric analysis, computing Malmquist productivity indexes, and we also resort to stochastic frontier analysis.

Results show that: i) private capital is important for growth, and they contribute in a significant manner to input accumulation; ii) public and human capital contribution is usually estimated as positive, but, depending on the specification, it was not always significant from a statistical point a view; iii) a governance indicator, a non-discretionary input, explains inefficiency. Our results also support the idea that better governance helps countries to achieve a better performance and to operate closer to the production possibility frontier.

Deterministic and stochastic estimation methods provide similar results and conclusions. Notably, non-parametric and parametric results coincide rather closely on the countries movements vis-à-vis the possibility frontier and on their relative distances to the frontier. The number of countries that can be nominated as efficient was stable throughout the period, with six or seven countries usually on the frontier (Belgium, Canada, Spain, Italy, Japan, Portugal, and the USA). In addition, it is worthwhile noticing the steady improvement in (technical) efficiency throughout the time sample for such countries as Ireland, Norway, and Finland, with the first two countries reaching the efficiency frontier in 2000. An opposite development can be seen for the case of Japan that shifts away from the efficiency frontier between 1970 and 2000.

Our estimations imply that policy may matter for growth by at least three different channels. One is public investment. The public capital elasticity is imprecisely estimated. These estimates and their variability are consistent with other results available in the literature concerning the effects of public investment across countries. The policy content of these results seems to be cautious – macroeconomic analysis can be no substitute for the careful evaluation of each public project on its own merits.

The other channel by which policy operates is governance. Our governance indicator is a weighted average (the principal component) of indicators related to voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, the rule of law, and control of corruption. These are all areas that depend on policy in the broad sense of the word, i.e., they result not only from policy measures, but also from the way institutions are at the same time shaped by history and designed by contemporaneous men and women. Research on the most important of these areas and how they evolve through time seems to be a promising and fruitful subject for further work.

Finally, our results are also consistent with the importance of human capital formation for growth. There is some evidence of a positive macroeconomic return for human capital investment. Some countries in our sample, even if they are close to the efficiency frontier (Portugal, Spain), are probably limited in their growth prospects by their relative human capital scarcity.

1 Introduction

The empirics of growth are generally based on an aggregate production function approach. In a typical framework, production depends on labour, physical capital, human capital and total factor productivity (TFP). Total factor productivity is an unobserved variable, and is generally estimated following a procedure that involves: i) specifying a production function (e.g. of a Cobb-Douglas variety); ii) estimating or calibrating the production function parameters; iii) and obtaining TFP as a Solow residual, the change in production that is not explained by changes in production factors.

The researcher is very often interested in TFP estimates. For example, one may be interested in how TFP differs across countries in response to different environments likely to affect growth (policies, governance, institutions...), and also in how TFP changes throughout time. However, TFP estimates obtained in the manner described above heavily depend on the assumptions about the production function.

In this paper we replace the macroeconomic production function by a production possibility frontier. TFP is computed as the composite effect of efficiency score and possibility frontier changes. The efficiency score provides information on how far away a country is from the frontier, given the inputs it is using in production. We will consider, in a cross section of countries, one output: GDP per worker; three inputs: human capital, public physical capital per worker and private physical per worker; and an environmental variable (a non-discretionary input), related to public policy, under the form of a governance indicator (St. Aubyn, 2007). These variables are usually useful to explain changes in country efficiency scores and therefore in the distance to the frontier.

We use two different methods to estimate the production possibility frontier.

Firstly, we apply the semi-parametric analysis with non-discretionary inputs in a similar manner as in Afonso and St. Aubyn (2006). This approach has one important advantage – the number of a priori assumptions is much smaller, as there is no need to specify a functional form for the relationship between inputs (production factors) and output (income). Namely, no a priori hypothesis is made in what concerns returns to scale or substitution elasticities[3]. The only restrictions imposed on the production frontier are that it is convex and monotonic (increasing factor quantities does not decrease production possibilities). Moreover, we take advantage of the time series dimension to assess the developments of TFP by computing Malmquist productivity indexes.

Secondly, we resort to stochastic frontier analysis (SFA). This is a parametric method, so that a specific functional form for the production possibility frontier has to be assumed. It retains, however, the idea that countries operate either on or below a production frontier. Consequently, improvements may be attained in two different ways, either by decreasing the inefficiency score, or by sharing the increased possibilities given by an upward shift in the frontier. Both efficiency measurement methods allow for a fruitful distinction between two different inputs.
Discretionary inputs are those that can be changed at will by the decision making unit (DMU). Taking a national economy as a DMU, we consider it chooses each period which quantity of production factors it employs (human and physical capital, labour). Non-discretionary or environment inputs are inputs which are pre-determined at least in the short to medium run. They affect the DMU operational conditions and its distance to the frontier. We consider governance as a non-discretionary input.

[3] Recall that the widely used Cobb-Douglas production function imposes in simultaneously a loglinear functional form, and a unit elasticity of factor substitution and constant returns to scale.

By resorting to the World Bank indicators, our paper provides evidence that governance is also an important non-discretionary factor explaining inefficiency, supporting the idea that better governance helps developed countries to achieve a better performance and to operate closer to the production possibility frontier.

The remainder of the paper is organised as follows. Section two briefly reviews the related literature. Section three presents the methodology used in the analysis. Section four reports and discusses the empirical analysis. Section five concludes the paper.

2 Literature

The use of non-parametric analysis to macroeconomic issues has been growing recently, notably in what concerns the assessment of public sector efficiency. For instance, Data Envelopment Analysis (DEA) became widely used to calculate changes in TFP within specific sectors, for instance, hospitals, schools, where price data is difficult to find and multi-output production is relevant, because it needs fewer assumptions about the form of the production technology. DEA analysis has also been used recently to assess the efficiency of the public sector in cross-country analysis in such areas as education and health (Afonso and St. Aubyn, 2005, 2006) and also for overall public sector efficiency analysis (Afonso et al., 2005).

A different but related small strand of the literature has applied DEA methods and the associated Malmquist TFP computations to GDP and GDP growth. Kumar and Russell (2002) and Krüger (2003) were among the first to adopt this approach. They only considered output and physical capital per worker. Henderson and Russell (2005) added human capital as an input, and Delgado-Rodríguez and Álvarez-Ayuso (2008) separated private from public capital. Apart from (important) differences in the considered sample and in the way stocks are measured, namely human capital, our work is to our knowledge the first to relate governance conditions to macroeconomic efficiency and factor productivity growth within this framework. Additional discussions and applications of the overall Malmquist productivity index to the traditional notion of total factor productivity can be found in Färe et al. (1994), Ray and Desli (1997), and Färe, Grosskopf and Norris (1997).

Applications of stochastic frontier analysis to infer efficiency changes in aggregate production across countries are even rarer. It is worthwhile mentioning the work of Mastromarco and Ghosh (2008) concerning developing countries, and of Koop, Osiewalski and Steel (2000) for Western economies, Poland and Yugoslavia. The latter estimate a Bayesian stochastic frontier for aggregate production, considering capital and labour as production factors and decompose growth between 1980 and 1990 into input growth, technical growth and efficiency growth. Mastromarco and Ghosh (2008) estimate a stochastic production frontier for 57 developing countries for the period 1960-2000. GDP depends on two production factors, labour and private capital. Efficiency or total factor productivity is driven by technology diffusion interacting with human capital.

Some recent papers have emphasised the importance of institutions and governance as a deep determinant for growth. For instance, Olson, Sarna and Swamy (2000) claim that differences in "governance" can explain why some developing countries grow rapidly, taking advantage of catching up opportunities, while others lag behind. In these authors' assessment, the quality of governance explains in a straightforward manner and in empirical terms, something that neither standard endogenous or exogenous growth models do – why a (small) number of developing countries converge towards higher income levels and therefore display high growth rates. In this literature strand, "governance" is measurable and reflects the quality of institutions and economic policies. Acemoglu, Johnson and Robinson (2001) provide empirical evidence favouring the idea that current institutions have a strong influence on current economic performance of countries with a colonial past. These institutions, measured by the average

protection against expropriation risk, are shaped by the way settlement occurred in the past, "extractive states" being opposed to "neo-Europe" colonies.

3 Methodology

3.1 DEA and the Malmquist index

The DEA methodology, originating from Farrell's (1957) seminal work and popularised by Charnes, Cooper and Rhodes (1978), assumes the existence of a convex production frontier. The production frontier in the DEA approach is constructed using linear programming methods. The term "envelopment" stems from the fact that the production frontier envelops the set of observations.[4]

The general relationship that we consider is given by the following function for each country *i*:

$$Y_i = f(X_i),\ i=1,\ldots,n \qquad (1)$$

where we have Y_i – GDP per worker, our output measure; X_i – the relevant inputs in country *i* (private and public capital per worker, human capital). If $Y_i < f(X_i)$, it is said that country *i* exhibits inefficiency. For the observed input levels, the actual output is smaller than the best attainable one and inefficiency can then be measured by computing the distance to the theoretical efficiency frontier.

The analytical description of the linear programming problem to be solved in the variable-returns to scale hypothesis is sketched below for an input-oriented specification. Suppose there are *k* inputs and *m* outputs for *n* Decision Management Units (DMUs). For the i-th DMU, y_i is the column vector of the inputs and x_i is the column vector of the outputs. We can also define *X* as the $(k\times n)$ input matrix and *Y* as the $(m\times n)$ output matrix. The DEA model is then specified with the following mathematical programming problem, for a given i-th DMU:[5]

$$\begin{aligned} &Min_{\ \delta,\lambda}\ \delta \\ &\text{s. to} \quad -y_i + Y\lambda \geq 0 \\ &\qquad\ \ \delta x_i - X\lambda \geq 0 \\ &\qquad\ \ n1'\lambda = 1 \\ &\qquad\ \ \lambda \geq 0 \end{aligned} \qquad (2)$$

In problem (2), δ is a scalar (that satisfies $\delta \leq 1$), more specifically it is the efficiency score that measures technical efficiency. It measures the distance between a country and the efficiency frontier, defined as a linear combination of the best practice observations. With $\delta<1$, the country is inside the frontier (i.e. it is inefficient), while $\delta=1$ implies that the country is on the frontier (i.e. it is efficient).

The vector λ is a $(n\times 1)$ vector of constants that measures the weights used to compute the location of an inefficient DMU if it were to become efficient, and *n1* is an n-dimensional vector of ones. The inefficient DMU would be projected on the production frontier as a linear combination of those weights, related to the peers of the inefficient DMU. The peers are other DMUs that are more efficient and are therefore used as references for the inefficient DMU. The restriction $n1'\lambda = 1$ imposes convexity of the frontier, accounting for variable returns to scale.

[4] Coelli et al. (1998) and Thanassoulis (2001) offer introductions to DEA.

[5] We simply present here the equivalent envelopment form, derived by Charnes et al. (1978), using the duality property of the multiplier form of the original programming model.

Dropping this restriction would amount to admit that returns to scale were constant. Problem (2) has to be solved for each of the *n* DMUs in order to obtain the *n* efficiency scores.

Figure 1 presents the DEA production possibility frontier in the simple one input-one output case. Countries A, B and C are efficient countries. Their output scores are equal to 1. Country D is not efficient. Its score [*d2/(d1+d2)*] is smaller than 1.

[Figure 1]

As explained in more detail in the following section, we will deal with panel data, observing countries at different points in time. One would normally expect the production frontier to change over time, as well as efficiency scores. Therefore, if a country sees its production changed, usually increased, from year t to year t+1, one would like to decompose the total variation into a part attributed to changes in efficiency and another ascribed to the frontier changes.

The output Malmquist productivity index, *MPI* (Malmquist, 1953) allows this decomposition in a straightforward and intuitive way.[6] For a given country, it is defined as:

$$MPI_{t+1}(y_t, x_t, y_{t+1}, x_{t+1}) = \left[\frac{d_o^t(y_{t+1}, x_{t+1})}{d_o^t(y_t, x_t)} \times \frac{d_o^{t+1}(y_{t+1}, x_{t+1})}{d_o^{t+1}(y_t, x_t)} \right]^{1/2}, \quad (3)$$

where $d_o^t(y_s, x_s)$ is the output distance score using the frontier at year *t* and inputs and outputs related to year *s*. In particular, $d_o^t(y_t, x_t)$ is the output efficiency score presented in the previous section and is not greater than one. However, $d_o^t(y_s, x_s)$ may be greater than one with $s \neq t$.

The *MPI* may also be written as:

$$MPI_{t+1}(y_t, x_t, y_{t+1}, x_{t+1}) = \frac{d_o^{t+1}(y_{t+1}, x_{t+1})}{d_o^t(y_t, x_t)} \times \left[\frac{d_o^t(y_{t+1}, x_{t+1})}{d_o^{t+1}(y_{t+1}, x_{t+1})} \times \frac{d_o^t(y_t, x_t)}{d_o^{t+1}(y_t, x_t)} \right]^{1/2}, \quad (4)$$

or, equivalently,

$$MPI_{t+1} = ECI_{t+1} \times TCI_{t+1}, \quad (5)$$

where $ECI_{t+1} = \frac{d_o^{t+1}(y_{t+1}, x_{t+1})}{d_o^t(y_t, x_t)}$ is the efficiency change index and $TCI_{t+1} = \left[\frac{d_o^t(y_{t+1}, x_{t+1})}{d_o^{t+1}(y_{t+1}, x_{t+1})} \times \frac{d_o^t(y_t, x_t)}{d_o^{t+1}(y_t, x_t)} \right]^{1/2}$ is the technology change index.

In the simple one input-one output case, the *MPI* and its decomposition has an intuitive geometrical interpretation, and this can be exemplified in Figure 2.

[Figure 2]

In Figure 2, we can observe for the exemplified DMU that it produces less than feasible under each period's production frontier. The decomposition of the Malmquist index according to equation (5) is given by the distance functions in equations (6) and (7):

[6] We present here the most important features. See Coelli, Rao and Battese (1998) for a more detailed explanation.

$$E = \frac{y_{t+1} / y_r}{y_t / y_p} \tag{6}$$

$$T = \left[\frac{y_{t+1} / y_q}{y_{t+1} / y_r} \times \frac{y_t / y_p}{y_t / y_q} \right]^{1/2} . \tag{7}$$

According to equations (6) and (7), efficiency change (E) is the ratio of the output-oriented measure of Farrell technical efficiency in period $t+1$ to that in period t and technical change (T) is the geometric mean of the shift in technology between period $t+1$ and t.

3.2 Stochastic frontier

The DEA frontier is assumed to be deterministic, and differences between the frontier and actual outputs are fully related to inefficiency. Suppose, alternatively to the DEA approach, that the frontier is stochastic. In that case, such differences may also stem from stochastic noise. Specifically, and after Coelli et al. (2005), assume the following model:

$$\ln y_{it} = F(X_{it}, \beta) + \eta_{it} + \varepsilon_{it} \tag{8}$$

$$\eta_{it} = \theta z_{it} \tag{9}$$

where i is the country and t the time period. We have:

y_{it} – the output, GDP per worker;

X_{it} – the vector of inputs, private and public capital per worker and human capital;

β – set of production function parameters to be estimated;

ε_i – normally distributed random error;

η_i – non-negative efficiency effect, assumed to have a truncated normal distribution;

z_i – non-discretionary factors (the governance indicators) that explain inefficiency;

θ – set of efficiency parameters to be estimated.

We have specified a log linear, Cobb-Douglas function for F(.). Within this setup, and defining $\gamma = \frac{\sigma_\eta^2}{\sigma_\eta^2 + \sigma_\varepsilon^2}$, it is possible to produce a likelihood ratio statistic to test if γ=0, i.e., that there are no random inefficiency effects.

Figure 3 illustrates the SFA production possibility frontier in the simple one input-one output case.

[Figure 3]

4 Empirical analysis

4.1 DATA

We use annual data for all inputs and outputs, for a set of OECD countries, covering the period 1970-2000. Our output measure is GDP, measured in units of national currency per PPS (purchasing power standard), per worker. As measures of inputs we include public capital,

private capital and human capital. The three measures of capital are also scaled by worker (see the Appendix for further details and sources).

Public capital was computed by using public capital to output ratios provided by Kamps (2006). Private capital was obtained by subtracting public capital from total capital. Human capital is the average years of schooling of the working age population.

Kaufmann, Kraay, and Mastruzzi (2006), based on hundreds of variables from several sources, provide six indicators for six different dimensions of governance: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption. We use the composite measure computed by St. Aubyn (2007), which is the principal component of the six sub-indicators after taking the average from 2000 to 2005.

4.2 Non-parametric analysis

We report in Table 1 the period by period, variable returns to scale, technical efficiency scores for each country, for the periods 1970, 1980, 1990 and 2000.[7] From Table 1 it is possible to observe that the number of countries that can be nominated as efficient was rather stable throughout the period, with six or seven countries usually on the frontier (Belgium, Canada, Spain, Italy, Japan, Portugal, and the USA).

[Table 1]

In addition, it is worthwhile noticing the steady improvement in technical efficiency throughout the time sample for such countries as Ireland, Norway, and Finland, with the first two countries reaching the efficiency frontier in 2000. An opposite development can be seen for the case of Japan that shifts away from the efficiency frontier between 1970 and 2000.

Table 2 reports the set of results for the Malmquist indices of efficiency, technology and total factor productivity changes for the period 1970-2000, using GDP per employee as the output measure and four inputs: private and public capital per employee and human capital per employee. The results show that, on average for this set of OECD countries, there was an improvement in total factor productivity (the change was equal to 1.057). On the other hand, the above unit average technology change (1.064) implies that there was also an improvement in the underlying technology. Such gains in technology were more than sufficient to produce an increase in total factor productivity throughout the period, more than compensating the slight drop in efficiency. Interestingly, the overall increase in total factor productivity in the period 1970-2000 occurred essentially in the 1980s and in the 1990s.

[Table 2]

The change in output can be decomposed into two components: the change in total factor productivity and the quantitative change in the inputs, in other words,

$$\Delta Output = \Delta TFP \times \Delta Input \,. \tag{10}$$

Since we know the change in GDP and we can get the change in Total Factor Productivity from the previous Malmquist set of results, the overall change in the inputs can then be computed as $\Delta Input = \Delta Output / TFP$. Therefore, we report in Table 3 the changes in the overall input necessary to attain the output change, given the TFP change.

[Table 3]

[7] DEA scores and Malmquist indexes computations were done with the software Win4DEAP, written by Tim Coelli, available at http://www.umoncton.ca/desliem/dea/.

As a next step, we can also compute the period changes in each of the inputs that we are considering, private capital, public capital and human capital. Table 4 reports those changes. For instance, and for the sub-period 1970-1980, we can observe for Australia overall period growth rates of 22.8%, 27.6%, and 10.5% respectively in public capital, private capital and human capital.

[Table 4]

In addition, we can also decompose the increase in the inputs into those three types of capital, imposing the restriction that the sum of the coefficients of the three inputs equals unity.[8] The specification is then

$$\Delta Input_i = a_1 PrivK_i + a_2 PubK_i + (1 - a_1 - a_2) HK_i . \quad (11)$$

where *PrivK*, *PubK* and *HK* are respectively private, public and human capital. The regressions results are shown in Table 5. It is interesting to observe that in the first sub-period, input growth can be attributed to private capital and public capital by around 28% each, while human capital would account for the remaining 44%. However, in the 1980s and in the 1990s the contribution of private capital became more relevant, while public capital was not statistically significant in the case of the1980s.

[Table 5]

In order to assess whether technical efficiency is related to better governance, we use a composite indicator of governance measures of the World Bank and test its contribution to efficiency. The results in Table 6 show a positive effect of improved governance in increasing technical efficiency, for all periods under consideration.

[Table 6]

4.3 Parametric analysis

Regarding our stochastic frontier analysis, we use the following baseline panel data specification

$$\ln GDP_{it} = \beta_0 + \beta_1 \ln PrivK_{it} + \beta_2 \ln PubK_{it} + \beta_3 HK_{it} + \eta_{it} + \varepsilon_{it} \quad (12)$$

where *i* and *t* index countries and time, respectively, GDP is GDP per employee, *PrivK*, *PubK* and *HK* are respectively private, public and human capital per employee. In (12), ε_{it} is a normally distributed random error, while η_{it} stands for a nonnegative inefficiency effect, assumed to have a truncated normal distribution. Inefficiency effects can be explained by nondiscretionary factors. In our case we assess whether the exogenous factor *wbg* , which is a composite indicator of governance measures of the World Bank, plays a role in explaining inefficiency scores.

The estimation of (12) produces estimates for the following parameters: the βs, the coefficients associated to the inputs; θ, the constant associated to inefficiency; σ_ε and σ_η the standard

[8] Delgado-Rodríguez and Álvarez-Ayuso (2008) followed a similar procedure, but did not impose the unit sum restriction.

deviations of respectively ε_{it} and $\bar{\eta}_{it}$. We report in Table 7 the results for the stochastic frontier estimation.[9]

[Table 7]

From Table 7 we observe that the inefficiency component of the model is almost statistically significant at the 10 percent level. Indeed, the LR statistic equals 3.670, and the critical value at 10 percent for a mixed chi-square distribution with 2 degrees of freedom is 3.808 (according to the tabulation of Kodde and Palm, 1986).

The coefficients for the three types of capital are all positive but only statistically significant for private capital and public capital. For instance, a one percent increase in private capital results in a 0.602 percent increase in output. In addition, a one percent increase in public capital leads to a 0.141 percent increase in output.[10]

Table 8 reports the stochastic frontier estimates of technical efficiency, per year, while Figure 1 illustrates the volatility of these efficiency measures. It is interesting to observe the high correlations between the SFA technical efficiency estimates (Table 8) and the DEA technical efficiency scores (Table 1) computed previously. Moreover, the patterns already mentioned for such countries as Ireland, Finland and Norway (towards the frontier) and Japan (away from the frontier) are also confirmed with the stochastic analysis.

[Table 8]

[Figure 1]

5 Conclusion

In a cross section of OECD countries we replace the macroeconomic production function by a production possibility frontier, TFP being the composite effect of efficiency scores and possibility frontier changes. We consider, for the periods 1970, 1980, 1990, 2000, one output, GDP per worker, and three inputs, human capital, public physical capital per worker and private physical per worker. We use a semi-parametric analysis, computing Malmquist productivity indexes, and we also resort to stochastic frontier analysis.

Our results show that: i) private capital is important for growth, and they contribute in a significant manner to output accumulation; ii) public and human capital contributions are usually estimated as positive, but, depending on the specification, were not always significant from a statistical point a view; iii) a governance indicator, a non-discretionary input, explains inefficiency. Indeed, our results support the idea that better governance helps countries to achieve a better performance and to operate closer to the production possibility frontier.

Deterministic and stochastic estimation methods provided similar results and conclusions. Notably, non-parametric and parametric results coincide rather closely on the countries movements vis-à-vis the possibility frontier and on their relative distances to the frontier. The number of countries that can be nominated as efficient was rather stable throughout the period, with six or seven countries usually on the frontier (Belgium, Canada, Spain, Italy, Japan, Portugal, and the USA).

Our results have several policy implications. Our estimations imply that policy may matter for growth by at least three different channels. One is public investment. The public capital

[9] The model is estimated by maximum likelihood using the software Frontier, version 4.1c, written by Tim Coelli, available at http://www.uq.edu.au/economics/cepa/frontier.htm.

[10] In the Annex we report additional SFA estimations considering a time trend, which confirm these results.

elasticity is imprecisely estimated. Our estimates and their variability are consistent with other results concerning the effects of public investment across countries. With other data and methods, we found that both patterns of crowding in (public investment stimulating private investment and growth) and of crowding out are to be found in the recent experience of industrialised countries.[11] The policy content of these results seems to be cautious - macroeconomic analysis can be no substitute for the careful evaluation of each public project on its own merits.

The other channel by which policy operates is governance. Recall that our governance indicator is a weighted average (the principal component) of indicators related to voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, the rule of law, and control of corruption. These are all areas that depend on policy in the broad sense of the word, i.e., they result not only from policy measures, but also from the way institutions are at the same time shaped by history and designed by contemporaneous men and women. Research on the most important of these areas and how they evolve through time seems to be a promising and fruitful subject for further work.

Finally, our results are consistent with the importance of human capital formation for growth. There is evidence of a positive macroeconomic return for human capital investment, even if in the SFA specification the human capital coefficient does not come out as statistically significant. Some countries in our sample, even if they are close to the efficiency frontier (Portugal, Spain) are probably limited in their growth prospects by their relative human capital scarcity.

[11] See Afonso and St. Aubyn (2008).

Appendix – Data sources

Original series	Ameco codes
Gross Domestic Product at 2000 prices, thousands national currency 1/	1.1.0.0.OVGD
Net capital stock at 2000 prices: total economy 1/	1.0.0.0.OKND
Employment, persons: all domestic industries (National accounts) 1/	1.0.0.0.NETD
GDP purchasing power parities, Units of national currency per PPS (purchasing power standard) 1/	1.0.212.0.KPN
Human capital (average years of schooling of the working age population)	2/
Government net capital stock, volume	3/
Private total net capital stock, volume	Our computation

1/ Series from the European Commission AMECO database.
2/ Cohen and Soto (2007).
3/ Kamps (2006).

Table 1 – Period by output oriented DEA VRS technical efficiency scores (output oriented; output: GDP per employee; inputs: private and public capital, human capital)

	1970	1980	1990	2000
Australia	0.932	0.937	0.924	0.970
Austria	0.897	0.905	0.854	0.817
Belgium	1.000	1.000	1.000	1.000
Canada	1.000	1.000	1.000	1.000
Germany	0.846	0.906	0.891	0.814
Denmark	0.999	1.000	1.000	1.000
Spain	1.000	1.000	1.000	0.943
Finland	0.812	0.852	0.864	0.915
France	0.942	0.935	0.941	0.920
UK	0.825	0.858	0.898	0.968
Greece	0.915	0.884	0.782	0.749
Ireland	0.744	0.737	0.765	1.000
Italy	1.000	1.000	1.000	1.000
Japan	1.000	0.984	0.877	0.775
Netherlands	0.912	0.919	0.869	0.871
Norway	0.882	0.917	0.955	1.000
Portugal	1.000	1.000	1.000	1.000
Sweden	0.929	0.900	0.975	0.881
USA	1.000	1.000	1.000	1.000
Average	0.928	0.933	0.926	0.928
Countries on the frontier	7	7	7	8

Note: VRS – variable returns to scale.

Table 2 – Malmquist efficiency, technology, and total factor productivity change indices: 1970-2000 (output; GDP; inputs: private and public capital, human capital)

	1970-1980			1980-1990			1990-2000			Summary		
	EC	TC	TFP	EC	TC	TFP	EC	TC	TFP	EC	TC	TFP
Australia	1.061	0.922	0.979	0.988	0.980	0.968	1.138	0.963	1.096	0.993	1.042	1.035
Austria	1.032	0.924	0.953	0.980	1.012	0.992	0.954	1.041	0.993	1.004	1.060	1.064
Belgium	1.000	1.009	1.009	1.000	1.059	1.059	1.000	1.042	1.042	0.994	1.053	1.047
Canada	1.000	0.952	0.952	0.954	0.991	0.945	1.139	0.935	1.065	0.980	1.030	1.009
Germany	1.111	0.967	1.074	0.999	1.039	1.037	1.028	0.993	1.021	1.009	1.123	1.134
Denmark	1.063	0.913	0.970	1.000	0.967	0.967	1.000	1.057	1.057	1.017	1.035	1.052
Spain	1.046	1.040	1.089	1.000	1.014	1.014	0.913	1.044	0.954	0.936	1.043	0.976
Finland	1.032	0.995	1.026	0.989	1.023	1.012	1.174	1.005	1.180	1.040	1.034	1.075
France	0.994	1.027	1.021	0.970	1.063	1.032	1.040	1.020	1.061	0.952	1.077	1.026
UK	1.098	0.919	1.009	1.070	0.960	1.027	1.115	0.972	1.084	1.000	1.183	1.183
Greece	0.992	1.055	1.047	0.869	1.020	0.887	0.961	1.083	1.040	0.956	1.075	1.028
Ireland	1.063	0.968	1.028	1.038	1.057	1.098	1.312	1.064	1.396	1.113	1.083	1.205
Italy	1.000	1.099	1.099	1.000	1.066	1.066	1.000	1.016	1.016	1.007	1.103	1.110
Japan	0.981	0.878	0.861	0.894	0.975	0.871	0.883	1.054	0.931	1.000	1.088	1.088
Netherlands	1.036	0.987	1.023	0.949	1.065	1.011	1.008	1.038	1.046	0.999	1.123	1.121
Norway	1.056	0.994	1.050	1.030	1.052	1.084	1.180	1.024	1.208	1.032	1.048	1.081
Portugal	1.000	0.958	0.958	1.000	0.945	0.945	0.947	0.948	0.897	0.970	0.975	0.946
Sweden	0.943	1.002	0.945	1.068	0.989	1.056	1.051	0.990	1.041	0.970	1.040	1.009
USA	1.029	0.959	0.987	1.028	1.026	1.054	1.000	1.058	1.058	0.916	0.930	0.852
Average	1.027	0.976	1.007	0.990	1.015	1.055	1.038	1.017	1.058	0.994	1.064	1.057

Notes: EC – Efficiency Change; TC – Technology Change; TFP – Total Factor Productivity change (TFP=EC*TC).

Table 3 – Output, input and TFP variations (index changes)

	1970-1980			1980-1990			1990-2000			1970-2000		
	ΔGDP	ΔTFP	ΔInput	ΔGDP	ΔTFP	ΔInput	ΔGDP	ΔTFP	ΔInput	ΔGDP	ΔTFP	ΔInput
Australia	1.189	0.922	1.215	1.121	0.968	1.158	1.199	1.096	1.094	1.598	1.035	1.539
Austria	1.387	0.924	1.456	1.233	0.992	1.243	1.205	0.993	1.214	2.061	1.064	2.196
Belgium	1.356	1.009	1.344	1.209	1.059	1.141	1.163	1.042	1.116	1.906	1.047	1.711
Canada	1.065	0.952	1.118	1.098	0.945	1.162	1.151	1.065	1.081	1.346	1.009	1.405
Germany	1.304	0.967	1.215	1.127	1.037	1.087	1.045	1.021	1.024	1.536	1.134	1.351
Denmark	1.198	0.913	1.235	1.189	0.967	1.229	1.202	1.057	1.137	1.710	1.052	1.725
Spain	1.440	1.040	1.322	1.259	1.014	1.242	1.077	0.954	1.128	1.951	0.976	1.852
Finland	1.337	0.995	1.303	1.271	1.012	1.256	1.295	1.180	1.098	2.200	1.075	1.795
France	1.315	1.027	1.288	1.223	1.032	1.185	1.139	1.061	1.074	1.833	1.026	1.640
UK	1.207	0.919	1.196	1.166	1.027	1.135	1.260	1.084	1.162	1.771	1.183	1.577
Greece	1.345	1.055	1.284	1.023	0.887	1.153	1.196	1.040	1.150	1.645	1.028	1.703
Ireland	1.451	0.968	1.412	1.370	1.098	1.248	1.434	1.396	1.027	2.850	1.205	1.809
Italy	1.365	1.099	1.242	1.262	1.066	1.184	1.162	1.016	1.144	2.003	1.110	1.683
Japan	1.462	0.878	1.698	1.273	0.871	1.462	1.135	0.931	1.219	2.113	1.088	3.026
Netherlands	1.228	0.987	1.201	1.112	1.011	1.100	1.118	1.046	1.069	1.527	1.121	1.411
Norway	1.277	0.994	1.216	1.253	1.084	1.156	1.266	1.208	1.048	2.025	1.081	1.473
Portugal	1.289	0.958	1.346	1.206	0.945	1.277	1.209	0.897	1.348	1.880	0.946	2.316
Sweden	1.131	1.002	1.197	1.164	1.056	1.102	1.281	1.041	1.230	1.687	1.009	1.624
USA	1.087	0.959	1.101	1.133	1.054	1.075	1.187	1.058	1.122	1.461	0.852	1.328

Note: □Input=□GDP/□Output.

Table 4 – Input variations (index changes)

	1970-1980			1980-1990			1990-2000			1970-2000		
	Public capital	Private capital	Human capital	Public capital	Private capital	Human capital	Public capital	Private capital	Human capital	Public capital	Private capital	Human capital
Australia	1.228	1.276	1.105	1.198	0.969	1.046	1.117	1.032	1.026	1.644	1.275	1.186
Austria	1.506	1.545	1.110	1.328	1.134	1.062	1.340	0.992	1.044	2.679	1.737	1.231
Belgium	1.313	2.042	1.114	1.141	1.366	1.086	1.217	0.969	1.081	1.824	2.702	1.307
Canada	1.119	0.935	1.117	1.197	1.057	1.066	1.073	1.107	1.058	1.437	1.094	1.260
Germany	1.332	1.453	1.136	1.111	1.003	1.044	1.076	0.947	0.980	1.592	1.380	1.163
Denmark	1.243	1.275	1.094	1.239	0.945	1.046	1.147	0.907	1.057	1.765	1.094	1.210
Spain	1.716	1.595	1.142	1.304	1.438	1.134	1.100	1.263	1.126	2.462	2.896	1.458
Finland	1.321	1.623	1.192	1.353	1.367	1.131	1.025	1.290	1.088	1.831	2.861	1.467
France	1.471	1.352	1.165	1.263	1.179	1.109	1.128	1.160	1.036	2.096	1.848	1.338
UK	1.201	1.291	1.121	1.151	0.884	1.061	1.201	1.048	1.069	1.660	1.196	1.272
Greece	1.720	1.331	1.145	1.167	1.193	1.128	1.128	1.176	1.137	2.264	1.868	1.468
Ireland	1.716	1.525	1.116	1.396	1.206	1.066	1.072	0.754	1.067	2.569	1.387	1.269
Italy	1.411	1.302	1.173	1.273	1.383	1.143	1.186	1.136	1.135	2.130	2.046	1.522
Japan	1.763	2.139	1.081	1.490	1.247	1.065	1.243	1.388	1.057	3.266	3.702	1.216
Netherlands	1.346	1.240	1.100	1.130	0.956	1.043	1.076	0.914	1.058	1.636	1.083	1.213
Norway	1.370	1.383	1.122	1.204	1.335	1.066	1.050	1.217	1.014	1.732	2.247	1.212
Portugal	1.403	1.274	1.357	1.286	1.385	1.061	1.285	1.634	1.231	2.317	2.885	1.772
Sweden	1.224	1.349	1.129	1.245	1.113	1.069	1.172	1.337	0.973	1.786	2.010	1.175
USA	1.130	0.928	1.082	1.088	1.023	1.035	1.151	1.096	1.001	1.415	1.040	1.121

Table 5 – Decomposition of the change in total input

	Private capital	Public capital	Human capital	R-square	N
1970-1980	0.277 ***	0.276 ***	0.446	0.77	19
	(3.63)	(4.50)			
1980-1990	0.733 ***	-0.025	0.293	0.79	19
	(11.65)	(-0.37)			
1990-2000	0.652 ***	0.183 ***	0.165	0.89	19
	(11.82)	(5.36)			
1970-2000	0.556 ***	0.116	0.328	0.80	19
	(6.93)	(1.61)			

Note: t-statistics in brackets.

Table 6 – Efficiency and governance (dependent variable: technical efficiency change)

	Constant	Governance	R-square	N
1970-1980	1.016 ***	0.011	0.20	19
	(79.50)			
		(1.45)		
1980-1990	0.970 ***	0.018 *	0.20	19
	(66.40)	(2.04)		
1990-2000	0.994 ***	0.043 **	0.20	19
	(33.37)	(2.46)		
1970-2000	0.985 ***	0.072 **	0.31	19
	(22.22)	(2.76)		
Pooled changes	0.993 ***	0.024 ***	0.16	57
	(79.14)	(3.23)		

Note: t-statistics in brackets.

Table 7 – Stochastic frontier estimation results

	Coefficient	Standard-error	t-statistic
Production function			
Constant	0.464	0.364	1.276
lnPrivK	0.602	0.0396	15.191
lnPubK	0.141	0.0674	2.089
HK	0.0249	0.0140	1.777
Inefficiency			
Constant	0.185	0.0750	2.463
$\hat{\sigma}_{\varepsilon}^{2}$	0.0141		
γ	0.9997		
LR-statistic (γ=0)*	3.670		
N. of observations	76		
N. of cross-sections	19		

* The LR statistic critical value at 10% for a mixed chi-square distribution with 2 degrees of freedom is 3.808, according to the tabulation of Kodde and Palm, 1986.

Table 8 – SFA efficiency scores

	1970	1980	1990	2000	Average	Ranking (average)
Australia	0.816	0.804	0.801	0.887	0.827	8
Austria	0.785	0.780	0.784	0.784	0.783	12
Belgium	0.903	0.918	0.961	0.977	0.940	2
Canada	0.902	0.879	0.843	0.901	0.881	7
Germany	0.713	0.715	0.745	0.756	0.732	19
Denmark	0.852	0.845	0.878	0.969	0.886	5
Spain	0.956	0.910	0.905	0.867	0.910	4
Finland	0.740	0.753	0.740	0.889	0.780	13
France	0.829	0.802	0.811	0.834	0.819	9
UK	0.729	0.736	0.788	0.865	0.779	14
Greece	0.826	0.751	0.666	0.702	0.736	18
Ireland	0.670	0.647	0.696	0.979	0.748	16
Italy	0.853	0.886	0.898	0.897	0.883	6
Japan	0.857	0.784	0.747	0.698	0.772	15
Netherlands	0.791	0.770	0.792	0.845	0.800	10
Norway	0.750	0.733	0.774	0.922	0.795	11
Portugal	0.991	0.971	0.954	0.894	0.953	1
Sweden	0.766	0.712	0.702	0.790	0.742	17
USA	0.874	0.871	0.925	0.996	0.916	3
Correlation with DEA output oriented TE scores	0.891	0.863	0.801	0.926	0.895	

Table 9 – Efficiency and governance (dependent variable: SFA efficiency change)

	Constant	Governance	R-square	N
1970-1980	0.971***	0.00613	0.051	19
	(89.79)			
		(0.961)		
1980-1990	0.993***	0.0145*	0.152	19
	(70.75)	(1.750)		
1990-2000	1.023***	0.0434**	0.251	19
	(33.16)			
		(2.39)		
1970-2000	0.990***	0.063**	0.290	19
	(24.31)	(2.64)		

Note: t-statistics in brackets.

Figure 1 – DEA production possibility frontier

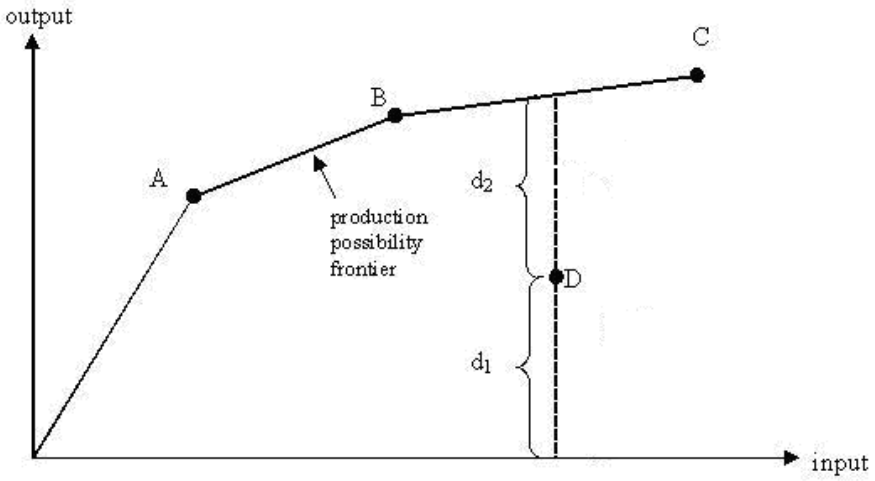


Figure 2 – Malmquist Productivity Index (constant returns to scale example)

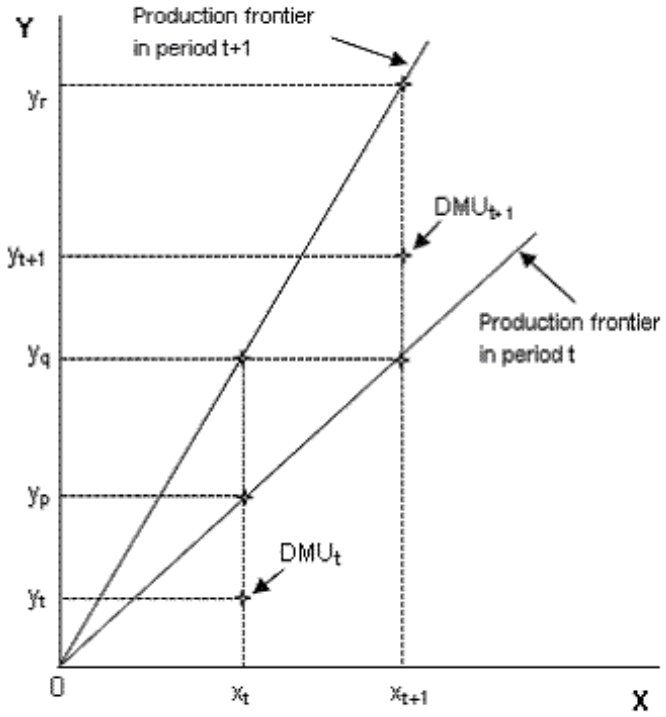


Figure 3 – SFA production possibility frontier

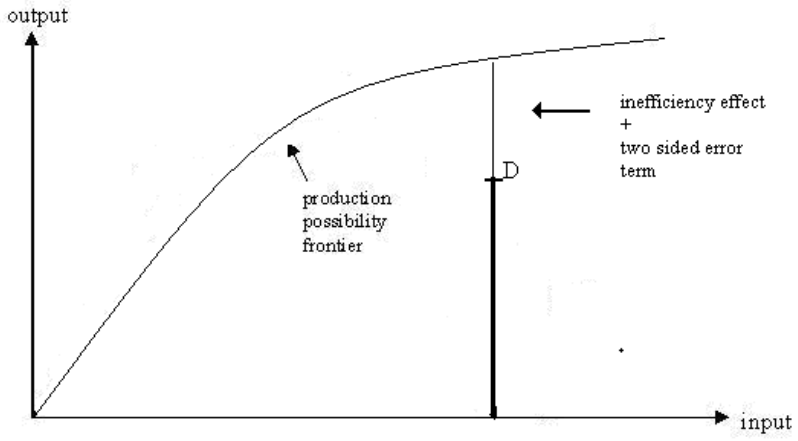
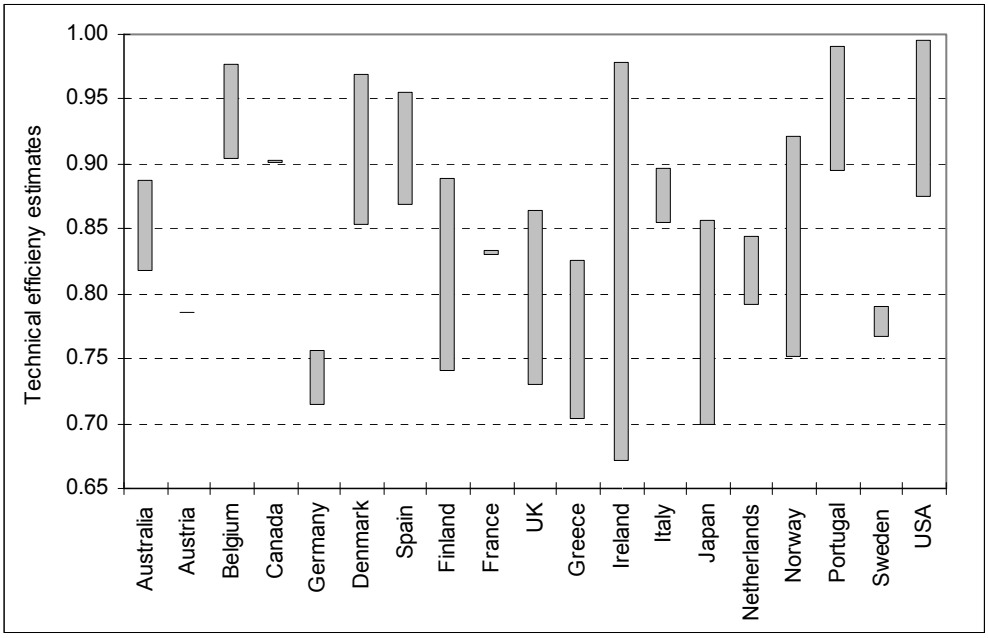


Figure 4 – SFA efficiency scores (1970, 1980, 1990, 2000)



Annex – Additional SFA estimates

Table A1 – Stochastic frontier estimation results (with time trend)

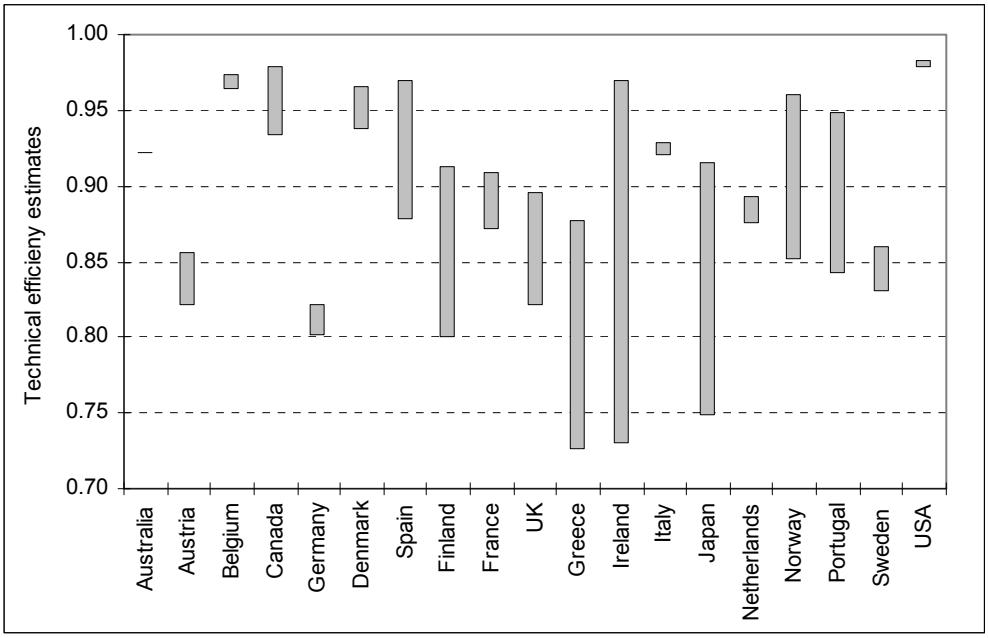
	Coefficient	Standard-error	t-statistic
Production function			
Constant	0.744	0.418	1.78
lnPrivK	0.538	0.133	4.04
lnPubK	0.118	0.053	2.23
HK	0.014	0.009	1.69
Trend	0.047	0.024	1.95
Inefficiency			
Constant	0.080	0.287	0.28
$\hat{\sigma}_{\varepsilon}^{2}$	0.935		
γ	0.744	0.418	1.78
LR-statistic (γ=0)*	2.44		
N. of observations	76		
N. of cross-sections	19		

* The LR statistic critical value at 10% for a mixed chi-square distribution with 2 degrees of freedom is 3.808, according to the tabulation of Kodde and Palm, 1986.

Table A2 – SFA efficiency scores (with time trend)

	1970	1980	1990	2000	Average	Ranking (average)
Australia	0.921	0.896	0.867	0.922	0.901	8
Austria	0.856	0.851	0.839	0.820	0.842	13
Belgium	0.963	0.969	0.977	0.974	0.971	2
Canada	0.979	0.956	0.904	0.932	0.943	3
Germany	0.821	0.820	0.825	0.800	0.817	16
Denmark	0.936	0.915	0.923	0.966	0.935	4
Spain	0.969	0.945	0.932	0.877	0.931	6
Finland	0.799	0.810	0.791	0.913	0.828	15
France	0.909	0.879	0.874	0.871	0.883	9
UK	0.820	0.815	0.841	0.896	0.843	12
Greece	0.877	0.805	0.704	0.725	0.778	19
Ireland	0.729	0.709	0.748	0.970	0.789	18
Italy	0.920	0.944	0.944	0.928	0.934	5
Japan	0.916	0.854	0.810	0.747	0.832	14
Netherlands	0.893	0.859	0.853	0.874	0.870	11
Norway	0.851	0.828	0.854	0.960	0.873	10
Portugal	0.948	0.930	0.898	0.841	0.904	7
Sweden	0.860	0.794	0.766	0.829	0.812	17
USA	0.977	0.964	0.974	0.983	0.975	1
Correlation with Malmquist DEA TE scores	0.956	0.901	0.791	0.860	0.894	

Figure A1 – SFA efficiency scores (1970, 1980, 1990, 2000)\ (with time trend)



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