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An analysis of EU and US productivity developments

(a total economy and industry level perspective)

by

Cécile Denis, Kieran McMorrow and Werner Röger
Directorate-General for Economic and Financial Affairs

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European Commission
Directorate-General for Economic and Financial Affairs
Publications
BU1 - -1/180
B - 1049 Brussels, Belgium

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AN ANALYSIS OF EU AND US PRODUCTIVITY DEVELOPMENTS

- A TOTAL ECONOMY AND INDUSTRY LEVEL PERSPECTIVE -

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INTRODUCTION

The 1990s have witnessed some important shifts in the underlying growth performances of the EU and US economies, with a significant gap opening up in terms of GDP, and more importantly, GDP per capita, growth rates. From a situation over the period 1980-1995 when EU and US living standards were growing at roughly an equivalent rate, the second half of the 1990s has seen the emergence of a significant growth gap in favour of the US. These EU-US differences are mirrored at the EU Member State level, with simple measures of dispersion indicating that individual country divergences relative to the average EU performance have grown by close to 50 per cent in the 1990s compared with the 1980s. These extra- and intra-EU divergences in economic fortunes have been the subject of intense research efforts in recent years,[1] with policy makers keen to decipher the reasons for their own respective outturns and to further refine the "magic formula" for boosting their long run growth performances.[2]

The present study will contribute to this ongoing debate regarding the sources of growth in general, with specific attention being devoted to productivity determinants given their importance in shaping medium to long run changes in living standards. Any analysis of growth however must be seen as an ongoing process, with economies in a constant process of "creative destruction" and with the emerging structural patterns difficult to disentangle from cyclical influences and policy adjustment lags. Consequently, while the main sources of growth over long periods of time are easily established, less success is possible in explaining more recent breaks in trends and in assessing whether these breaks are durable or not.[3] While the evidence of a break in the US is becoming more compelling, for the EU, short-run transitional factors severely complicates an assessment at this point in time.

While conscious of such uncertainties the present study examines the empirical evidence to ascertain whether some tentative conclusions can be drawn regarding recent trends and future prospects in terms of productivity. The study is particularly interested in examining the evidence as to whether a genuine break has occurred in the 1990s in the post World War II pattern of EU convergence to US living standards, with the previous rapid progress of the 1960s and 1970s, and the stabilisation of the 1980s, now giving way to a further pulling ahead by the US over the second half of the 1990s. A number of key questions are addressed, firstly, as mentioned above, whether this break in the convergence pattern is likely to be permanent or transitory; secondly, in terms of explaining recent EU and US trends in investment and technical progress, what was the role played by information and communication technologies

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1 See, amongst others, Scarpetta et al (2000); Bassanini et al (2002); Colecchia and Schreyer (2002); and OECD (2003).

2 See, for example, Temple (1999) and Ahn and Hemmings (2000) for surveys of the literature on economic growth.

3 As a general point, readers should be mindful that international comparisons of growth performances are particularly problematic at the present time due to a range of differences in the measurement techniques used in the national accounts of the respective countries. These differences include, for example, the use or non-use of new methodologies for constructing price deflators for the output of fast growing, high technology, industries or for measuring the output of a number of the service sectors. Some of these measurement issues have been overcome in the industry datasets used in section 2 of this paper.

(ICT)[4] and by increases in the employment content of growth; and finally whether any policy lessons need to be learnt by EU, and especially continental EU, Member States, from the growth pattern which has emerged in the US and a small number of individual EU countries.

In terms of content, following the present introduction, Sections 1 and 2 present the broad stylized facts concerning growth and productivity trends at the economy-wide and industry levels for the US and the 15 EU Member States.

- Section 1, drawing on official data sources and using mainly a growth accounting approach, concludes that the EU is now, for the first time in decades, on a trend productivity growth path which is lower than that of the US. This recent EU performance reflects a deterioration in terms of both investment and innovation and marks a serious downgrading relative to the situation in the early 1990s when annual EU labour productivity growth was averaging nearly 2 ½ per cent, compared with 1 per cent for the US. Since then EU labour productivity growth has declined by a full 1 % point to 1½ per cent, compared with an acceleration of ¾ of a % point in the US to 1¾ per cent.
- Section 2, exploiting two new, internationally comparable, industry datasets based on the OECD's STAN database, goes on to pinpoint the small number of industries which have been driving the EU-US productivity differentials over recent decades and in particular over the second half of the 1990s.[5] In terms of individual countries, it also highlights the negative contributions from a number of the larger Member States, most notably Italy, in driving the overall deterioration in the EU's performance. An interesting feature of this dataset is that, for all countries, it uses US hedonic deflators for deflating the relevant ICT industries and classifies computer software as investment expenditure (and not as a business expense which is the convention in a large number of EU countries). It therefore provides a more accurate, internationally comparable, estimate of the contribution of ICT to the growth performances of the respective countries. In this way it is possible to assess whether the decline in EU labour productivity growth could be due, as some commentators have suggested,[6] to mismeasurement of the growth impact of ICT.[7] Unfortunately, despite pointing to a positive contribution to growth from ICT in the EU, the industry level analysis still confirms the conclusion from the economy-wide analysis in Section 1, namely that the EU as a whole has experienced a significant decline in its trend productivity growth rate over the second half of the 1990s. The positive contribution of ICT to EU productivity growth over this period in time, both in terms of capital deepening and TFP growth, was

4 See, for example, Gordon (2000); Oliner and Sichel (2000); Council of Economic Advisors (2000); Pilat and Lee (2001); Baily and Lawrence (2001); and Daveri (2002).

5 The data used in section 2 draws heavily on a study prepared for the Enterprise Directorate-General by M. O'Mahony and B. van Ark (2003): "EU Productivity and Competitiveness: An Industry Perspective - Can Europe Resume the Catching-up Process?".

6 For example, Jorgenson (2003) asserts that ICT has made a much larger contribution to growth in the non-US G7 countries than that suggested by official statistics. In his recent paper, "Information Technology and the G7 economies", he compares the growth performances of the G7 economies, on the basis of an internationally comparable dataset (similar to the one used in section 2) which focusses on the impact of investment in IT equipment and software. See also the "Economist" article "Computing the gains", of 25 October 2003, which summarises the Jorgenson paper.

7 Regarding price measurement issues for ICT goods, see Colecchia and Schreyer (2002), and Pilat and Lee (2001).

firstly on a lower scale than that experienced in the US and secondly, all the EU gains on the ICT side were more than offset by a sharp deterioration in the performance of the non-ICT part of the EU economy, which it must be stressed still accounts for around 70 per cent of EU output. In contrast the non-ICT part of the US economy, whilst not showing the spectacular gains experienced on the ICT side, has nevertheless steadily improved its productivity performance over the second half of the 1990s (part of which may be linked to positive spillover effects from the heavy ICT investments which have taken place in those industries).

Section 3 of the paper tries to draw some policy lessons from the aggregate and industry analyses. In particular it addresses two key questions, firstly, why the EU as a whole has not gained as much as the US in terms of ICT; and secondly, why the non-ICT part of the US economy has been doing significantly better than the equivalent part of the EU economy in terms of both investment and innovation trends. The section tries to answer these questions by assessing the relative merits of the major hypotheses for explaining productivity growth over time[8]– i.e. the role played by the regulatory environment (product, labour and financial markets)[9]; by the degree of openness of economies[10]; by the efficiency of knowledge production (R&D and education)[11]; by the determinants of physical investment levels[12]; and finally by demographics.[13] An analytical framework is presented which combines standard growth regressions with recent developments in endogenous growth theory.

The final section of the paper demonstrates the usefulness of the analytical framework by presenting a number of historical analyses for the 1990's and a "Lisbon Strategy" simulation for the EU and the US for the period up to 2010. Regarding the historical period, an assessment is made of issues such as whether the second half of the 1990s was exceptional in terms of ICT technologies (with regard to both industry specialisation and the speed of diffusion) and whether the slowdown in EU productivity growth over this period simply reflected the temporary negative effects of a higher employment content of growth. The "Lisbon" simulation examines the impact on EU growth of implementing those policy reforms which have been established by the regression analysis (covering a total of 21 OECD countries) as being vital for sustaining labour productivity growth in the long run. In terms of policy conclusions, this last section stresses that international labour productivity differentials to a large extent reflect differences in the basic determinants affecting physical capital formation (especially the regulatory environment and the structure of financial markets) and the creation of knowledge (where R&D expenditures are closely linked with educational attainment levels, the openness of economies and market size considerations).

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8 See Barro (1990), Barro and Sala-i-Martin (1995), and Mendoza et al (1997).

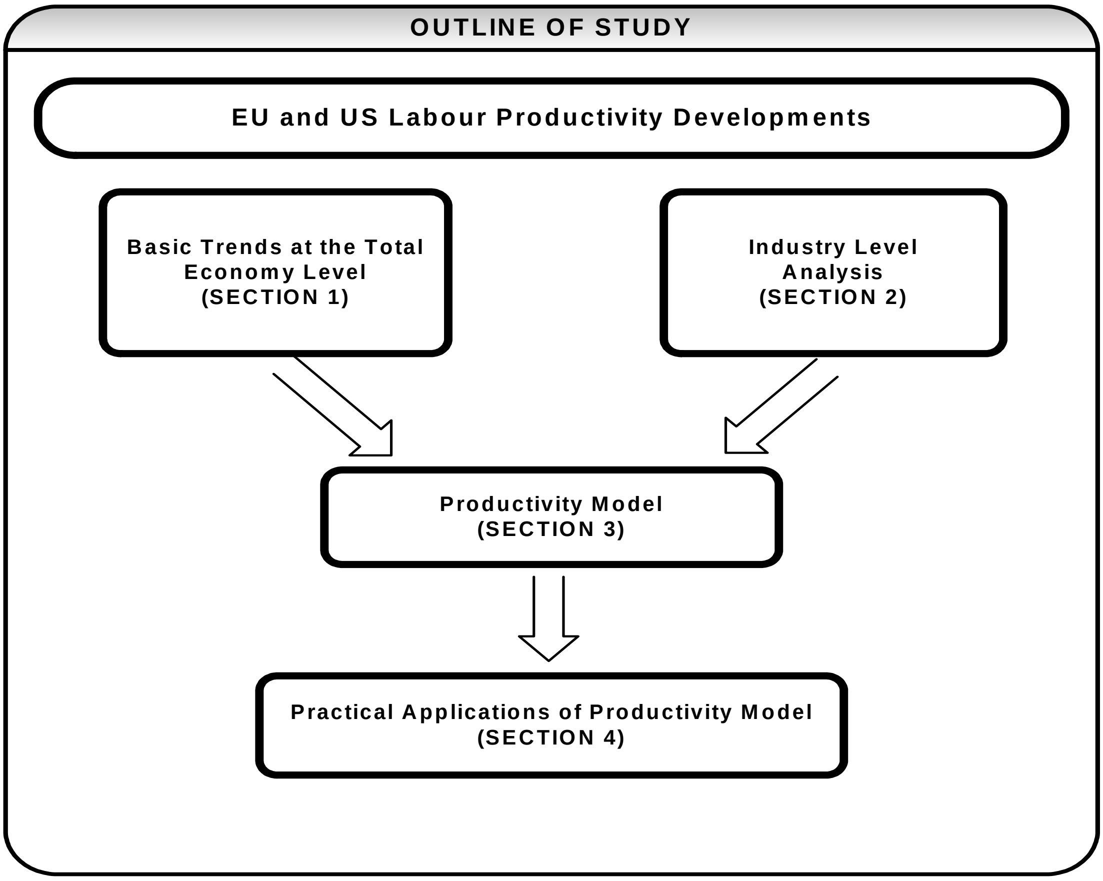
9 See Soskice (1997), Nickell et al. (1997), Eichengreen and Iversen (1999), Nickell and Layard (1999), Nicoletti et al (2001), Scarpetta and Tressel (2002), Scarpetta et al (2002), and IMF (2003).

10 See Sachs and Warner (1997), Alesina et al (1997), Frankel and Romer (1999), and Ben-David and Kimhi (2000).

11 See Lucas (1988), Romer (1990), Grossman and Helpman (1991), Coe and Helpman (1995), and Aghion and Howitt (1998).

12 See Arrow (1962), Romer (1986), De Long and Summers (1991), Mankiw, Romer and Weil (1992), and Levine (1997).

13 See EU Review (2002) and Jones (2002).


OUTLINE OF STUDY
EU and US Labour Productivity Developments
Basic Trends at the Total Economy Level (SECTION 1)
Industry Level Analysis (SECTION 2)
Productivity Model (SECTION 3)
Practical Applications of Productivity Model (SECTION 4)

SECTION 1 : BASIC TRENDS AT THE TOTAL ECONOMY LEVEL

The main objective of this section is to present the basic stylised facts concerning growth patterns in the EU and the US over the last 40 years. In order to get a more complete understanding of the underlying factors driving the aggregate performance and to set the stage for the industry analysis in Section 2, the results of some basic growth accounting analyses are described.[14] At the outset it is important to distinguish between the different measures of growth performance which will be used. In addition to actual GDP, this section will make reference to two basic indicators of the relative performance of the different economies, namely GDP per capita (which simply adjusts for changes in population and represents the widest possible measure of a country's living standards) and GDP per hour worked (which adjusts the GDP per capita measure for changes in employment and hours worked and constitutes the primary indicator used in this study to compare the underlying productivity performance of the various countries).

GDP AND GDP PER CAPITA TRENDS 1960-2002 : In terms of GDP and GDP per capita, Table 1 and Graph 1[15] provide an overview of the EU and US performances over the last four decades. At the outset, the EU enjoyed a period of strong convergence towards US standards of living, with an average annual growth rate of GDP per capita of 3 ¼ per cent in the 1960s and 1970s, which was ¾ of a percentage point higher than that of the US. This performance formed part of a continuous post World War II process of EU income convergence, with GDP per capita levels rising from less than 50 per cent of the US level in the 1950s to over 70 per cent by the early 1980s. Over the subsequent period to 1995, the convergence process in effect stalled, with GDP per capita growth rates in the EU only managing to grow at rates similar to those of the US, with both areas growing by about 2-2¼ per cent, on an annual average basis, in the 1980s and by 1-1¼ per cent in the first half of the 1990s. While a stalling of the process was an obvious concern to EU policy makers over this period, especially given the relatively low level at which the convergence process had halted, a more worrying trend emerged over the second half of the 1990s, with US living standards clearly moving onto a higher growth path relative to that of the EU, with the result that the convergence process went into reverse. This trend break which, on the basis of standard statistical techniques, can be traced to the year 1995, witnessed the US growing at nearly ½ a percentage point higher, in GDP per capita terms, compared with the EU over the period 1996-2000, with Graph 1 also indicating that this trend break has largely persisted over the period 2000-02.

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[14] See, in particular, Barro (1991); Sala-i-Martin (1997); Temple (1999); Durlauf and Quah (1999); and Levine and Renelt (1992).

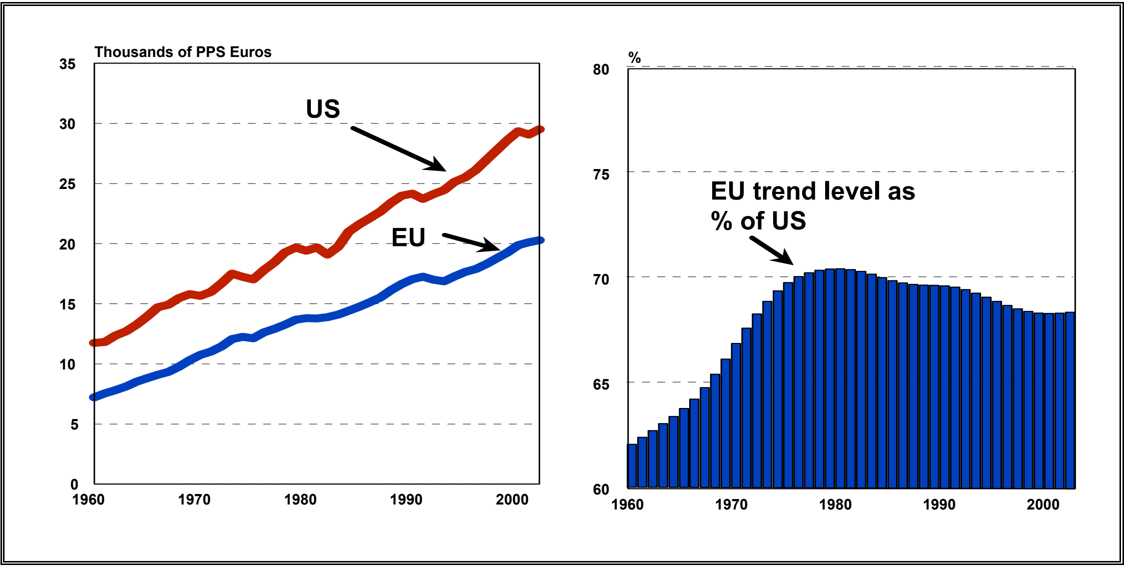
[15] Given the problem of deciphering underlying patterns in the data series, the present paper makes recourse to trend series which have been calculated using a Hodrick Prescott statistical filter. These trend series are mainly used in the graphs, with the actual data series (normally period averages) being given in the Tables.

TABLE 1 : GDP, POPULATION AND GDP PER CAPITA TRENDS 1981-2000 : ANNUAL AVERAGE % CHANGES FOR THE US AND EU15

	EU15	US
1961-1980		
- GDP	3.9	3.7
- POPULATION	0.6	1.2
- GDP PER CAPITA	3.3	2.5
1981-1990		
- GDP	2.4	3.2
- POPULATION	0.3	1.0
- GDP PER CAPITA	2.1	2.2
1991-1995		
- GDP	1.6	2.4
- POPULATION	0.4	1.3
- GDP PER CAPITA	1.2	1.1
1996-2000		
- GDP	2.7	4.1
- POPULATION	0.3	1.3
- GDP PER CAPITA	2.4	2.8

SOURCE : AMECO

GRAPH 1 : GDP PER CAPITA : EU + US (1960-2002)



SOURCE : AMECO

1.1 STANDARD GROWTH ACCOUNTING ANALYSIS[16] **:** Theories about what exactly determines economic growth at a high and sustainable rate have been discussed at length since the 1950s and are not exempted from controversy. However, in recent years, the neo-classical growth model, initially proposed by R. Solow (1956) has been increasingly used in "growth accounting" analyses which decompose real GDP growth into its main determinants. The objective is to try to measure the proportion of

[16] In this section GDP is decomposed into employment (adjusted for hours worked) and hourly labour productivity. While labour productivity per hour worked is theoretically the more appealing concept (see OGWG report to EPC), nevertheless a large number of productivity reports still use a breakdown based on labour productivity per person employed. For comparative purposes therefore Annex 5 includes the equivalent data and trends based on labour productivity per person employed.

the overall growth rate of GDP which can be attributed to the accumulation of factors of production (i.e. to the growth of employment and fixed capital) and the part which can be attributed to independent technical progress or total factor productivity (i.e. the so-called *Solow growth residual*). Indeed, such a framework captures the essential characteristics of the US, EU and individual EU Member States performances and is useful in pinpointing the broad sources of the recent changes in growth. In fact, as Graph 2 and Tables 2 and 3 show, the engines of growth have changed significantly in the course of the 1990s, with marked differences not only between the EU and the US but also within the EU itself.

TABLE 2 : DECOMPOSITION OF US AND EU15 AVERAGE GDP GROWTH RATES

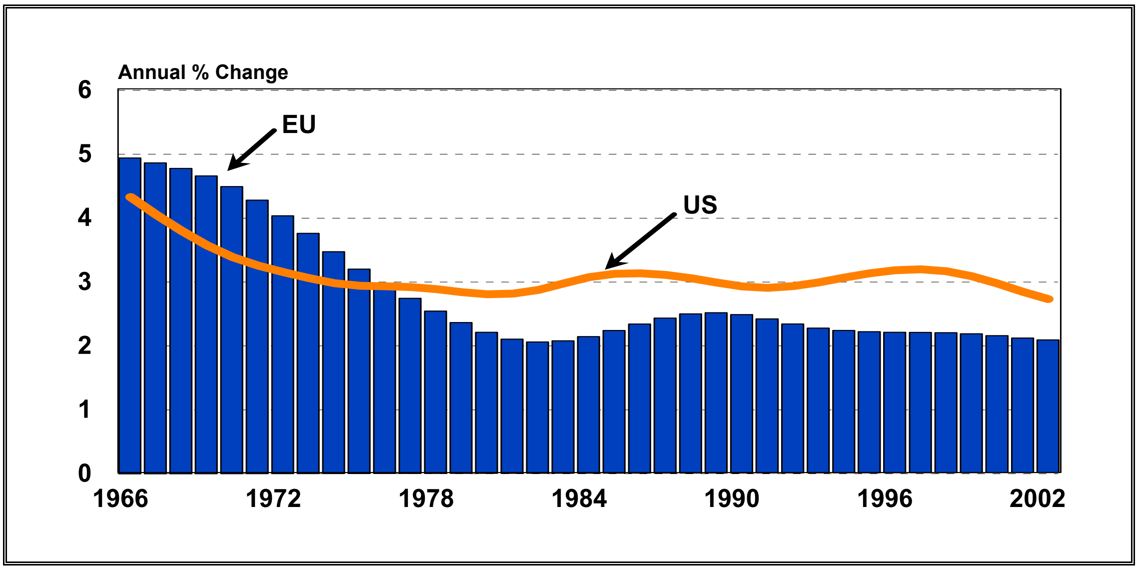
	1966-1970	1971-1980	1981-1990	1991-1995	1996-2000	1996-2002
US						
GDP	**3.4**	**3.2**	**3.1**	**2.4**	**4.0**	**3.2**
LABOUR	**1.6**	**1.6**	**1.7**	**1.3**	**2.4**	**1.5**
(HOURS WORKED)	*(-0.8)*	*(-0.5)*	*(-0.1)*	*(0.2)*	*(0.4)*	*(0.2)*
(EMPLOYMENT)	*(2.4)*	*(2.1)*	*(1.8)*	*(1.1)*	*(2.0)*	*(1.3)*
LABOUR PRODUCTIVITY (HOURLY)	**1.8**	**1.6**	**1.4**	**1.0**	**1.6**	**1.7**
(TFP)	*(1.2)*	*(1.1)*	*(1.1)*	*(0.8)*	*(1.2)*	*(1.1)*
(CAPITAL DEEPENING)	*(0.6)*	*(0.5)*	*(0.3)*	*(0.2)*	*(0.4)*	*(0.6)*
EU15						
GDP	**5.0**	**3.2**	**2.4**	**1.7**	**2.6**	**2.2**
LABOUR	**-0.7**	**-0.6**	**0.1**	**-0.7**	**1.1**	**0.9**
(HOURS WORKED)	*(-0.9)*	*(-0.9)*	*(-0.6)*	*(-0.5)*	*(-0.3)*	*(-0.3)*
(EMPLOYMENT)	*(0.2)*	*(0.3)*	*(0.7)*	*(-0.2)*	*(1.4)*	*(1.2)*
LABOUR PRODUCTIVITY (HOURLY)	**5.6**	**3.8**	**2.2**	**2.4**	**1.6**	**1.4**
(TFP)	*(3.8)*	*(2.4)*	*(1.5)*	*(1.4)*	*(1.2)*	*(0.9)*
(CAPITAL DEEPENING)	*(1.8)*	*(1.4)*	*(0.7)*	*(1.0)*	*(0.4)*	*(0.5)*

SOURCE : ALL DATA ARE FROM AMECO, EXCEPT FOR THE HOURS WORKED SERIES WHICH IS TAKEN FROM THE GRONINGEN GROWTH AND DEVELOPMENT CENTRE (GGDC) (NOTE : FOR US EMPLOYMENT NUMBERS AMECO USES DATA FOR FULL TIME EQUIVALENTS FROM THE BUREAU OF ECONOMIC ANALYSIS (BEA). THESE FIGURES ARE CLOSE TO THE PERSONS EMPLOYED SERIES FROM THE BUREAU OF LABOUR STATISTICS (BLS)

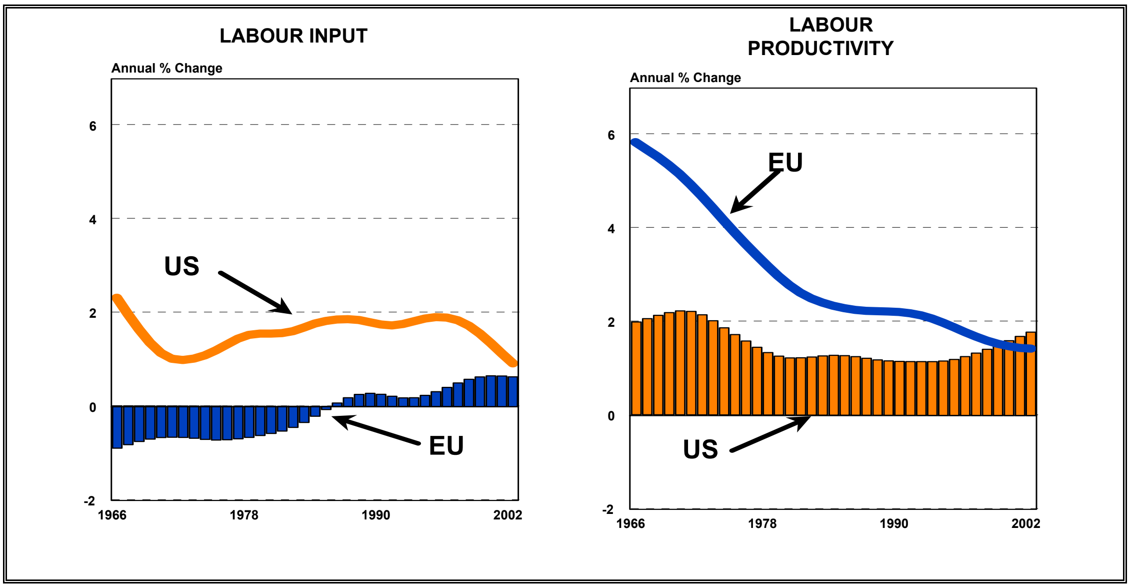
DECOMPOSITION OF EU AND US GROWTH PERFORMANCES INTO THE CONTRIBUTIONS FROM LABOUR AND LABOUR PRODUCTIVITY : While the post 1995 experience is the time period of most intense interest to policy makers, for a more complete understanding Table 2 and Graph 2 show data from the mid 1960s in order to put the most recent years into their proper historical context. What is striking from the data presented is the fact that the long established US and EU trends for both labour utilisation and labour productivity have each been altered dramatically over the second half of the 1990s.

GRAPH 2 : TREND GROWTH AND ITS LABOUR AND LABOUR PRODUCTIVITY COMPONENTS (1966-2002)

A. TREND GDP GROWTH



B. TREND LABOUR INPUT + TREND HOURLY LABOUR PRODUCTIVITY



- **LABOUR UTILISATION** : The second half of the 1990s has witnessed a reversal of the US trend of a strong contribution to growth from labour which has been a feature of the US performance since the 1960s. From a situation as recently as the mid 1990s when over 60 per cent of the US overall trend growth rate was emanating from labour, in 2002 only 1/3 was attributable to this factor of production. This however must be seen in the context of the recent period of "jobless growth" in the US and with the fact that the US employment rate is at around 72 per cent compared with 64 per cent in the EU. For the EU the turnaround in its performance has been significant, with its origins around the start of the 1990s but with the trend accelerating strongly over the second half of the decade. In terms of trend growth, the EU is now in a situation where labour is contributing almost as much as in the US which compares with the situation in the mid 1990s when labour's contribution to growth in the EU was only one-tenth of that of the US.[17]

- **Labour productivity** : Unfortunately, for the EU the strong recovery which took place in terms of the utilisation of the factor of production labour was accompanied by a correspondingly negative trend which emerged for labour productivity. In addition, for the first time in decades the EU has now a rate of productivity growth which is lower than that of the US. Whilst there has been a reversal in the extent of the employment content of US growth, nevertheless the US is still in the relatively unique position internationally of being able to combine both a high employment rate and a strong productivity performance. In terms of employment creation, the US has since the early 1970s consistently outperformed the EU, with the present employment rate 8 percentage points higher in the US. Indeed until recently the EU was able to maintain its relatively high standards of living compared to the US due to its superior productivity performance. If this productivity route to prosperity is now in doubt, the EU is facing a difficult future since the present recovery in labour utilisation rates is, by definition, a temporary phenomenon. Furthermore, looking towards the medium term, it is only a matter of a few years before the negative effects of ageing populations really start to impact on the potential growth rates of a large number of EU Member States.

1.2 : Further breakdown of labour utilisation and labour productivity : An inverse relationship between the contributions to growth from labour utilisation and labour productivity has been very evident for the EU, and to a lesser extent the US, over the second half of the 1990s. This suggests that a further breakdown of both growth components is needed in order to decipher the underlying determinants.

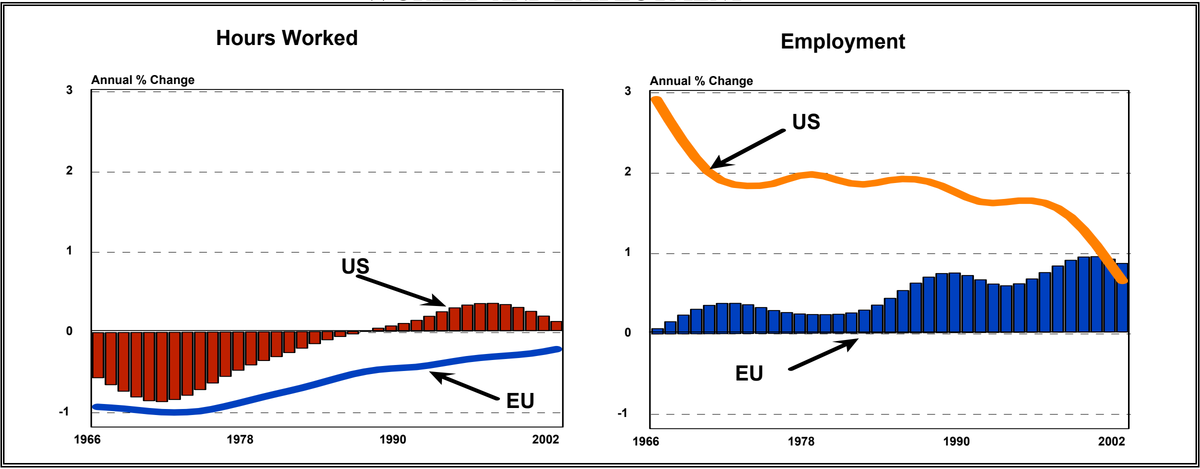
Labour utilisation decomposition into hours worked and employment : The breakdown of the individual roles played by hours worked and employment in determining the overall labour input trend is shown in Graph 3:

- For the EU, the marked upward trend in the overall contribution from labour is driven by employment growth rather than by an increase in hours worked. While the fall in average hours worked is now substantially less than in previous decades, nevertheless the average time spent at work continues to fall in the EU.
- The situation in the US is very different to that in the EU, with the average hours worked per worker starting to rise in the late 1980s and with this trend persisting up until 2002. At the same time the US employment creation performance is on a downward trend, driven by the jobless growth pattern of

[17] Factor input proportions in the EU have altered in a labour-friendly way over recent years. This pattern reflects the effects of the real wage moderation which took place over the period as well as the support provided by some structural labour market reform efforts. Employment growth has also been accompanied by a marked decline in capital/labour substitution, which is suggestive that EU employment creation has been occurring in the relatively less capital intensive service industries (see Section 2).

recent years, with the EU now in the historically unusual position of having an employment growth rate which compares favourably with that of the US.

GRAPH 3 : BREAKDOWN OF TREND LABOUR INPUT INTO HOURS WORKED AND EMPLOYMENT



LABOUR PRODUCTIVITY DECOMPOSITION INTO CAPITAL DEEPENING AND TOTAL FACTOR PRODUCTIVITY (TFP):

- **CAPITAL DEEPENING**: The growth process in industrialised countries is characterised by a process of continuous capital deepening, which is crucial for productivity and, consequently, income growth. In terms of capital deepening trends for the EU, following a long period stretching over 3 decades when the growth rate of the capital/labour ratio in the EU was at significantly higher levels than in the US, a growing gap has emerged over the second half of the 1990s in favour of the US (Graph 4).[18] While it can be questioned whether the US trend is a sustainable one given the "bubble-like" features evident over this period, what is more puzzling is the poor EU performance, with meagre/falling rates of investment despite rising profitability and declining costs of capital. The significant fall in EU capital deepening reflects not only a halt to unfavourable capital-for-labour substitution trends but also other, hopefully temporary, phenomena such as the negative effects emanating from the collapse in equity markets. While this latter, generally more sanguine, view of recent investment patterns will hopefully turn out to be the reality, other more worrying structural factors may also be at play, such as locational investment considerations[19] and adverse demographic trends.[20]

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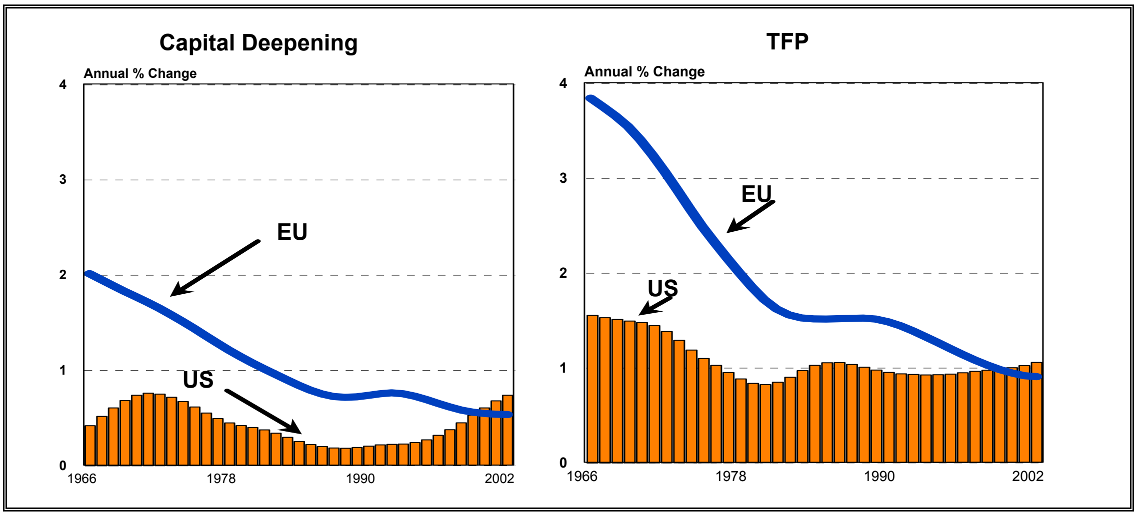
[18] The smaller capital-deepening component in EU labour productivity growth over the period 1996-2002 partly reflects the reversal of the unfavourable capital-for-labour substitution of earlier periods. In addition, a slowdown in the rate of capital substitution at a macroeconomic level does not of course automatically imply that firms are switching to more labour intensive forms of production. In fact in the case of the EU, the slower increase in capital/labour substitution to a large extent reflects an increase in employment in those industries which are more employment intensive, such as certain service industries. These employment increases in the generally non-capital intensive, more traditional, service industries can also explain a proportion of the apparent fall in EU labour productivity over the same period since these service industries have in the past been characterised by comparatively low productivity growth rates. However, while such employment patterns may be temporarily negative for productivity growth, they are nevertheless positive for GDP per capita.

[19] Various factors influence the investment to GDP ratio, with current and expected profitability and capital costs being the major driving forces. These factors are themselves determined by demand conditions, the availability of (skilled) workers, tax levels, expected rates of innovation etc. With improved international communications

- **TFP**: Finally, and from an EU perspective potentially the most concerning aspect of the analysis so far, is the evolution of the TFP trend. For the first time in a generation the US has a trend rate of TFP growth which is higher than that of the EU (Graph 4). This significant turning point results from a combination of a sharp downturn in the EU trend and an acceleration for the US. Given the crucial importance of the evolution of TFP to long-run growth perspectives, this recent reversal in TFP fortunes for the EU bodes ominously for its future prosperity.

GRAPH 4 : BREAKDOWN OF TREND LABOUR PRODUCTIVITY INTO CAPITAL DEEPENING AND TFP



INTRA-EU DIFFERENCES IN OVERALL GROWTH PERFORMANCES : Table 3 shows the large differences in overall GDP growth performances amongst the EU's 15 Member States.

- There are 3 broad groups of countries which can be delineated in terms of their overall growth performance since the early 1990s. The first group, comprising two of the largest Member States, namely Germany and Italy, stand out for their persistently poor outturns relative to the EU average throughout the 1990s. They collectively represent around 40 per cent of total EU15 output, thus their performance constituted a significant drag on the

and reductions in transport costs, international locational choices for investors have increased and investment is undertaken in those regions which offer the most favourable (expected) ratio between capital productivity and capital cost. The US investment boom in the 1990's offers a good example of how investment opportunities in one country can attract substantial foreign direct investment. Falling ICT investment prices and high rates of innovation, as expressed by accelerating productivity and TFP growth rates, created an exceptionally positive investment climate in the US in the 1990's which in turn led to a strong increase in US investment. These international investment trends were unfortunately not without repercussions for domestic EU investment rates.

[20] Demographic trends in the EU are also likely to affect the investment rate negatively. With an increasing dependency ratio, it is likely that domestic investment as a share of GDP declines, or remains constant in a situation of falling interest rates. There are several reasons for this to occur. First of all, a declining population requires less net investment in order to keep the capital/labour ratio constant. Secondly, a declining domestic labour force reduces the return prospects from domestic investment as well as the risk associated with over-investment. In a world with free capital mobility this effect is likely to be even stronger since firms can avoid pressure on domestic returns by investing abroad. It is also interesting to note that the falling trend in the investment rate is likely to be accompanied by a secular decline in interest rates, with falling borrowing costs in this case reflecting the lower returns from capital investment (due to expected decreases in labour supply and domestic demand reductions) rather than acting as a stimulus to undertake additional investment.

aggregate EU position. A second group, made up of Belgium, Denmark, France, Austria and the UK, grew close to the EU average. The final group of mainly small countries (Greece, Spain, Ireland, the Netherlands, Portugal, Finland and Sweden), managed to grow at a significantly faster pace than the EU as a whole, especially over the second half of the 1990s. For example, for the period 1996-2002, this latter group of EU countries grew on average by 3½ per cent, compared with 3¼ for the US and 2¼ for the EU15 as a whole.

- For Greece, Spain, Ireland and Portugal, the trends for the 1990s are in part influenced by an element of catching-up. Each of these 4 countries had standards of living in the early 1990s which were significantly below that of the EU as a whole, with Greece and Portugal at around 70 per cent of the EU average and with Spain and Ireland at close to 80 percent.
- While a large number of the EU countries shared in the general EU upturn in the contribution to growth from labour, there were notably poor performances from countries such as Belgium, Germany, Greece and Austria. With regard to the contribution from labour productivity, the differences across countries were quite marked. From a contribution to average growth of only 0.8/1.0 per cent in Italy/Spain respectively, at the other end of the spectrum labour productivity added nearly 5½ percentage points to the aggregate Irish performance. Despite the wide variation in performances, a large number of the smaller EU countries, namely Belgium, Greece, Ireland, Austria, Portugal, Finland and Sweden had labour productivity performances which were higher than both the EU and US averages.
- Finally, if one excludes the catching-up countries which were coming from relatively low starting positions in the early 1990s, the most striking labour productivity performances came from Belgium, Austria, Finland and Sweden. However, amongst the latter, it is important to distinguish those countries which were unable to combine high rates of both labour utilisation and labour productivity (namely Belgium and Austria) and those which could (namely Finland and to a lesser extent Sweden). In addition with regard to Greece, Ireland and Portugal, whilst Ireland performed spectacularly well in relation to both employment and productivity growth rates, Greece and Portugal were only average in terms of their labour utilisation rates.

TABLE 3 : DECOMPOSITION OF AVERAGE GDP GROWTH RATES				
	1981-1990	**1991-1995**	**1996-2000**	**1996-2002**
BELGIUM				
GDP	2.0	1.6	2.7	2.1
LABOUR INPUT IN HOURS	-0.5	-0.1	0.1	0.5
LABOUR PRODUCTIVITY PER HOUR	2.5	1.7	2.6	1.6
DENMARK				
GDP	1.6	2.0	2.7	2.3
LABOUR INPUT IN HOURS	-0.3	0.1	1.2	0.8
LABOUR PRODUCTIVITY PER HOUR	1.8	1.9	1.4	1.6
GERMANY				
GDP	2.3	1.6	1.8	1.4
LABOUR INPUT IN HOURS	0.4	0.9	0.0	-0.2
LABOUR PRODUCTIVITY PER HOUR	1.9	0.7	1.8	1.6
GREECE				
GDP	0.7	1.2	3.4	3.5
LABOUR INPUT IN HOURS	0.6	0.7	0.6	0.4
LABOUR PRODUCTIVITY PER HOUR	0.1	0.6	2.8	3.1
SPAIN				
GDP	2.9	1.5	3.8	3.3
LABOUR INPUT IN HOURS	0.1	-0.4	2.9	2.6
LABOUR PRODUCTIVITY PER HOUR	2.8	1.9	0.8	0.8
FRANCE				
GDP	2.4	1.1	2.6	2.4
LABOUR INPUT IN HOURS	-0.6	-0.4	1.2	0.9
LABOUR PRODUCTIVITY PER HOUR	3.0	1.5	1.4	1.5
IRELAND				
GDP	3.5	4.6	9.3	8.3
LABOUR INPUT IN HOURS	-0.7	1.0	3.9	3.2
LABOUR PRODUCTIVITY PER HOUR	4.2	3.6	5.4	5.1
ITALY				
GDP	2.2	1.3	1.9	1.7
LABOUR INPUT IN HOURS	0.3	-1.0	0.9	1.0
LABOUR PRODUCTIVITY PER HOUR	2.0	2.3	1.0	0.7
NETHERLANDS				
GDP	2.2	2.1	3.6	2.8
LABOUR INPUT IN HOURS	0.0	0.6	2.4	1.8
LABOUR PRODUCTIVITY PER HOUR	2.2	1.5	1.2	1.0
AUSTRIA				
GDP	2.4	2.0	2.7	2.2
LABOUR INPUT IN HOURS	-0.2	-1.3	0.1	0.1
LABOUR PRODUCTIVITY PER HOUR	2.6	3.4	2.7	2.1
PORTUGAL				
GDP	3.2	1.7	3.8	3.0
LABOUR INPUT IN HOURS	-0.1	-1.2	0.7	0.7
LABOUR PRODUCTIVITY PER HOUR	3.3	2.9	3.1	2.3
FINLAND				
GDP	3.1	-0.6	4.7	3.7
LABOUR INPUT IN HOURS	0.0	-3.6	1.7	1.1
LABOUR PRODUCTIVITY PER HOUR	3.0	3.0	3.1	2.6
SWEDEN				
GDP	2.2	1.3	3.2	2.7
LABOUR INPUT IN HOURS	1.0	-1.3	0.9	0.6
LABOUR PRODUCTIVITY PER HOUR	1.1	2.5	2.3	2.1
UK				
GDP	2.6	1.7	2.9	2.6
LABOUR INPUT IN HOURS	0.4	-1.4	1.2	1.0
LABOUR PRODUCTIVITY PER HOUR	2.3	3.1	1.7	1.6

SOURCE : AMECO, GGDC, OECD AND OWN CALCULATIONS.

MAIN POINTS TO BE RETAINED FROM SECTION 1 : The EU15 as a whole and the US have experienced significant breaks in the 1990s in terms of employment (measured in hours worked) and productivity. The EU has experienced sharp increases in the contribution of labour to growth and equally sharp reductions in the contribution from productivity, with the latter reflecting the dual impact of lower capital deepening and TFP growth. The opposite pattern emerged in the US.

- In terms of labour input (i.e. employment * hours worked), following decades of negative contributions to growth, the 1990s, and especially the second half, has seen the EU display a strong recovery in its contribution from labour. At the same time, the opposite trend was emerging in the US, although adequate account needs to be taken of the effect on these employment patterns of the downturn in US growth rates since 2000. Bearing in mind this latter qualification, the EU now has a labour contribution to growth which is very similar to that of the US.
- In terms of productivity, again as with labour utilisation rates, the reversal of past trends in the 1990s in both the EU and the US is remarkable. For example, for the first time in the post-World War II period, the EU is now on a trend productivity growth path which is lower than that of the US. Since the mid-1990s, the EU has been incapable of arresting the long-run decline in its productivity performance whereas the US has enjoyed a notable recovery in its secular trend, with productivity per hour growth rates in the US starting to recover to the rates of growth last experienced in the 1960s. Thus the EU is facing a future of increasing divergence, as opposed to convergence, with respect to US living standards.
- At the individual EU Member State level, a much more nuanced picture emerges. In terms of labour productivity, 7 of the EU's smaller Member States had performances which were not only well above the EU average but were also higher than that of the US. However, only 3 of the 7, namely Ireland, Finland and Sweden, were capable of combining both strong productivity growth and high labour utilisation rates.

Given the large divergences at both the EU/US and the intra-EU levels, it is important to dig a little deeper to try to ascertain whether these divergences in labour productivity performances can be explained by firstly looking at differences in the industrial structure of economies (Section 2) or secondly, at a deeper level, by an analysis of the underlying determinants of productivity growth (Section 3).

Total Economy Analysis

EU's STANDARD OF LIVING IS NOW LESS THAN 70% OF US LEVELS AND FALLING

EU's SUCCESS ON EMPLOYMENT FRONT MORE THAN OFFSET BY DETERIORATION IN LABOUR PRODUCTIVITY

BOTH COMPONENTS OF EU LABOUR PRODUCTIVITY (CAPITAL DEEPENING & TFP) HAVE DETERIORATED SHARPLY OVER THE SECOND HALF OF 1990's

US LABOUR PRODUCTIVITY IS ON A CLEAR UPWARD TREND WITH A SHARP IMPROVEMENT IN CAPITAL DEEPENING & A MODEST ACCELERATION IN TFP

2. INDUSTRY LEVEL ANALYSIS[21]

The purpose of the present section is to look beneath the economy-wide trends to assess the broad structural changes which have occurred at the industry level in the EU and US economies over the period since 1980. This analysis is needed to pinpoint the specific industries which are driving the EU-US productivity differentials. In particular the following key issues are addressed:

- Firstly, do divergences in labour productivity growth trends between the EU and the US emanate from either structural employment shifts in the respective economies from low to high productivity industries or do they simply reflect higher productivity growth rates in specific industries (Section 2.1)?
- Secondly, are differences emanating from specific industries in the manufacturing or services sectors or are the EU-US productivity differentials more pervasive? In this regard, a key related question is whether the US economy is benefiting to a greater extent than the EU from the productivity gains associated with innovation in general and specifically from the adoption of IC technologies (Sections 2.2 and 2.3).

INDUSTRY DATASETS : To address these issues this section draws on two separate, internationally comparable, DG Enterprise/GGDC[22] industry datasets which cover the period 1979-2001 and provide different levels of detail regarding the industrial structures of the EU and US economies:

- The "Industry Labour Productivity Database", which is used for the shift share analysis in section 2.1 and for the wider analysis in 2.2, includes a detailed breakdown of the total output of the US and all of the EU's Member States at the greatest level of disaggregation which is presently possible i.e. a 56 industry decomposition. This dataset, which is an expanded version of the OECD's STructural ANalysis (STAN) database, contains a large number of variables for the 56 industries, including numbers employed and hours worked (which can both be combined to give overall labour utilisation rates) and most importantly, for the present study, labour productivity per hour figures.
- The "Industry Growth Accounting Database", which is described in Section 2.3, and which permits a growth accounting analysis at the industry level similar to that given in Section 1 for the total economy. Due to space restrictions, Section 2.3 avoids any decomposition of labour utilization rates at the industry level into employment and hours worked and instead focuses solely on a decomposition of the hourly labour productivity trends described in Sub-section 2.2 into the contributions from capital deepening and TFP. In addition since the capital stock series at the industry level is further disaggregated into 6 different asset types, 3 of which are ICT-related assets, it is possible to calculate the contribution of the ICT and non-ICT parts of the EU and US economies to overall labour productivity growth. Due to data constraints, however, this second database is only available for the US and 4

[21] Annex 2 gives a short technical description of the basic methodologies applied in this section as well as providing information on other issues such as the handling of the data series used for the analysis.

[22] GGDC (Groningen Growth and Development Centre).

of the 15 EU Member States (i.e. France, Germany, the Netherlands and the UK). It also only disaggregates total output into 26 industries compared with the 56 industries in the "Industry Labour Productivity Database".

Both these datasets have a number of important advantages compared with the one used for the economy-wide analysis in Section 1. Firstly, using shift-share analysis and other techniques, these datasets can be used to give a highly disaggregated picture of industry trends. Secondly, they overcome one of the main criticisms levelled at carrying out international comparisons of productivity performances on the basis of official national accounts data, namely that, outside the US and Canada, most other statistical offices underestimate the role played by IC technologies in recent output and productivity growth trends. Two issues in particular which may lead to an underestimation of the role played by IT are firstly, the fact that software is often excluded from investment expenditure in the national accounts (i.e. it is classified as a business expense in most EU countries and therefore excluded from final output) and secondly, the well documented problem of hedonic deflators. As stressed in the introduction, both these concerns have been addressed in the construction of the GGDC datasets, with US ICT industry deflators being applied to the equivalent industries in all countries and with ICT investment spending being defined in all countries as including software spending (software is in fact one of 3 ICT related assets, the others being computing and communications equipment).[23]

2.1 SHIFT SHARE ANALYSIS

Aggregate productivity is equal to a weighted average of underlying industry productivity, with the weights being determined by each industry's share in overall employment.[24] Consequently, the change in an economy's productivity growth rate over a specific period of time is determined not only by the productivity growth rate of the individual industries but also by changes in the industry composition of employment. Aggregate changes in productivity are due to either the former, within-industry, effect or they reflect the latter phenomenon of structural shifts in resources between contracting / expanding industries. Shift-share analysis (see Annex 2 for a technical overview of this approach) is the most commonly used algebraic method for carrying out such a decomposition, with aggregate productivity growth capable of being broken down into the sum of the following 3 effects:

- **1. INTRA-INDUSTRY PRODUCTIVITY GROWTH EFFECT :** equal to the sum of productivity growth in the individual industries in the absence of structural change (i.e. on the assumption that there are no changes in the employment shares of specific industries). This "growth" effect is the natural starting point for interpreting the shift-share decomposition since it provides the hourly labour productivity growth rate in a situation where the structure of the economy remains fixed. For example, if the "intra-industry growth" effect is

[23] This ICT investment breakdown applies only to the "Industry Growth Accounting Database".

[24] The value added of all the different industries are aggregated using Törnqvist indices (based on average nominal value added shares) and, in combination with the employment levels (adjusted for hours worked), the hourly labour productivity estimates are calculated accordingly. For calculating the contribution of an individual industry to aggregate labour productivity growth, the share of the specific industry in total value added (in nominal terms) is used as weights (see Annex 2 for additional details).

smaller than aggregate productivity growth then the expectation would be that industries with higher productivity growth have increased their share in total employment.

- **2. "STRUCTURAL" CHANGE EFFECT :** equal to the contribution to overall productivity growth of a shift of employment resources from low to high productivity industries (i.e. the shift effect). When the structural change effect is both positive and increasing over time, this is indicative of a healthy process of restructuring occurring in an economy. Boosting overall growth in this manner is also suggestive that a favourable up-skilling process is occurring in terms of employment.

- **3. INTERACTION EFFECT :** This is a residual term which captures the dynamic component of structural change.[25] It attempts to measure correlations in an economy between productivity and employment changes, with positive/negative efficiency gains interacting with the expansion/contraction[26] of specific industries. The interaction term is positive when the first two effects (i.e. the intra-industry plus the "structural" effects) are complementary (i.e. productivity growth is positive in expanding industries and negative in contracting industries). The interaction effect is, in turn, negative when the first two effects are substitutes (i.e. productivity growth is positive in contracting industries - a good example being the agriculture sector - and negative in expanding industries).

Based on this decomposition one can ask why the EU and the US economies differ in terms of their labour productivity growth rates, with a combination of three explanations being possible: firstly, differences in the average productivity growth rates of individual industries; secondly, differences in the reallocation of employment resources between industries; and finally, the initial starting conditions in both countries may not be uniform (i.e. a level effect which encapsulates the potential for catching-up).

The main points to be retained from the analysis are as follows (see Graphs 5a to 5c):

- Firstly, for all three periods the intra-industry growth effect dominates the outcome, accounting for between 85-100 per cent of aggregate productivity growth in the case of the EU and from 105-130 per cent of the change in the US.[27]

[25] The sum of the structural change and interaction effects is sometimes used as a measure of the overall reallocation process in an economy. Nevertheless, this study takes the view that some additional insights can be derived from examining the shift and interaction effects separately. For example, some countries might be able to increase their employment share in fast growing productivity industries whilst in other countries fast productivity growth could be the result of low productivity firms exiting the market.

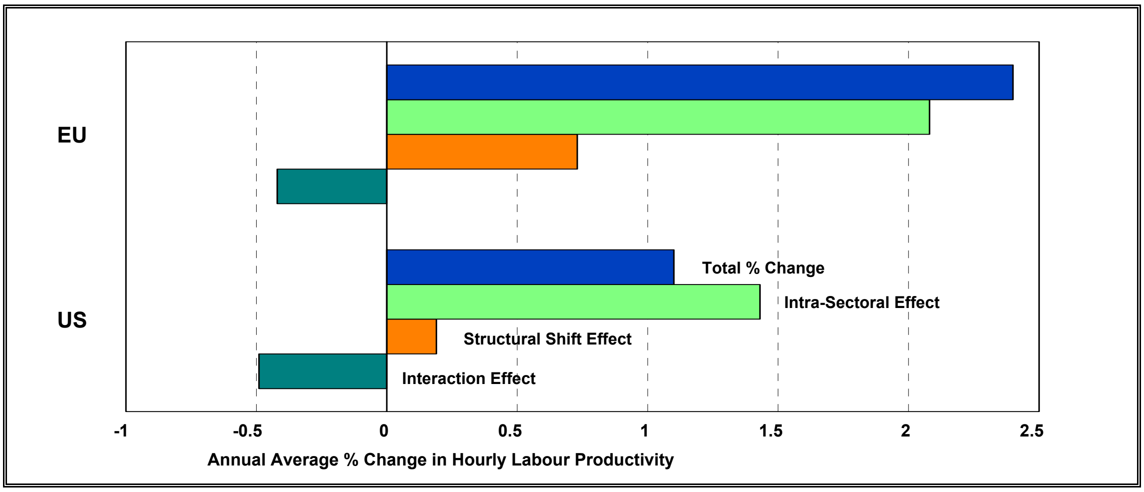
[26] Expanding or contracting in terms of employment or, in the case of the present analysis, employment as measured in terms of hours worked.

[27] Results from a similar analysis by the OECD (OECD 2003) for the non-farm business sector (i.e. the manufacturing plus private services sectors) confirms the importance of the intra-industry effect. For the services sector, while the net shift effect made an important contribution for a period of time in certain countries, due to the increased size of business services, this effect faded out in the 1980's. For the manufacturing sector, employment shifts across industries did not play a significant role in productivity trends (see also Van Ark (1996) and Employment in Europe (2003).

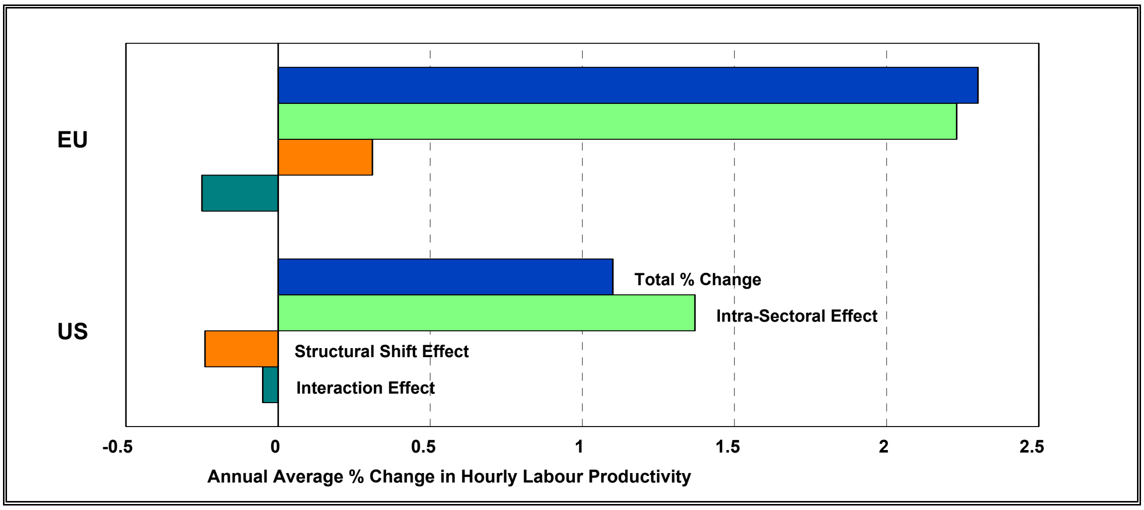
- Secondly, the shift effect has been positive over the last 2 decades for the EU, compared with a consistent negative pattern for the US in the 1990's. Thus the EU is still gaining from a shift of employment from low productivity industries such as agriculture to higher productivity jobs in manufacturing or services. For the US, however, this process would appear to be completed with negative contributions from the shift term suggesting that workers are on average moving into lower productivity service industries. In overall terms, over the period 1980-2000, the EU has been able to use changes in the industry composition of employment as a mechanism for closing the productivity gap with the US. However, the contribution from this "catching-up" mechanism has been declining over time, more than halving in fact between the 1980s and the 1990s, falling from a contribution of ¾ of a percentage point over the 1980-1990 period to an average of less than a ¼ of a percentage point in the 1990s. In addition, the positive structural change effect was also offset by a negative "interaction" effect on productivity. The EU is therefore becoming increasingly like the services-dominated US economy where employment shifts from manufacturing to service industries are often associated with declines in productivity growth. In these circumstances the only option for the EU, as has been the case for the US over the last number of decades, is to generate productivity gains at the intra-industry level.
- Finally, the shift-share analysis for the US suggests a surge of "pure" productivity gains from within the industries themselves, more than compensating for the negative effect from the reallocation of employment resources between industries. The extent of the surge is suggestive of the emergence of a new technological regime which is permeating a wide range of US industries and positively influencing their productivity performance. This new regime could, in part at least, be driven by the efficiencies being reaped from the use of ICT products and services and the wider changes associated with the diffusion and creation of ICT-specific knowledge. Isolating the wide-ranging contribution of IC technologies to aggregate productivity growth, in terms of both the production and use of ICT, is where we now focus our attention in Sub-sections 2.2 and 2.3.

Graph 5 : Shift Share Analysis for EU + US : Decomposition of Hourly Labour Productivity Growth Rates (Annual Averages)

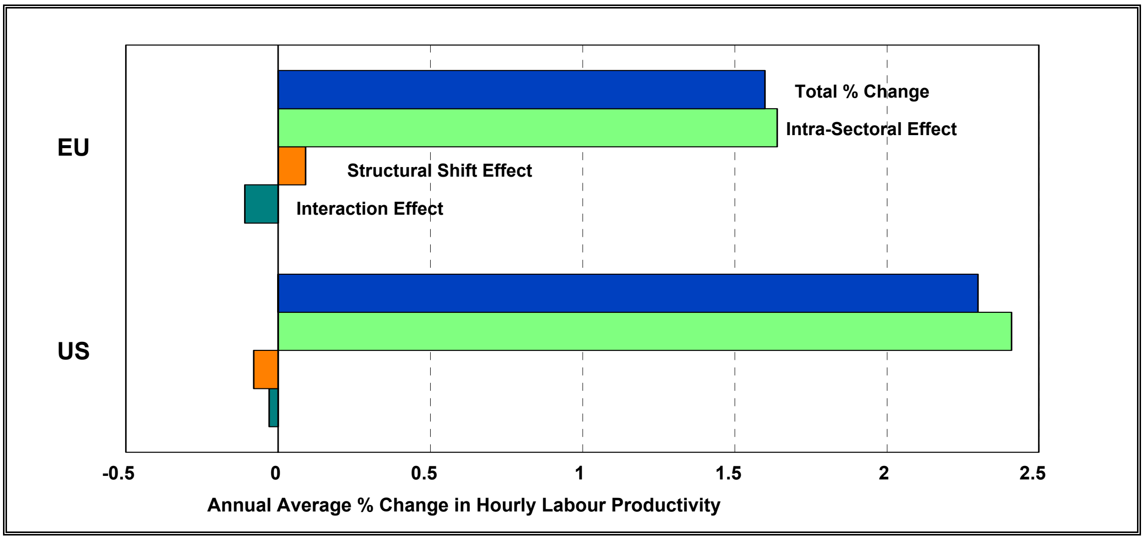
Graph 5A : 1981-1990



Graph 5B : 1991-1995



Graph 5C : 1996-2000



Source : GGDC and own calculations

2.2 : KEY INDUSTRIES DRIVING THE EU-US PRODUCTIVITY GROWTH GAP : The shift share analysis has established that most of the growth in labour productivity over the second half of the 1990s occurred within the industries themselves rather than due to a reallocation of resources between industries. Consequently, EU-US productivity growth differentials are overwhelmingly due to differences in the size of the productivity gains in individual EU and US industries. Using the "Industry Labour Productivity Database", this Sub-section firstly isolates the broad groups of industries (i.e. manufacturing and private services) which are driving the productivity differentials (Sub-section 2.2.1) and secondly assesses the specific role of ICT-producing and intensive ICT-using industries in determining overall productivity trends (Sub-section 2.2.2).

2.2.1 OVERVIEW OF LABOUR PRODUCTIVITY TRENDS : Table 4 gives a quick overview of the industrial structure of the EU and US economies on the basis of an aggregation of the 56 industries into the standard four categories of primary production, manufacturing, private services and government services. In terms of productivity levels, Table 4 underlines the extent of the deterioration experienced by the EU over the second half of the 1990s, with the US pulling ahead in virtually all areas of the economy. This compares with a situation in the early 1990s when the EU was making steady progress in all 4 categories in converging towards US productivity levels.

In terms of labour productivity growth rates, an aggregation of the 56 industries displays trends similar to those established in Section 1 on the basis of the economy-wide data, namely a sharp deterioration in EU labour productivity growth over the two halves of the 1990s and an acceleration for the US. Consequently, while the use of hedonic deflators and equivalent definitions of what constitutes ICT investment expenditure did help, to a small extent, in reducing the pace of decline in EU labour productivity growth rates over the 1990s, these adjustments were insufficient to change the overall pattern. Graph 6 confirms the US dominance in productivity terms over the period 1996-2000, with the US doing better in terms of manufacturing and private service industries and with the EU only ahead in the "rest of the economy" category (which includes primary industries and public services). When one looks in more detail at the trends for the manufacturing and private services industries (see Graph 7), one sees the extent of the transformation in relative performances, with the US powering ahead over the 1990s as a whole in both areas, compared with persistent downward trends for the EU in both industry categories.[28]

[28] Graph 7 also shows that average trend productivity growth in the manufacturing sector has always been higher than that of services in both the EU and the US. While this is still the case, the recent surge in productivity growth in US service industries is suggestive that the latter industries could challenge manufacturing in the not too distant future. (For a further discussion on these issues, see Bernard and Jones (1996) and Triplett and Bosworth (2002)). If this were to occur it would have enormous implications for the overall growth performance of the US economy since the private services sector is over 3 times larger than that of manufacturing in terms of both output and employment shares. In addition, at least up until the mid-1990's, the manufacturing sector accounted for between 60-75 per cent of total US productivity growth despite representing only 15-20 per cent of total employment. Finally, Graph 7 shows that the EU has experienced a marked downward trend in productivity growth in both its manufacturing and service industries over both decades. The US in contrast is characterised, in manufacturing, by a declining trend only up until the end of the 1980's followed by a strong recovery in the 1990's. For services the US has been on a steady upward trend since the early 1980's and has now opened up a marked advantage over the EU in such industries, with US private services productivity growing from a pace of less than 1 percentage point, on an annual average basis, in the early 1980's to well over 2 per cent in the second half of the 1990's.

TABLE 4 : OVERVIEW OF THE SECTORAL COMPOSITION + PRODUCTIVITY LEVELS OF THE EU AND US ECONOMIES (1981-2000)

	SHARE OF TOTAL OUTPUT (NOMINAL)		SHARE OF TOTAL EMPLOYMENT (ADJUSTED FOR HOURS WORKED)		EU PRODUCTIVITY LEVEL (US=100)
	EU	US	EU	US	EU
PRIMARY INDUSTRIES					
(1981-1990)	.05	.05	.10	.04	47.8*
(1991-1995)	.04	.03	.07	.04	63.8* *
(1996-2000)	.03	.03	.06	.03	58.1* **
MANUFACTURING					
(1981-1990)	.24	.20	.24	.19	78.9
(1991-1995)	.21	.18	.21	.17	81.4
(1996-2000)	.20	.17	.19	.15	73.5
PRIVATE SERVICES					
(1981-1990)	.50	.52	.42	.49	82.9
(1991-1995)	.53	.54	.45	.50	98.4
(1996-2000)	.55	.57	.47	.53	91.9
PUBLIC SERVICES					
(1981-1990)	.21	.23	.24	.28	72.4
(1991-1995)	.22	.25	.27	.29	83.8
(1996-2000)	.22	.23	.28	.29	89.3
TOTAL ECONOMY					
(1996-2000)	1	1	1	1	86.4

SOURCE : DG ENTERPRISE / GGDC AND OWN CALCULATIONS
*=1980 **=1995 ***=2000

2.2.2 SPECIFIC ROLE OF ICT-PRODUCING AND ICT-USING INDUSTRIES IN DETERMINING OVERALL LABOUR PRODUCTIVITY TRENDS : While sub-section 2.2.1 has displayed the broad overall trends for labour productivity at the industry level, it is necessary to dig a little deeper to see the important role which IC technologies are playing in the substantial transformation of industrial structures in the EU and US economies. Building on the 4-way breakdown of industries given earlier in Table 4, and in order to isolate the increasing role being played by ICT in the respective economies, these 4 categories are further sub-divided in Table 5 on the basis of the ICT content of the different industries. The complete breakdown of the ICT intensity of all 56 industries into ICT-producing, intensive ICT-using and less intensive ICT-using industries is provided in Table 6.[29] This three-way ICT breakdown can also be used as a rough proxy for high, medium and low productivity industries in the EU and US as a whole.

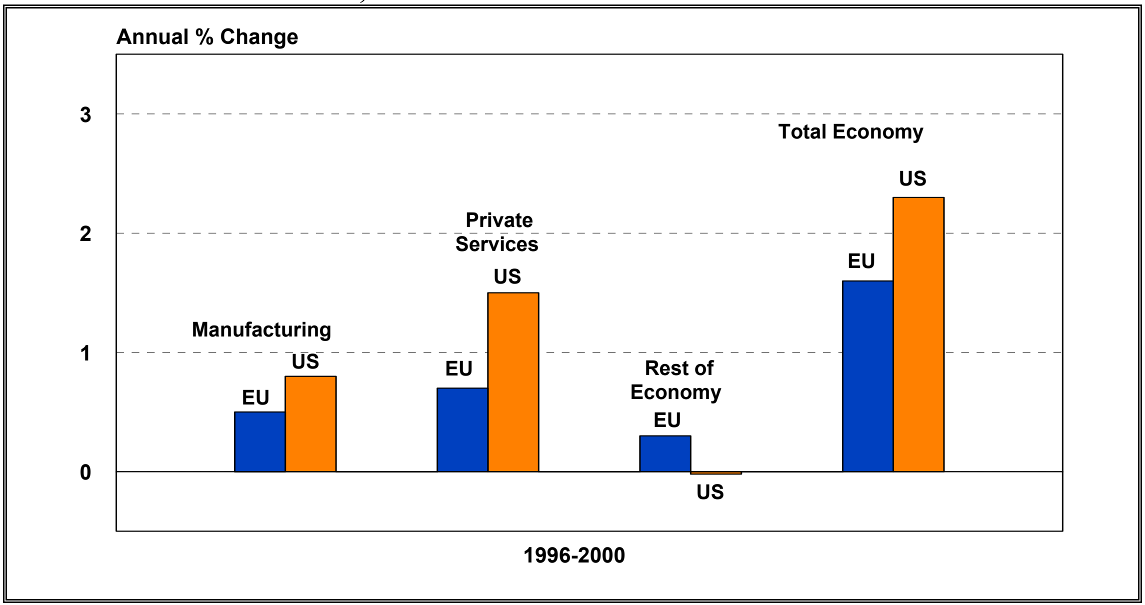
[29] This three-way categorisation of the 56 industries is based on the University of Groningen's Growth and Development Centre's ICT intensity breakdown for these industries - see also OECD (2000) "Measuring the ICT Sector"; and Sutton (2000).

TABLE 5 : INDUSTRIES CLASSIFIED ON THE BASIS OF THEIR ICT-CONTENT : AN OVERVIEW FOR THE PERIOD 1996-2000

	SHARE OF TOTAL OUTPUT (NOMINAL)		SHARE OF TOTAL EMPLOYMENT (ADJUSTED FOR HOURS WORKED)		EU PRODUCTIVITY LEVEL (US=100)*
	EU	US	EU	US	EU
1.PRIMARY INDUSTRIES *(LESS-ICT INTENSIVE)*	**.03**	**.03**	**.06**	**.03**	**58.1**
2.TOTAL MANUFACTURING	**.20**	**.17**	**.19**	**.15**	**73.5**
(ICT-PRODUCING)	*(.01)*	*(.02)*	*(.01)*	*(.02)*	*(46.3)*
(INTENSIVE ICT-USING)	*(.06)*	*(.05)*	*(.07)*	*(.05)*	*(95.8)*
(LESS-ICT INTENSIVE)	*(.12)*	*(.10)*	*(.12)*	*(.08)*	*(82.7)*
3.TOTAL PRIVATE SERVICES	**.55**	**.57**	**.47**	**.53**	**91.9**
(ICT-PRODUCING)	*(.04)*	*(.04)*	*(.03)*	*(.03)*	*(116.1)*
(INTENSIVE ICT-USING)	*(.21)*	*(.26)*	*(.20)*	*(.25)*	*(79.7)*
(LESS-ICT INTENSIVE)	*(.30)*	*(.27)*	*(.24)*	*(.25)*	*(101.5)*
4.PUBLIC SERVICES *(LESS-ICT INTENSIVE)*	**.22**	**.23**	**.28**	**.29**	**89.3**
TOTAL ECONOMY	1	1	1	1	86.4

SOURCE : DG ENTERPRISE / GGDC AND OWN CALCULATIONS
*=2000

GRAPH 6 : CONTRIBUTION TO TOTAL ECONOMY LABOUR PRODUCTIVITY GROWTH FROM MANUFACTURING, PRIVATE SERVICES AND THE REST OF THE ECONOMY



SOURCE : DG ENTERPRISE / GGDC AND OWN CALCULATIONS

Table 6 : ICT Breakdown of all Industries (ISIC Rev 3)*

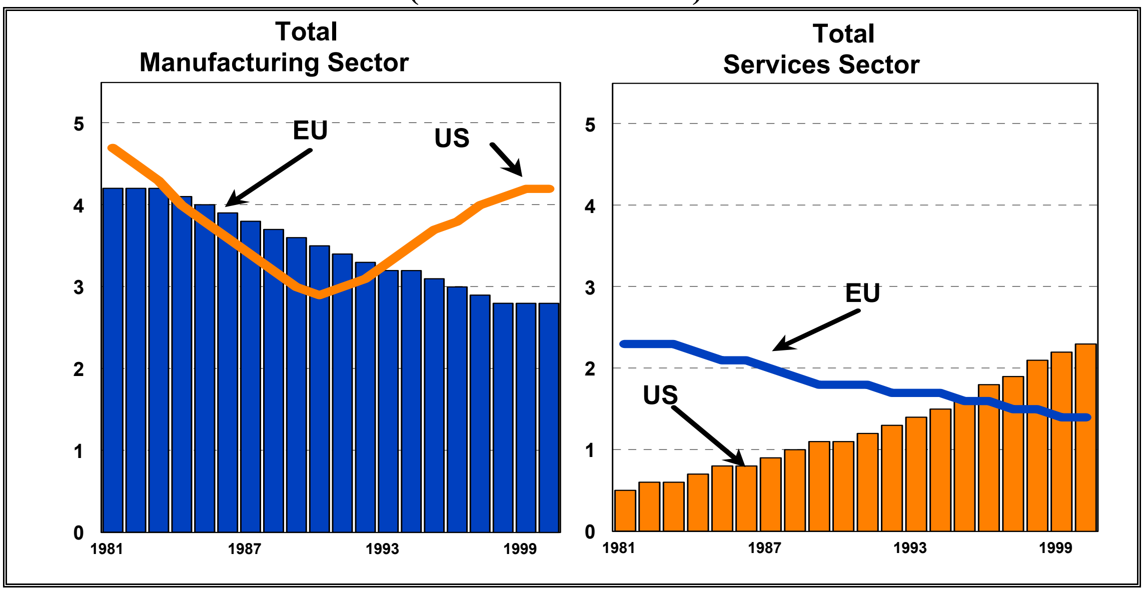
1. Primary Production (Less intensive ICT Using Industries)	2. Non-Farm Business Sector						3. Government Services (Less intensive ICT-Using Industries)
	2A : Manufacturing			2B : Services			
	ICT-Producing Manufacturing	Intensive ICT-Using Manufacturing	Rest of Manufacturing (Less intensive ICT-Using Industries)	ICT-Producing Services	Intensive ICT-Using Services	Rest of Services /other industries (Less intensive ICT-Using Industries)	
Agriculture (01)	Office and computing equipment (30)	Clothing (18)	Food, Drink and Tobacco (15-16)	Post and Telecommunications (64)	Wholesale trade (51)	Repairs (50)	Public Adminstration and defence (75)
Forestry (02)	Insulated Wire and Cables (313)	Printing and Publishing (22)	Textiles (17)	Computer and related services (72)	Retail trade (52)	Hotels and restaurants (55)	Education (80)
Fishing (05)	Semiconductors and Other electronic components (321)	Machinery and Equipment (29)	Leather and Footwear (19)		Financial Intermediation (65)	Inland transport (60)	Health and social work (85)
Mining (10-14)	Communication and Broadcasting Equipment (322)	Other Electrical Machinery (31 ex. 313)	Wood Products (20)		Insurance and Pension Funding (66)	Water transport (61)	Other community, social and personal services (90-93)
	Radio and TV Receivers (323)	Other Instruments (33 ex. 331)	Pulp and paper products (21)		Activities auxiliary to financial intermediation (67)	Air transport (62)	Private households with employed persons (95)
	Scientific instruments (331)	Building and repairing of ships and boats (351)	Oil refining and nuclear fuel (23)		Renting of machinery and equipment (71)	Auxiliary Transport activities (63)	
		Aircraft and spacecraft (353)	Chemicals (24)		Research and development (73)	Real estate activities (70)	
		Railroad and transport equipment (352+359)	Rubber and plastics (25)		Professional business services (741-743)	Other business services (749)	
		Misc. Manufacturing (36-37)	Non-metallic mineral products (26)			Electricity, gas and water supply (40-41)	
			Basic Metals (27)			Construction (45)	
			Fabricated Metal Products (28)				
			Motor Vehicles (34)				

Source : GGDC
*ISIC rev 3 codes in Brackets

ARE THE ICT-PRODUCING MANUFACTURING OR THE INTENSIVE ICT-USING SERVICE INDUSTRIES DRIVING THE EU-US PRODUCTIVITY DIFFERENTIALS ? : Table 7 gives an overview of the total economy, broken down into the same 3 categories which were used for Graph 6, namely manufacturing, private services (both of which when combined form the non-farm business sector) and the "rest of the economy". These 3 groups of industries are in turn broken down into ICT-producing, intensive-ICT-using and less-intensive ICT-using industries. This latter 3-way breakdown is not however applied to the "rest of the economy" grouping since the 9 industries which are included in this category (i.e. primary industries and government services) are all classified as less intensive ICT-using industries.

In order to assess the relative importance of the different groups of industries to overall productivity growth, Table 7 gives firstly the productivity growth rates of each group, and secondly (using their respective nominal shares in total economy output as weights) their contribution to economy-wide labour productivity growth. As can be seen from the Table (which confirms the story given in Graphs 6 and 7), the non-farm business sector is where the divergences in EU-US productivity growth rates are emanating from. In fact, in terms of overall contributions to productivity growth, the non-farm business sector can explain virtually all of the change in aggregate productivity trends over the two halves of the 1990s for both the EU and the US.[30]

GRAPH 7 : TREND LABOUR PRODUCTIVITY GROWTH RATES FOR THE MANUFACTURING AND PRIVATE SERVICES SECTORS : EU V US (1981-2000) (ANNUAL % CHANGE)



SOURCE : DG ENTERPRISE / GGDC AND OWN CALCULATIONS

[30] This in fact is what one would have expected since the non-farm business sector accounts for roughly 75 per cent of total output in the EU and the US.

TABLE 7 : BREAKDOWN OF TOTAL ECONOMY INTO 3 CATEGORIES – 2 ICT CATEGORIES (ICT PRODUCING + INTENSIVE ICT-USING) AND 1 CATEGORY OF LESS INTENSIVE ICT USING (I.E. MORE TRADITIONAL) INDUSTRIES

	Average % Change in Labour Productivity per Hour			Contribution to Total Change in Labour Productivity per Hour (%)*		
	1981-1990	1991-1995	1996-2000	1981-1990	1991-1995	1996-2000
Total Economy (1+2+3)						
EU	**2.4**	**2.3**	**1.6**	**2.4**	**2.3**	**1.6**
US	**1.1**	**1.1**	**2.3**	**1.1**	**1.1**	**2.3**
1+2 Total Non-Farm Business Sector**						
EU	**2.7**	**2.5**	**1.7**	**2.0**	**1.8**	**1.3**
US	**1.6**	**1.7**	**3.1**	**1.1**	**1.2**	**2.3**
1. Manufacturing Sector						
EU	**3.9**	**3.7**	**2.6**	**1.0**	**0.9**	**0.5**
US	**3.6**	**3.6**	**4.6**	**0.8**	**0.7**	**0.8**
1(a) ICT-Producing Manufacturing Industries						
EU	(13.9)	(9.6)	(17.1)	(0.2)	(0.2)	(0.2)
US	(16.2)	(16.4)	(26.0)	(0.4)	(0.4)	(0.7)
1(b) Intensive ICT-Using Manufacturing Industries						
EU	(2.8)	(2.6)	(2.0)	(0.2)	(0.2)	(0.1)
US	(0.8)	(-0.6)	(1.4)	(0.1)	(0.0)	(0.1)
1(b) Rest of Manufacturing (Less-Intensive ICT using)						
EU	(3.2)	(3.6)	(1.6)	(0.5)	(0.5)	(0.2)
US	(2.4)	(2.6)	(0.6)	(0.3)	(0.3)	(0.1)
2. Private Services Sector						
EU	**2.0**	**1.9**	**1.4**	**1.0**	**1.0**	**0.7**
US	**0.8**	**1.0**	**2.7**	**0.4**	**0.5**	**1.5**
2(a) ICT-Producing Service Industries						
EU	(4.1)	(4.8)	(6.8)	(0.1)	(0.2)	(0.2)
US	(2.1)	(2.4)	(0.8)	(0.1)	(0.1)	(0.0)
2(b) Intensive ICT-Using Service Industries						
EU	(2.2)	(1.8)	(2.1)	(0.4)	(0.4)	(0.4)
US	(1.6)	(1.6)	(5.3)	(0.3)	(0.4)	(1.3)
2(b) Rest of Services (Less-Intensive ICT using)						
EU	(1.7)	(1.7)	(0.2)	(0.5)	(0.5)	(0.1)
US	(-0.2)	(0.2)	(0.3)	(0.0)	(0.1)	(0.1)
3. Rest of Economy (Primary Industries + Public Services) (Less Intensive ICT-Using)						
EU	**1.6**	**2.0**	**1.1**	**0.4**	**0.5**	**0.3**
US	**0.2**	**-0.3**	**-0.1**	**0.0**	**-0.1**	**0.0**

SOURCE : GGDC AND OWN CALCULATIONS

* In terms of contributions to the change in labour productivity, the aggregate figures given in the table include the sum of the intra-industry, shift and interaction effects. However, since it is not possible to allocate the structural shift and interaction effects to specific manufacturing and service industries, the sum of the labour productivity contributions from these industries may not therefore equal the total change in labour productivity per hour at the aggregate industry level. The size of the residuals are however very small (in all cases not more than 0.1) since the intra-industry effect accounts for the bulk of the overall change in hourly labour productivity in both the US and the EU as a whole. As shown in Tables 9b-9d, however, this conclusion does not apply to all of the individual EU Member States where these residuals (i.e. the combined effect of the shift and interaction terms) are somewhat larger.

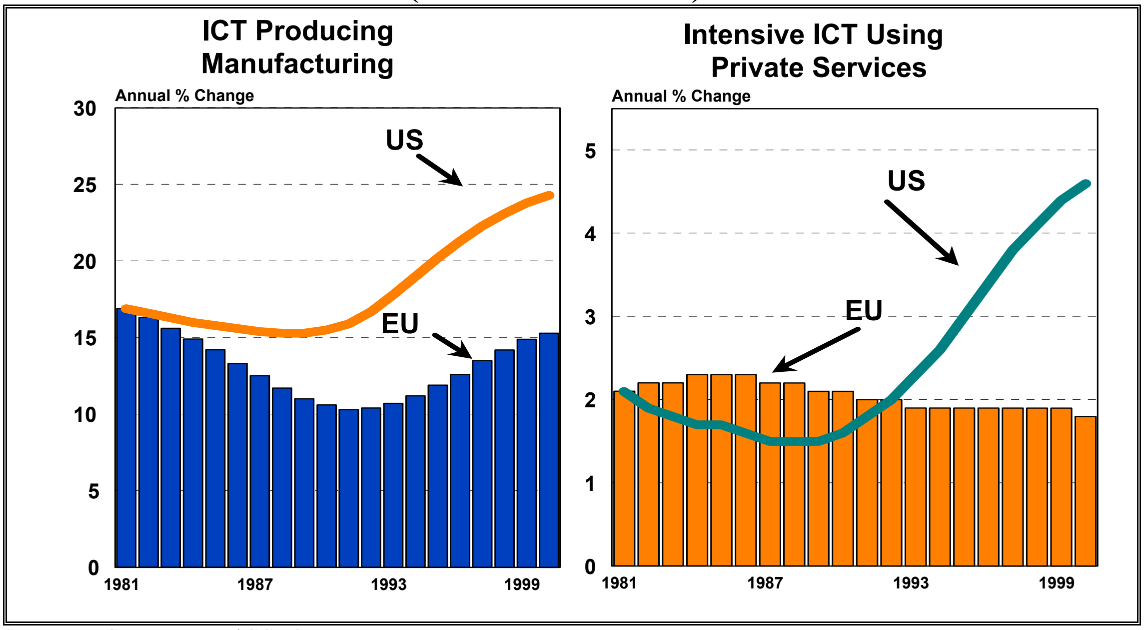
**Total economy excluding agriculture and government services.

The key results from Table 7 are as follows:

- Firstly, at an overall level, despite having productivity growth rates which were often 3 to 4 times higher than that of services, the manufacturing sector, due to its smaller share in overall GDP, had a contribution to aggregate productivity growth in both the EU and the US which was often only about the same as that of services. In addition, over the most recent 1996-2000 period, it is services which is by far the biggest contributor to total labour productivity growth, especially in the US.

- Secondly, looking at the ICT based breakdown for manufacturing, the highest productivity growth rates have been achieved in the ICT-producing industries, reaching over 25 per cent in the US and 17 per cent in the EU, on an annual average basis, over the second half of the 1990s (Graph 8). While these industries only account for between 1-2 per cent of EU and US GDP respectively, by virtue of their exceptionally high growth rates, they contributed 13 per cent (EU) and 30 per cent (US) to overall productivity growth over the 1996-2000 period. For the intensive ICT-using and non-ICT (i.e. less ICT-intensive) manufacturing industries, which combined represent by far the largest share of the overall manufacturing sector, the EU has consistently outperformed the US over the last 2 decades.

GRAPH 8 : TREND LABOUR PRODUCTIVITY PER HOUR IN ICT-PRODUCING MANUFACTURING AND INTENSIVE ICT-USING PRIVATE SERVICES (ANNUAL % CHANGE)



SOURCE : DG ENTERPRISE / GGDC AND OWN CALCULATIONS

NOTE : SCALES ARE DIFFERENT FOR THE ICT-PRODUCING MANUFACTURING AND ICT-USING SERVICES GRAPHS.

- In addition, despite having productivity growth rates which were much lower than those of the ICT-producing industries, nevertheless given their higher share in EU GDP, these industries made, until recently, a higher contribution to overall productivity growth in the EU. For the US, the ICT-producing industries have consistently outperformed the rest of US manufacturing over the period as a whole.

- Thirdly, in terms of private services industries, which account for 55 and 57 per cent of overall EU and US output respectively, the EU has consistently outperformed the US in terms of ICT-producing services (i.e. mainly telecommunications), and indeed up until the mid 1990s in all areas of services. However, over the second half of the 1990s, the US has pulled significantly ahead in ICT-using private services industries (see Graph 8). In terms of contributions to total productivity growth, since ICT-using services industries are substantially larger in terms of GDP than the ICT-producing services sector, they are crucial in determining the growth rate for services as a whole, especially in the US. As Table 7 shows, ICT-using services contributed well over half of all US productivity growth in the second half of the 1990s. For the non-ICT (i.e. the less intensive-ICT-using) service industries, which collectively form the largest share of total services, the EU had been consistently outperforming the US up until the most recent period.

- Finally, as Table 8 shows, within the ICT-producing and ICT-using categories, the 5 most important individual industries, in terms of contributions to economy-wide productivity growth, are semiconductors and other electronic equipment; telecommunications; wholesale trade; retail trade; and financial services. In 4 of these 5 industries (telecommunications is the exception), the EU has to radically improve its performance over the coming years in order to match the US position, with the 5 specific industries shown in Table 8 contributing 80 per cent of the US total productivity growth rate over the 1996-2000 period, compared with only 40 per cent in the case of the EU.

In overall terms, therefore, the story which has emerged from Table 7 and Graph 8 is one in which the US has pulled ahead of the EU over recent years in terms of productivity growth rates. This is essentially due to the superior performance of the US in a wide range of ICT-producing and ICT-using industries. This conclusion applies to both the manufacturing and services sectors as a whole. In manufacturing, while EU productivity growth rates in ICT-producing industries are not dramatically different from those in the US, unfortunately the size of the EU ICT-producing sector is much smaller than the equivalent sector in the US, and the contribution to overall productivity growth is correspondingly smaller. With regard to services, which is the main source of the US productivity advantage over the EU, the US appears to have benefited enormously from substantial investments in the intensive ICT-using service industries such as wholesale and retail trade and financial services. Finally, regarding the non-ICT part of the respective economies, the slowdown in the EU's productivity growth rate in both the "rest of manufacturing" and the "rest of services" categories is marked over the most recent period. These industries collectively still account for over 40 per cent of EU GDP. The US has also experienced a slowdown in productivity growth in these, relatively less high-tech, manufacturing industries, whilst showing a marginal improvement in the "rest of services" category.

TABLE 8 : FIVE MOST IMPORTANT INDUSTRIES FROM AN EU + US LABOUR PRODUCTIVITY PERSPECTIVE (1996-2000)*

	LABOUR PRODUCTIVITY GROWTH RATE		SHARE OF TOTAL OUTPUT		CONTRIBUTION TO TOTAL LABOUR PRODUCTIVITY GROWTH	
	EU	US	EU	US	EU	US
ICT-PRODUCING MANUFACTURING INDUSTRIES						
1. SEMICONDUCTORS AND OTHER ELECTRONIC EQUIPMENT						
(1981-1990)	22.6	23.3	0.2	0.4	0.04	0.09
(1991-1995)	35.6	38.2	0.1	0.6	0.05	0.22
(1996-2000)	57.3	52.9	0.2	0.9	0.10	0.46
ICT-PRODUCING SERVICE INDUSTRIES						
2. POST AND TELECOMMUNICATIONS SERVICES						
(1981-1990)	5.0	1.0	2.1	2.8	0.10	0.03
(1991-1995)	6.3	2.4	2.2	2.3	0.14	0.05
(1996-2000)	10.0	5.9	2.4	2.4	0.24	0.14
ICT-USING SERVICE INDUSTRIES						
3. WHOLESALE TRADE						
(1981-1990)	2.2	2.8	4.7	6.3	0.10	0.17
(1991-1995)	3.3	2.9	4.9	5.5	0.16	0.16
(1996-2000)	2.0	8.3	5.0	5.6	0.10	0.47
4. RETAIL TRADE						
(1981-1990)	2.0	3.1	4.7	6.9	0.10	0.21
(1991-1995)	1.7	2.0	4.8	6.5	0.08	0.13
(1996-2000)	1.6	6.6	4.7	6.5	0.07	0.43
5. FINANCIAL SERVICES**						
(1981-1990)	2.2	-0.7	4.7	4.7	0.11	-0.03
(1991-1995)	0.8	1.7	5.5	5.9	0.05	0.10
(1996-2000)	2.9	5.0	5.4	7.1	0.16	0.35
TOTAL OF ABOVE 5 INDUSTRIES***						
(1981-1990)	2.9	2.3	16.3	21.1	0.45 (19)	0.47 (43)
(1991-1995)	2.7	3.2	17.5	20.8	0.48 (21)	0.66 (60)
(1996-2000)	3.7	8.3	17.6	22.4	0.67 (42)	1.85 (80)

SOURCE : DG ENTERPRISE / GGDC AND OWN CALCULATIONS

* These are the five most important industries in terms of growth rates if one takes the average of the EU and US economies (note : the sixth industry in this ranking is office machinery). There is a different ranking of course if one looks at the top 5 industries for the EU and the US separately in terms of contributions to labour productivity growth (which is what is done in Box 1). For the EU the 5 industries with the fastest growth rates were telecommunications; financial services; electricity, gas and water supply; office machinery; and wholesale trade. Compared with the list shown in Table 8, it is interesting that the EU is experiencing fast productivity gains in recently liberalised industries such as the utilities. For the US, the top 5 were semiconductors and other electronic equipment; wholesale trade; retail trade; financial services; and telecommunications.

** Financial services includes financial intermediation, insurance and pension funding and auxiliary financial services

*** Share of total labour productivity growth is given in brackets.

BOX 1 : TOP 10 INDUSTRIES IN THE EU AND THE US[31]

TABLE A : TOP 10 INDUSTRIES IN EU (MEASURED IN TERMS OF CONTRIBUTION TO TOTAL LABOUR PRODUCTIVITY GROWTH RATE) (1996-2000)

INDUSTRIES (SHARE OF TOTAL VALUE ADDED / SHARE OF TOTAL LABOUR INPUT GIVEN IN BRACKETS*)	CONTRIBUTION TO GROWTH RATE OF		
	HOURLY LABOUR PRODUCTIVITY	LABOUR INPUT *	GDP (VALUE ADDED)
1.TELECOMMUNICATIONS (2.4 / 1.6)	0.24	0.01	0.24
2. FINANCIAL SERVICES (5.4 / 3.3)	0.16	0.02	0.20
3. ELECTRICITY, GAS & WATER (2.4 / 0.8)	0.14	-0.03	0.06
4. OFFICE MACHINERY (0.2 / 0.1)	0.12	-0.01	0.12
5. WHOLESALE TRADE (5.0 / 4.0)	0.10	0.07	0.18
6. AGRICULTURE (2.3 / 5.2)	0.10	-0.12	0.04
7. SEMICONDUCTORS (0.2 / 0.1)	0.10	0.01	0.10
8. CHEMICALS (2.2 / 1.2)	0.09	-0.01	0.07
9. RETAIL TRADE (4.7 / 8.7)	0.07	0.09	0.12
10. PUBLIC ADMINISTRATION + DEFENCE (6.8 / 7.3)	0.07	-0.02	0.05
TOTAL OF 10 INDUSTRIES (% SHARE OF ALL INDUSTRIES IN BRACKETS)	1.18 (73)	0.0 (0)	1.18 (44)

* Employment adjusted for hours worked

TABLE B : TOP 10 INDUSTRIES IN US (MEASURED IN TERMS OF CONTRIBUTION TO TOTAL LABOUR PRODUCTIVITY GROWTH RATE) (1996-2000)

INDUSTRIES (SHARE OF TOTAL VALUE ADDED / SHARE OF TOTAL LABOUR INPUT GIVEN IN BRACKETS*)	CONTRIBUTION TO GROWTH RATE OF		
	HOURLY LABOUR PRODUCTIVITY	LABOUR INPUT *	GDP (VALUE ADDED)
1.WHOLESALE TRADE (5.6 / 5.4)	0.47	0.08	0.55
2. SEMICONDUCTORS (0.9 / 0.3)	0.46	0.01	0.49
3. RETAIL TRADE (6.5 / 10.5)	0.43	0.11	0.50
4. FINANCIAL SERVICES (7.1 / 4.4)	0.35	0.10	0.52
5. OFFICE MACHINERY (0.4 / 0.2)	0.24	-0.01	0.22
6. AGRICULTURE (1.5 / 2.5)	0.16	-0.01	0.15
7. TELECOMMUNICATIONS (2.4 / 1.6)	0.14	0.04	0.21
8. REAL ESTATE ACTIVITIES (10.3 / 1.2)	0.12	0.03	0.36
9. PUBLIC ADMINISTRATION + DEFENCE (9.2 / 6.5)	0.08	0.02	0.11
10. ELECTRICITY, GAS &WATER (2.6/ 0.8)	0.06	-0.01	0.02
TOTAL OF 10 INDUSTRIES (% SHARE OF ALL INDUSTRIES IN BRACKETS)	2.50 (109)	0.37 (42)	3.12 (72)

* Employment adjusted for hours worked

[31] The contributions to the growth rate of labour productivity and of value added (1st and 3rd columns) are the growth rates of the relevant variable multiplied by their share in total value added. For the contribution to the growth rate of labour input (2nd column), the growth rate is multiplied by its share in total employment. Therefore, when the share in value added is close to the share in employment, the third column is close to / equal to the sum of the first two columns (i.e. value added growth is equal to the sum of labour productivity and employment). When the shares in value added and in employment are very different, like in the case of "Real Estate Activities", we observe large differences. (Note : The rankings in Table 8 and Box 1 are not directly comparable).

2.2.3 : HOW DO THE INDIVIDUAL MEMBER STATES PERFORM ? : As with the aggregate analysis in Section 1, it is important to differentiate the overall EU performance from that of the individual Member States. As Tables 9a-9d show, the deterioration in the EU's trend productivity growth rate is largely due to the performance of a number of the larger Member States, most notably Italy.

As with the analysis at the overall EU level, labour productivity trends in the individual Member States are determined for the most part by the non-farm business sector. Table 9d shows how the EU Member States have been performing over the second half of the 1990s, in terms of this crucial sector (Tables 9b and 9c show the figures for 1981-1990 and 1991-1995 respectively). Again, there is an extremely wide range of experiences, from zero productivity growth in the business sector in the case of Spain to 6 per cent in the case of Ireland. Three EU countries, namely Ireland, Austria and Portugal, achieved business sector productivity growth rates which matched or even exceeded that of the US over the second half of the 1990s. Within the total business sector of these countries, Austria and Portugal managed to achieve a reasonable balance between manufacturing and service industries. In Ireland, on the other hand, business sector productivity growth emanates predominantly from manufacturing.

TABLE 9A : CONTRIBUTIONS TO TOTAL EU-15 LABOUR PRODUCTIVITY GROWTH 1981-2000

	1981-1990	1991-1995	1996-2000
BELGIUM	0.09	0.07	0.07
DENMARK	0.04	0.04	0.03
GERMANY	0.54	0.59	0.56
GREECE	0.02	0.01	0.04
SPAIN	0.21	0.13	0.03
FRANCE	0.57	0.27	0.25
IRELAND	0.03	0.03	0.06
ITALY	0.28	0.38	0.09
LUX	0.01	0.00	0.00
NETHS	0.12	0.06	0.06
AUSTRIA	0.06	0.09	0.08
PORTUGAL	0.03	0.02	0.04
FINLAND	0.04	0.06	0.03
SWEDEN	0.06	0.07	0.06
UK	0.32	0.45	0.29
EU15	2.4	2.3	1.6

TABLE 9B : HOURLY LABOUR PRODUCTIVITY GROWTH : 1981-1990
(CONTRIBUTIONS FROM MANUFACTURING, PRIVATE SERVICES AND REST OF ECONOMY)

	TOTAL ECONOMY (1 + 2 + 3)	TOTAL NON-FARM BUSINESS SECTOR (1 + 2)	1. CONTRIBUTION FROM MANUFACTURING				2. CONTRIBUTION FROM PRIVATE SERVICES				3.CONTRIBUTION FROM REST OF ECONOMY (PRIMARY INDUSTRIES + PUBLIC SERVICES) (LESS INTENSIVE ICT USING INDUSTRIES)
			TOTAL	ICT PRODUCING	INTENSIVE ICT USING	REST (LESS INTENSIVE ICT USING)	TOTAL	ICT PRODUCING	INTENSIVE ICT USING	REST (LESS INTENSIVE ICT USING)	
BELGIUM	**2.6**	**2.5**	**1.4**	0.2	0.2	1.0	**1.1**	0.1	0.5	0.5	**0.2**
DENMARK	**2.2**	**1.4**	**0.4**	0.1	0.1	0.2	**1.0**	0.1	0.5	0.4	**0.8**
GERMANY	**2.1**	**1.8**	**0.8**	0.2	0.2	0.4	**1.0**	0.1	0.4	0.5	**0.3**
GREECE	**1.0**	**0.9**	**0.1**	0.1	0.0	0.0	**0.7**	0.1	-0.1	0.8	**0.1**
SPAIN	**3.1**	**2.4**	**1.5**	0.2	0.3	1.0	**0.9**	0.0	0.3	0.6	**0.8**
FRANCE	**3.0**	**2.4**	**0.7**	0.3	0.2	0.2	**1.6**	0.2	0.8	0.7	**0.6**
IRELAND	**4.5**	**3.3**	**2.5**	0.5	0.3	1.4	**0.4**	0.0	0.4	-0.1	**1.2**
ITALY	**2.1**	**1.7**	**1.1**	0.2	0.2	0.7	**0.6**	0.1	0.1	0.4	**0.3**
LUX	**3.7**	**3.0**	**1.0**	0.0	0.2	0.9	**1.9**	0.2	1.1	0.7	**0.7**
NETHS	**2.3**	**1.9**	**0.8**	0.2	0.2	0.5	**1.1**	0.0	0.5	0.6	**0.4**
AUSTRIA	**2.8**	**2.4**	**1.1**	0.2	0.3	0.6	**1.2**	0.1	0.6	0.5	**0.4**
PORTUGAL	**3.1**	**2.1**	**0.7**	0.2	0.1	0.4	**1.3**	0.1	0.7	0.4	**1.0**
FINLAND	**3.1**	**2.5**	**1.5**	0.2	0.4	0.8	**1.1**	0.1	0.5	0.5	**0.6**
SWEDEN	**1.6**	**1.5**	**0.9**	0.3	0.1	0.4	**0.6**	0.1	0.4	0.1	**0.2**
UK	**2.1**	**2.1**	**1.6**	0.4	0.4	0.8	**0.7**	0.1	0.3	0.3	**0.1**
EU15	**2.4**	**2.0**	**1.0**	0.2	0.2	0.5	**1.0**	0.1	0.4	0.5	**0.4**
US	**1.1**	**1.1**	**0.8**	0.4	0.1	0.3	**0.4**	0.1	0.3	0.0	**0.0**

Source : DG Enterprise / GGDC and own calculations

TABLE 9C : HOURLY LABOUR PRODUCTIVITY GROWTH : 1991-1995
(CONTRIBUTIONS FROM MANUFACTURING, PRIVATE SERVICES AND REST OF ECONOMY)

	TOTAL ECONOMY (1+2+3)	TOTAL NON-FARM BUSINESS SECTOR (1+2)	1. CONTRIBUTION FROM MANUFACTURING				2. CONTRIBUTION FROM PRIVATE SERVICES				3.CONTRIBUTION FROM REST OF ECONOMY (PRIMARY INDUSTRIES + PUBLIC SERVICES) (LESS INTENSIVE ICT USING INDUSTRIES)
			TOTAL	ICT PRODUCING	INTENSIVE ICT USING	REST (LESS INTENSIVE ICT USING)	TOTAL	ICT PRODUCING	INTENSIVE ICT USING	REST (LESS INTENSIVE ICT USING)	
BELGIUM	**2.5**	**1.9**	**0.8**	0.1	0.2	0.5	**1.1**	0.1	0.9	0.2	**0.6**
DENMARK	**1.9**	**1.1**	**0.5**	0.1	0.2	0.3	**0.6**	0.3	0.1	0.2	**0.8**
GERMANY	**2.4**	**1.9**	**0.8**	0.1	0.2	0.6	**0.9**	0.2	0.5	0.2	**0.5**
GREECE	**0.8**	**0.3**	**0.3**	0.0	0.1	0.2	**-0.3**	0.1	-0.3	0.0	**0.4**
SPAIN	**1.7**	**1.3**	**0.7**	0.1	0.1	0.5	**0.6**	0.0	-0.2	0.7	**0.4**
FRANCE	**1.5**	**1.4**	**0.7**	0.1	0.2	0.4	**0.6**	0.0	0.2	0.4	**0.4**
IRELAND	**4.1**	**3.2**	**2.4**	0.8	0.4	1.1	**0.8**	0.5	-0.1	0.4	**0.8**
ITALY	**2.3**	**1.9**	**0.9**	0.1	0.3	0.5	**1.0**	0.2	0.5	0.4	**0.4**
LUX	**2.2**	**1.7**	**1.0**	0.0	0.0	1.0	**0.9**	0.3	0.6	0.2	**0.5**
NETHS	**1.4**	**0.9**	**0.7**	0.1	0.2	0.5	**0.2**	0.0	0.1	0.1	**0.5**
AUSTRIA	**3.8**	**2.9**	**1.2**	0.1	0.2	0.8	**1.6**	0.2	0.8	0.7	**0.9**
PORTUGAL	**2.1**	**1.4**	**0.6**	0.1	0.2	0.3	**0.7**	0.2	0.0	0.4	**0.7**
FINLAND	**2.9**	**3.0**	**1.3**	0.1	0.4	0.8	**1.7**	0.1	0.1	1.6	**0.3**
SWEDEN	**2.0**	**2.1**	**0.9**	0.1	0.3	0.5	**1.2**	0.2	0.4	0.7	**0.0**
UK	**3.1**	**2.5**	**1.1**	0.3	0.2	0.5	**1.5**	0.2	0.5	0.9	**0.7**
EU15	**2.3**	**1.8**	**0.9**	0.2	0.2	0.5	**1.0**	0.2	0.4	0.5	**0.5**
US	**1.1**	**1.2**	**0.7**	0.4	0.0	0.3	**0.5**	0.1	0.4	0.1	**-0.1**

Source : DG Enterprise / GGDC and own calculations

TABLE 9D : HOURLY LABOUR PRODUCTIVITY GROWTH : 1996-2000
(CONTRIBUTIONS FROM MANUFACTURING, PRIVATE SERVICES AND REST OF ECONOMY)

	TOTAL ECONOMY (1+2+3)	TOTAL NON-FARM BUSINESS SECTOR (1+2)	1. CONTRIBUTION FROM MANUFACTURING				2. CONTRIBUTION FROM PRIVATE SERVICES				3.CONTRIBUTION FROM REST OF ECONOMY (PRIMARY INDUSTRIES + PUBLIC SERVICES) (LESS INTENSIVE ICT USING INDUSTRIES)
			TOTAL	ICT PRODUCING	INTENSIVE ICT USING	REST (LESS INTENSIVE ICT USING)	TOTAL	ICT PRODUCING	INTENSIVE ICT USING	REST (LESS INTENSIVE ICT USING)	
BELGIUM	**2.2**	**2.1**	**0.8**	0.1	0.2	0.6	**1.2**	0.3	0.2	0.8	**0.2**
DENMARK	**1.4**	**1.3**	**0.5**	0.0	0.1	0.4	**0.7**	0.2	0.7	-0.2	**0.2**
GERMANY	**2.0**	**1.7**	**0.4**	0.2	0.2	0.1	**1.2**	0.4	0.4	0.3	**0.2**
GREECE	**2.6**	**2.2**	**0.3**	0.0	0.1	0.2	**1.7**	0.2	0.6	0.8	**0.3**
SPAIN	**0.5**	**0.0**	**0.1**	0.1	0.1	0.0	**-0.1**	0.1	0.0	-0.3	**0.3**
FRANCE	**1.4**	**1.0**	**0.6**	0.2	0.1	0.3	**0.3**	0.2	0.2	-0.1	**0.3**
IRELAND	**7.6**	**6.0**	**5.2**	2.5	1.0	1.7	**1.3**	0.1	0.5	0.6	**0.8**
ITALY	**0.7**	**0.4**	**0.2**	0.1	0.1	0.1	**0.1**	0.2	0.3	-0.5	**0.2**
LUX	**1.5**	**1.3**	**0.4**	0.0	-0.1	0.4	**0.8**	0.2	0.6	0.0	**0.1**
NETHS	**1.3**	**1.2**	**0.3**	0.0	0.1	0.2	**0.9**	0.1	0.6	0.1	**0.1**
AUSTRIA	**2.7**	**2.4**	**1.0**	0.1	0.3	0.6	**1.3**	0.1	0.6	0.6	**0.3**
PORTUGAL	**3.0**	**2.3**	**1.1**	0.1	0.2	0.8	**1.1**	0.2	0.4	0.5	**0.6**
FINLAND	**2.2**	**1.5**	**1.0**	0.3	0.1	0.4	**0.5**	0.2	0.5	-0.1	**0.4**
SWEDEN	**2.1**	**1.2**	**0.4**	-0.1	0.1	0.4	**0.9**	0.2	0.6	0.1	**0.7**
UK	**2.2**	**1.9**	**0.6**	0.4	0.1	0.1	**1.4**	0.2	0.9	0.3	**0.3**
EU15	**1.6**	**1.3**	**0.5**	0.2	0.1	0.2	**0.7**	0.2	0.4	0.1	**0.3**
US	**2.3**	**2.3**	**0.8**	0.7	0.1	0.1	**1.5**	0.0	1.3	0.1	**0.0**

Source : DG Enterprise / GGDC and own calculations

2.3 WHAT PROPORTION OF ECONOMY-WIDE LABOUR PRODUCTIVITY GROWTH CAN BE ATTRIBUTED TO THE EFFECT OF ICT (ICT INVESTMENTS AND TECHNICAL PROGRESS IN ICT-PRODUCING INDUSTRIES) : Section 2.2 described the contribution of ICT-producing and ICT-using industries to overall labour productivity growth. Although this analysis suggests that the production and use of ICT technologies is playing an important role, it is not possible to infer how much of the productivity increases are directly linked to ICT investments in the economy and to innovation in ICT-producing industries. The present section, using the "Industry Growth Accounting Database" provides a quantification of the overall contribution of ICT to labour productivity trends via the investment and TFP transmission channels. This is done by calculating firstly, the contribution to capital deepening from investment in ICT and secondly by measuring the contribution to TFP growth from technical progress in ICT-producing industries in both the manufacturing and services sectors (see Annex 2 for details).

As explained at the start of Section 2, due to significant data constraints in terms of capital stock data for the respective industries, the EU average used for this exercise is made up of only 4 countries. These countries do, however, provide a reasonably representative picture for the EU as a whole since they include France, Germany, the Netherlands and the UK which collectively account for nearly 2/3 of EU GDP.

In order to reflect the respective contributions from the ICT and non-ICT parts of the economy to overall investment and TFP trends, Graphs 9 and 10 give a breakdown of labour productivity into the contributions from capital deepening and TFP. This decomposition shows :

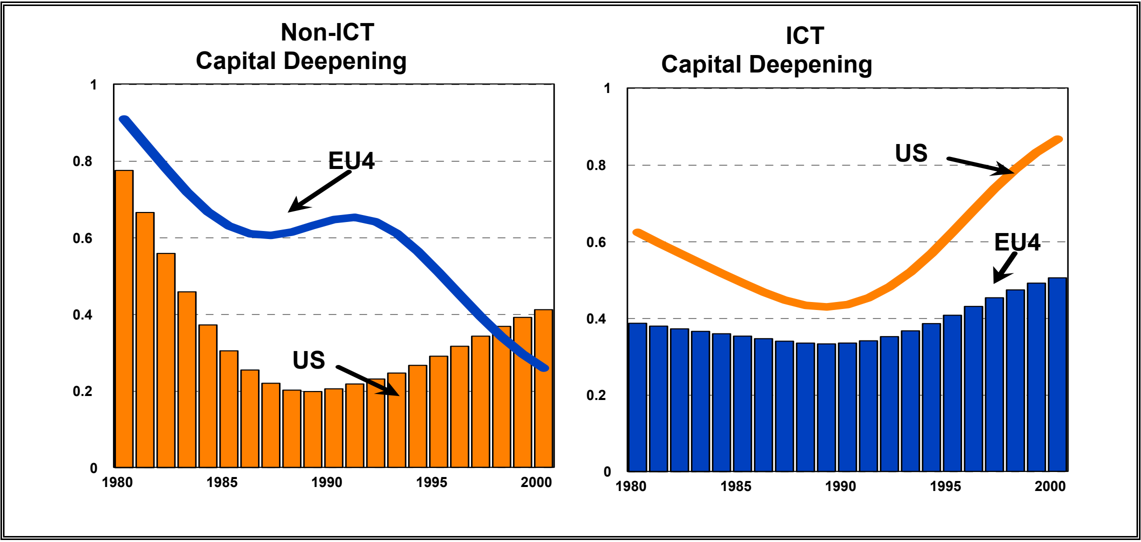
- firstly, that whilst investment in ICT equipment contributed positively to labour productivity growth in the EU4 over the second half of the 1990s, the contribution was substantially less than that in the US, and if anything the gap appears to be widening in favour of the US.
- secondly, that non-ICT capital deepening has fallen significantly in the EU over the 1996-2000 period, with only part of the relatively poor investment performance due to the higher labour content of growth (with perhaps, as mentioned in Section 1, other factors such as locational investment considerations or adverse demographic trends playing a role). Over the same period the US has experienced a small acceleration in its trend rate of non-ICT capital spending.
- thirdly, in terms of TFP, the contribution of technical progress in ICT-producing industries such as semiconductors and telecommunications equipment has been consistently higher in the US since the early 1990s but the divergence with the EU is not as high compared with ICT investment spending due to the good performance of the EU in the telecommunications industry.
- finally, the contribution to TFP from the non-ICT-producing industries has shown a slight downward trend since the late 1980s in the EU, with the US sharing this trend up until around the mid-1990s but with a clear upward pattern emerging over the last years of the 1990s.[32] This upward pattern may

[32] Research by Baily and Lawrence (2001) and Oliner and Sichel (2002) would support this empirical finding.

be suggestive of some positive growth spillovers from ICT investment, including both embodiment effects associated with a more modern capital stock and possible tangential gains in areas such as network externalities.[33]

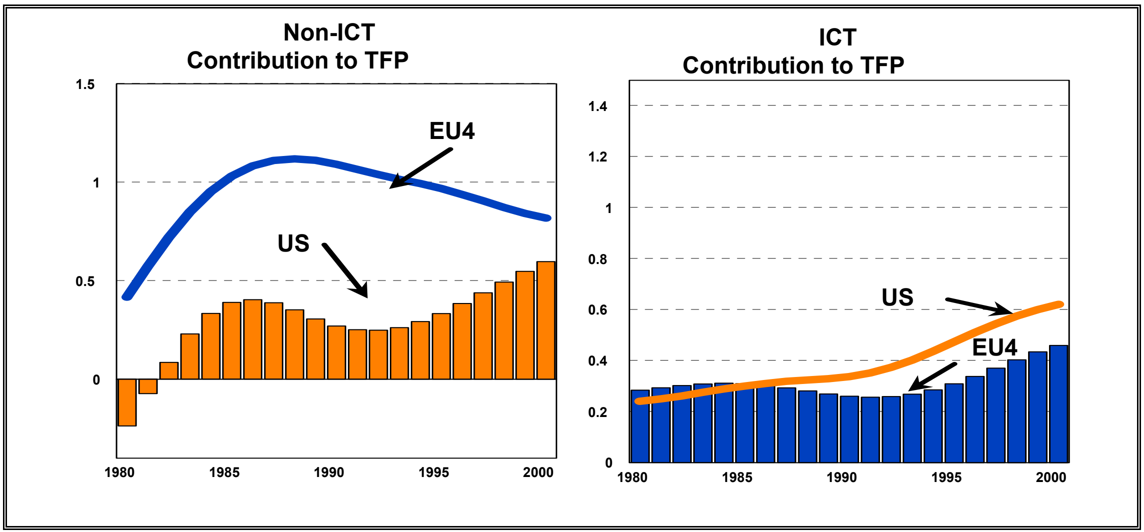
In overall terms, from the ICT investment and TFP channels described above, it would appear that ICT was contributing roughly 60 per cent of US labour productivity growth at the end of the 1990s compared with around 40 per cent in the case of the EU-4.

GRAPH 9 : BREAKDOWN OF TREND CAPITAL DEEPENING INTO ICT AND NON-ICT COMPONENTS



Source : DG Enterprise / GGDC and own calculations

GRAPH 10 : BREAKDOWN OF TREND TFP INTO ICT AND NON-ICT COMPONENTS

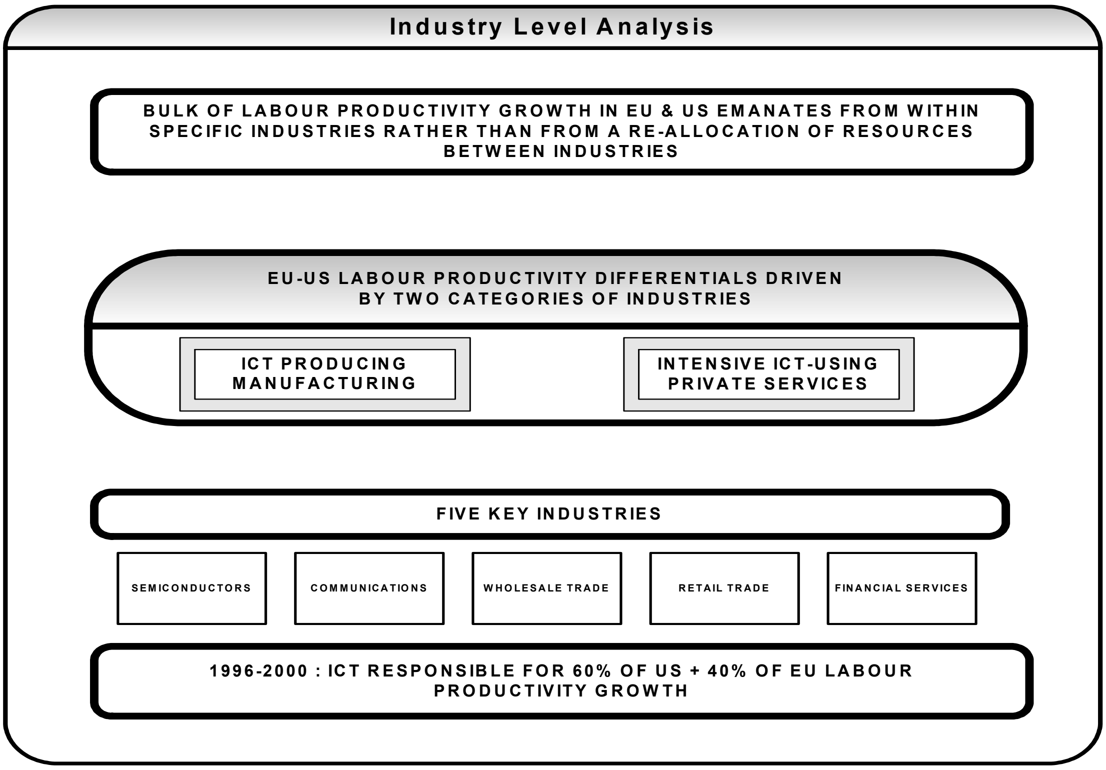


Source : DG Enterprise / GGDC and own calculations

[33] In trying to assess spillover effects in ICT-using industries, caution is undoubtedly warranted since researchers are confronted with 2 major difficulties, firstly measurement problems in a number of the intensive ICT-using industries, such as financial services, wholesale and retail trade; and secondly, identifying the long-run impact of innovative, ICT-based, businesses and markets, many of which are now only in the start-up phase of their operations. For a discussion of these issues see Coppel (2000); Fixler and Zieschang (1999); Gullickson and Harper (1999); and Moulton, Parker and Seskin (1999).

MAIN CONCLUSIONS TO BE RETAINED FROM SECTION 2 :

- Firstly, the industry analysis confirms the broad conclusion from the aggregate analysis in Section 1, namely that the US has achieved a significant turnaround in its labour productivity performance over the second half of the 1990s whereas the EU's long-run trend of declining productivity growth has, if anything, accelerated over the same period.
- Secondly, the superior performance of the US in ICT-producing manufacturing and ICT-using service industries is the source of the diverging productivity trends. While the ICT-producing manufacturing industries have been growing at a substantially faster pace than the associated ICT-using service industries, nevertheless it is the latter grouping which accounts for the largest part of the US upsurge in productivity. This higher contribution to growth from ICT-using service industries simply reflects their higher share in overall value added. Measurement issues also need to be borne in mind.
- The individual EU Member States show a high degree of dispersion in their respective performances, with four EU countries (Greece, Ireland, Austria and Portugal) all achieving labour productivity growth rates which matched or even exceeded those of the US over the period 1996-2000.
- Finally, Section 2.3 concluded that the overall contribution to labour productivity growth from ICT investments and from technical progress in the production of ICT goods and services accounted for about 60 per cent of US labour productivity growth over the second half of the 1990s, compared with 40 per cent in the EU. If one was to apply these ratios to the aggregate labour productivity growth rates given in Section 1, this would translate over the second half of the 1990s into an ICT contribution to labour productivity growth of around 1 percentage point in the US and 2/3 of a percentage point in the case of the EU.



SECTION 3 : KEY MACRO DETERMINANTS OF LABOUR PRODUCTIVITY GROWTH – AN ANALYTICAL FRAMEWORK

Following on from the aggregate and industry analyses in Sections 1 and 2, the present section builds on the insights gained so far in terms of explaining the relative growth performances of the EU and the US economies over the 1980s and the 1990s. While the highly industry-specific nature of the growth rate differentials in recent years cannot be disputed, it is nevertheless important to place these stylised facts into a more policy relevant context by examining the factors which have shaped the wider economic environment in both the EU and the US over recent decades.

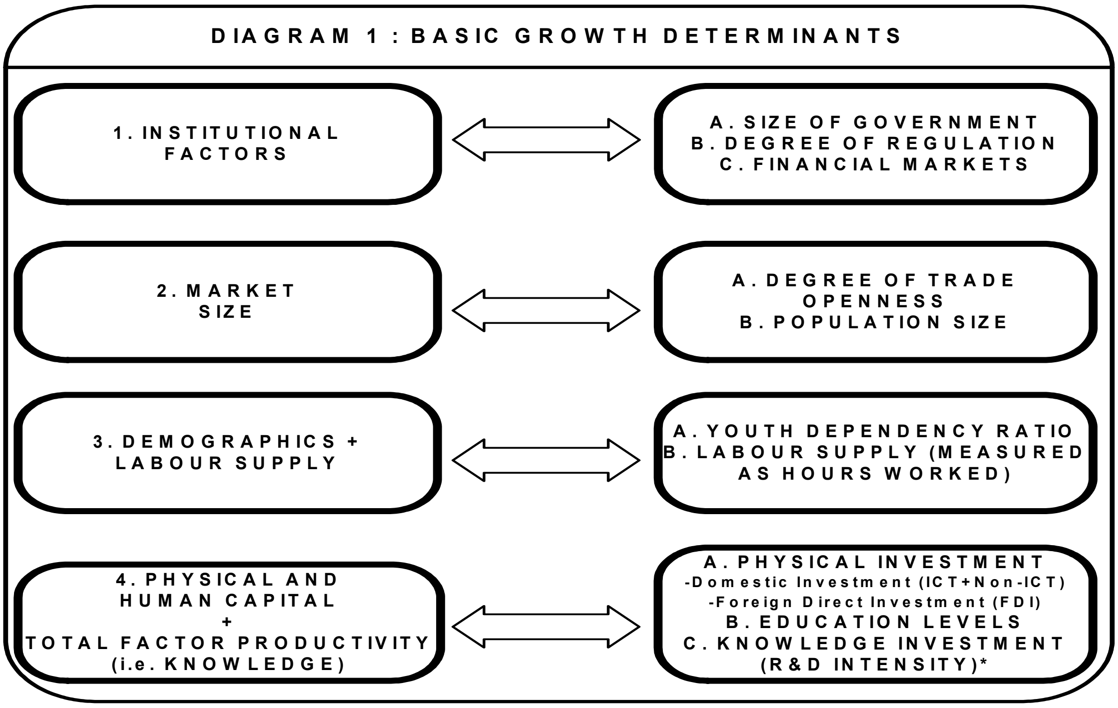
3.1 : THE BASIC PRODUCTIVITY DETERMINANTS : The achievement of a better understanding of the key determinants of productivity growth has been high on the research agenda of international organisations and the academic community for some decades now.[34] The present research represents an attempt to combine a detailed knowledge of these growth determinants (based on reviews of the literature and regression analysis) with the central policy concerns of European governments. It identifies five areas which are both quantitatively important for productivity and relevant in a European context i.e. the level of regulation; the structure of financial markets; the degree of product market integration; the size of knowledge investment; and the ageing of the labour force.

- **LEVEL OF REGULATION** : In recent studies both the OECD (2003) and the IMF (2003) have stressed that levels of regulation are potentially crucial driving forces for efficiency gains. Given the EU's relatively weak performance on a range of different measures of regulation, the IMF study concluded that deregulating the EU economy to US levels could increase output by nearly 7 per cent and productivity by 3 per cent in the longer term (see Bayoumi et al. (2003)). The OECD study pointed to deleterious effects in terms of physical investment rates and to a particularly negative impact from regulation in a panel of OECD service industries.
- **STRUCTURE OF FINANCIAL MARKETS** : In academic discussions a lot of attention has been given to the link between financial markets and growth (see, for example, Levine (1997)). Special emphasis is devoted to the question of the relative effectiveness of bank based or equity based financial systems. Could stockmarkets, for example, have special advantages in the commercial assessment of innovations or as vehicles for fostering international portfolio and direct investment? The question of financial market efficiency is also a central concern for the EU authorities, with the Financial Services Action Plan (FSAP) summarising a large set of policy initiatives aimed at improving the functioning of the EU's financial architecture.
- **PRODUCT MARKET INTEGRATION** : Related to the creation of the single market and EMU, the relationship between trade integration and productivity growth becomes relevant. Here again recent studies (see, for example Frankel and Rose (2000) and Alesina et al. (1998)) suggest significant gains from further integration. In this context, the initial benefits from increased trade openness

[34] See, for example, Bassanini, Hemmings and Scarpetta (2001).

amongst Euro area Member States are already beginning to emerge in the post-EMU environment.

- **KNOWLEDGE INVESTMENT** : With the striking impact of ICT, there has been considerable interest in analysing the effects of investments in knowledge and human capital formation. With Europe lagging behind not only in terms of ICT penetration rates but also with regard to other indicators of knowledge production (such as R&D investments and the share of high tech industries) the creation of knowledge capital has emerged as a central policy concern. Both the Lisbon process and the more recent EU growth initiative are concrete examples of ongoing policy programmes aimed at boosting the pace of innovation.
- **AGEING** : An unavoidable consequence of declining birth rates is an ageing of the labour force. While so far there has been little research carried out on the possible consequences of ageing for productivity, nevertheless there is a widespread suspicion that an older labour force will be less adept in creating and adopting new technologies. Given the magnitude of the demographic transition in Europe, it seems appropriate to explore the possible consequences for productivity of this "greying" phenomenon.



*Knowledge investment is in fact defined in much wider terms in the analysis to include spending on higher education, software as well as R&D spending.

In order to integrate all these diverse aspects into a unifying framework, growth regressions are used to draw lessons from the growth experiences of OECD member states over the last 2½ decades. In a more forward looking perspective, estimated multipliers are employed to provide some tentative projections concerning the possible impact of specific policy measures. On the analytical side an attempt is made to integrate recent developments in endogenous growth theory into the specification. This burgeoning growth literature combined with the distinctive nature of recent growth patterns has underlined the importance of knowledge production for productivity growth. In broad terms growth theory isolates two productivity enhancing channels, namely capital deepening and technical progress which is deemed proportional to knowledge. By looking at how these basic growth elements affect knowledge and physical capital formation enables one to establish a more nuanced understanding of the channels through which they affect productivity. A detailed technical description of the model used as well as a discussion of the theoretical linkages is provided in Annex 1, which also contains the regression results.

It must be mentioned at the outset that we are far from a complete understanding of the determinants of productivity. The growth experience since the mid 1990s is a reflection of continuous structural changes. Any empirical study which draws on past data must be aware of these shifts. Special emphasis will therefore be devoted to the issue of understanding recent trends. In interpreting these trends two main questions arise, firstly how do the basic growth determinants affect physical investment and knowledge production, and secondly what is the relative importance of physical and knowledge capital formation for productivity growth.

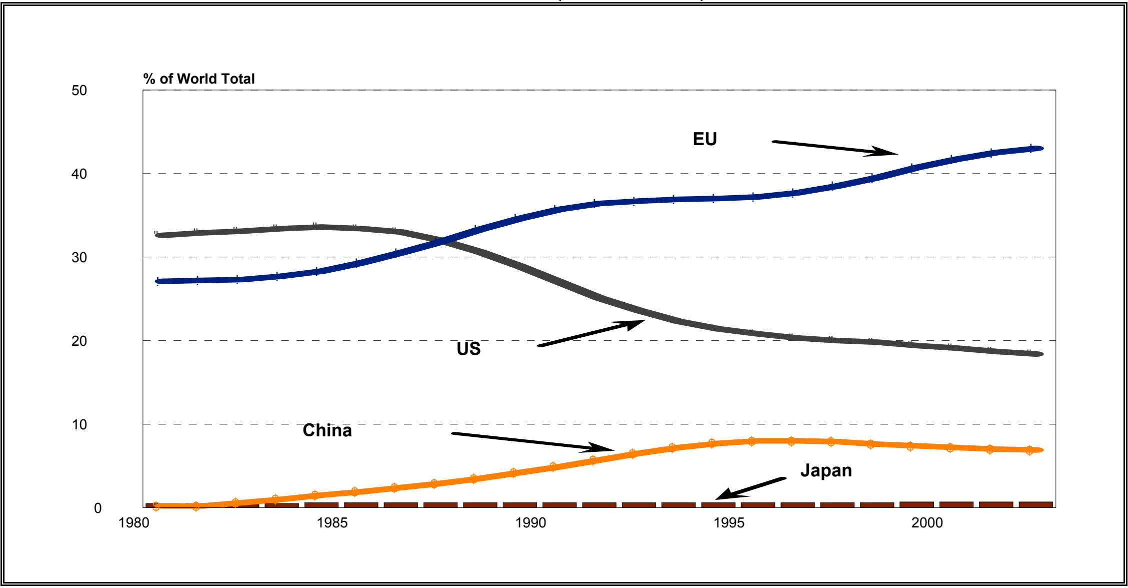
3.2 : How do the basic growth determinants affect investment and knowledge production ?

When analysing investment one has to take into account the fact that its structure is changing in at least two important dimensions:

- ***Firstly, the growth in the importance of more knowledge intensive forms of investment :*** The share of ICT investment in total investment has grown steadily over the 1990s, with the ICT share of non-residential gross fixed capital formation in the US presently approaching 1/3. ICT investment itself has not only a larger knowledge share in terms of software and R&D spending but is also complementary to skilled labour. In addition, overall R&D spending (whilst still comparatively small in terms of overall GDP) is playing a more prominent role in many of the more advanced economies.
- ***Secondly, the observed increase in the international mobility of capital*** : Technology, allied to globalisation and capital market liberalisation, has generated a huge increase in the volume of capital movements in general and FDI flows in particular. The growing importance of multinationals in determining worldwide investment trends is reflected in the fact that the stock of FDI assets have grown from around 5 per cent of world GDP in the mid 1980s to over 15 per cent at the end of the 1990s (see Box 2). In order to capture these structural shifts, it is important not only to look at aggregate investment but also at specific investment categories such as ICT, FDI and R&D.

BOX 2 : FDI

GRAPH A : FDI INFLOWS : TREND SHARES OF WORLD TOTAL FOR EU, US, JAPAN AND CHINA (1980-2002)



Source : UNESCO and own calculations

TABLE A : TREND PERCENTAGE SHARES OF TOTAL EU FDI INFLOWS (1970-2002)

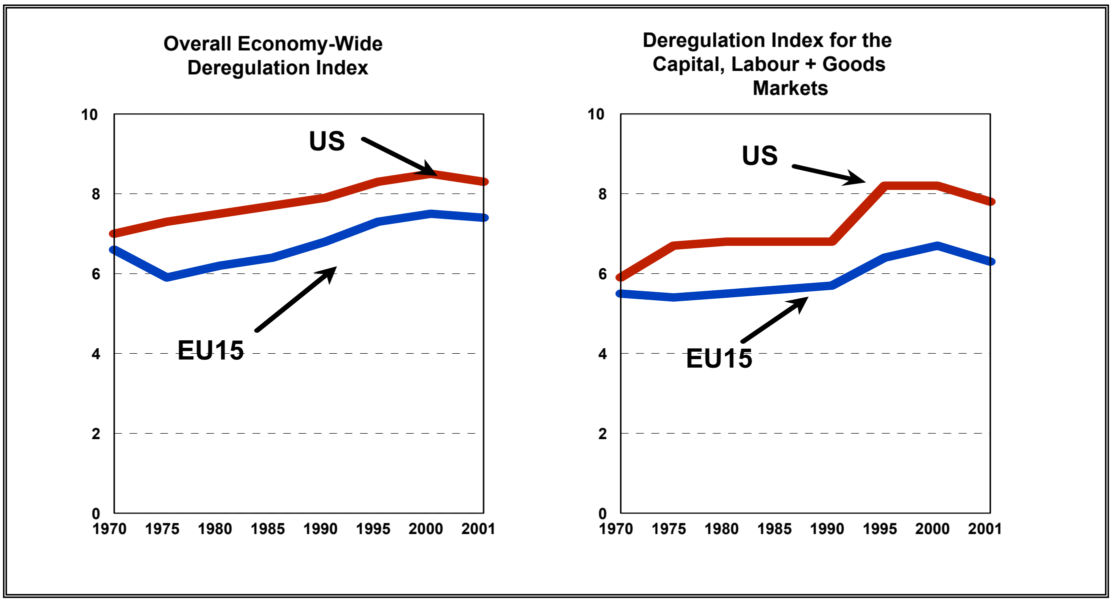
	1970	1980	1990	2000	2002
BELGIUM / LUXEMBOURG	7.0	8.3	9.5	18.2	19.7
DENMARK	2.5	0.7	1.6	3.1	3.0
GERMANY	21.5	7.5	4.8	12.3	12.8
GREECE	0.4	3.1	1.6	0.4	0.3
SPAIN	2.9	9.7	13.3	5.9	5.4
FRANCE	10.9	15.3	17.3	14.2	13.7
IRELAND	0.5	1.5	1.0	3.4	3.6
ITALY	10.1	5.6	5.7	2.7	2.7
NETHS	12.1	9.8	9.7	10.7	10.7
AUSTRIA	2.2	1.2	1.3	1.6	1.5
PORTUGAL	0.9	0.9	2.0	1.2	1.1
FINLAND	0.4	0.5	0.9	1.3	1.3
SWEDEN	1.3	1.3	4.3	6.8	6.5
UK	27.2	35.6	27.9	18.5	17.8

3.2.1 DETERMINANTS OF PHYSICAL INVESTMENT : Amongst all the various growth determinants assessed in the regression analysis in Annex 1, regulation appears to be the most important driver of investment rates. The degree of regulation plays an especially important role for foreign direct investment but it is also a crucial driver for new forms of investment such as ICT. These results are consistent with a recent empirical study by Alesina et al (2003) which uses OECD regulatory indices for service industries. As discussed in Annex 1, these results are in accordance with theoretical priors. There is also some evidence that equity based financial systems are more favourable to physical investment. Again, FDI flows are positively correlated with a more equity based structure for financial markets. Finally, education appears to be an important factor for foreign direct investment. These results suggest that in an environment characterised by increasing international capital mobility, levels of regulation, financial market conditions and human capital endowments are important determinants for the attractiveness of a country as an investment location.

DETERMINANTS OF R&D INVESTMENT : The determinants of knowledge investment are different to those of physical investment. Firstly, R&D is less affected by the regulatory environment. What seems to be more important for R&D is market size as measured by openness and population size. The lack of importance of regulation for R&D could be due to the fact that entry barriers are less important for R&D activities which are typically concentrated amongst incumbent firms

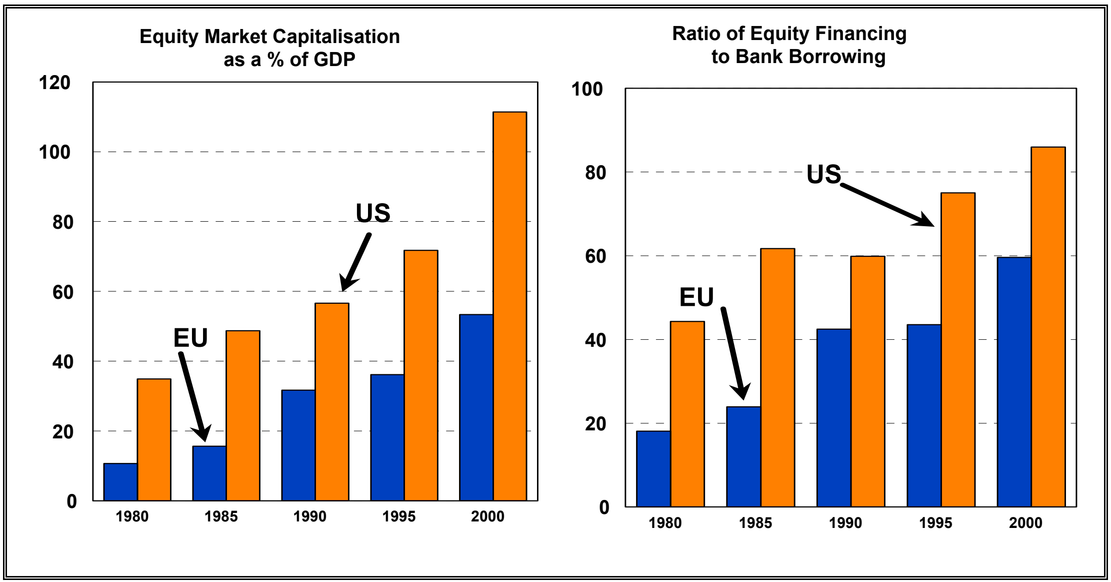
Also, theoretically the link between regulation and research intensity is less clearcut. Given the sunk cost nature of R&D activities, the prospects of more secure rents provided by product market regulations (for example in the form of higher protection against violation of property rights from new inventions) may act as an incentive for R&D.The sunk cost nature of R&D also makes it plausible that market size matters in that firms located in more open and/or larger economies will typically engage more strongly in R&D activities. Investments in R&D are usually more risky than in physical investments and therefore the attitude of all financial institutions towards the financing of such investments is important. More market based financing mechanisms, including equity markets and venture capital funds, tend to favour riskier investments. This is borne out in the empirical analysis where it is found that stock market turnover indices move more closely with R&D investment compared with bank credit measures. Whether this can be unambiguously interpreted in a causal sense is an open question. An alternative interpretation could be that stock markets simply value the returns from R&D investments more highly. This argument would be supported by the fact that R&D expenditures can equally well be explained by only concentrating on fundamentals such as market size, education and government involvement. In this case the role of education as a fundamental determining factor of R&D becomes more evident.

GRAPH 11 : FRASER INSTITUTE DEREGULATION INDICES



Source : Fraser Institute

GRAPH 12 : FINANCIAL MARKET INDICATORS



Source : World Bank, World Development Indicators (2002)

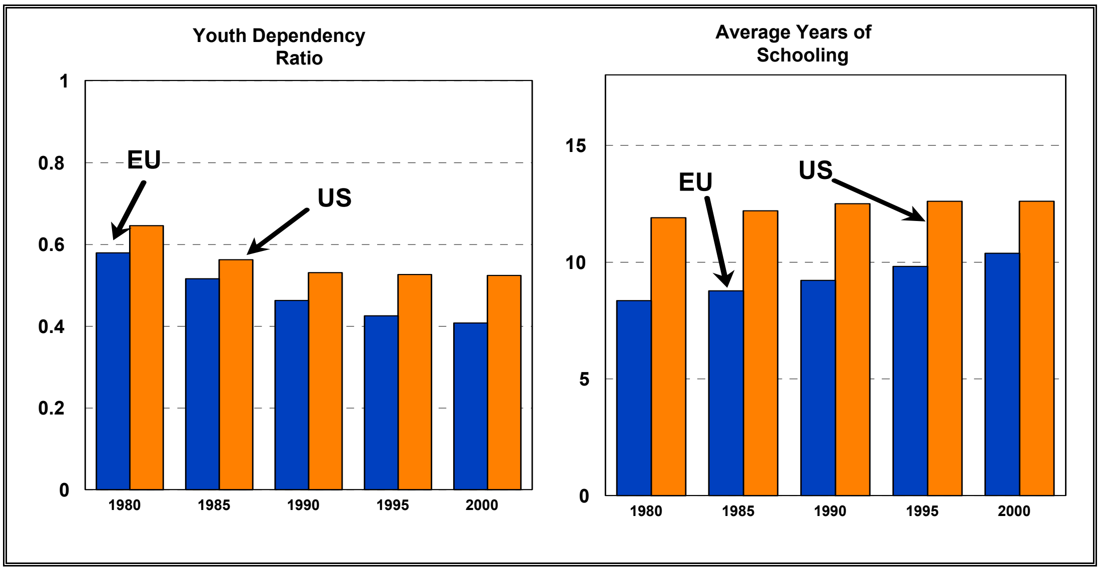
3.2.2 KNOWLEDGE PRODUCTION : THE EFFECT OF R&D, EDUCATION, MARKET SIZE AND DEMOGRAPHIC INFLUENCES : In addition to analysing the specific determinants of R&D investment (see Table A1), Annex 1 also assesses the role of R&D as one element in the overall knowledge production process in economies (Table A2). In this context, the empirical growth literature emphasises knowledge and the creation of knowledge via the investment activities of firms, households and the government in both R&D and education as crucial for enhancing the level of technology (i.e. TFP). As shown in Table A2, both R&D as well as education are significant drivers of total factor productivity.

Like in the case of R&D, only a limited role is found for deregulation in boosting the growth of knowledge.[35] ECFIN's results broadly occupy a mid-point between a 2003 joint CEPR and IFS study which reports a negative association between regulation and TFP and an OECD (Nicoletti and Scarpetta (2003)) study which finds a more positive effect of deregulation on TFP.

Trade openness/market size also appears to be especially important. However, it is interesting that this particular determinant only affects TFP growth via its impact on the level of R&D investment. This is suggestive that country size/scale effects bestow no particular efficiency gains in terms of other aspects of productivity growth.

Another important feature revealed by these regression results is the impact of an ageing labour force on TFP. Since the mid 1970s the youth dependency ratio has declined in all OECD countries. This has led to a reduction in the inflow of young workers into the labour force and has increased their mean age. Little is known so far on the impact this might have on the creation and adoption of new ideas and technologies. The results reported in Table A2 suggest however that this process could have been one of the main contributors to the slowdown in productivity growth.

GRAPH 13 : DEMOGRAPHICS + EDUCATION



SOURCE : WORLD BANK, DE LA FUENTE AND DOMÉNECH, OWN CALCULATIONS

WHAT IS THE RELATIVE IMPORTANCE OF PHYSICAL INVESTMENT AND KNOWLEDGE CAPITAL FORMATION FOR PRODUCTIVITY GROWTH ? : The previous paragraphs have described how the basic determinants affect physical capital formation and the creation of knowledge. The present section looks at the relative contribution of these two factors to labour productivity growth when they are combined with two other

[35] The fact that regulation is neither significant for R&D nor for TFP points in the direction that the link between regulation and moving the technology frontier is rather weak. Any gains from deregulation in terms of technological catching-up or from privatisations should therefore be interpreted more in terms of static efficiency gains and not with the dynamic gains needed for outward shifts in the technology frontier.

factors, namely the growth in the employment rate and the potential for catching-up. The neoclassical growth model makes fairly precise quantitative predictions concerning these four factors, with Annex 1 showing that the estimated labour productivity growth contributions from the ECFIN model are very close to those predicted by the neoclassical model. The main results are as follows:

1. Physical investments and the impact of regulation :

- ***Physical Investment :*** A permanent 1 % point increase in gross fixed capital formation results in a 1.8 per cent long run effect on the level of labour productivity. This is equivalent to an annual average effect of 0.05 on the growth rate of labour productivity in the long run (i.e. over 30 years).
- ***Regulation :*** The implied change of moving to US levels of regulation, as measured by the Fraser index, would suggest a long run labour productivity effect of about 5 per cent (i.e. 0.15 on the long run growth rate of productivity).

2. Knowledge investments (TFP effects) :

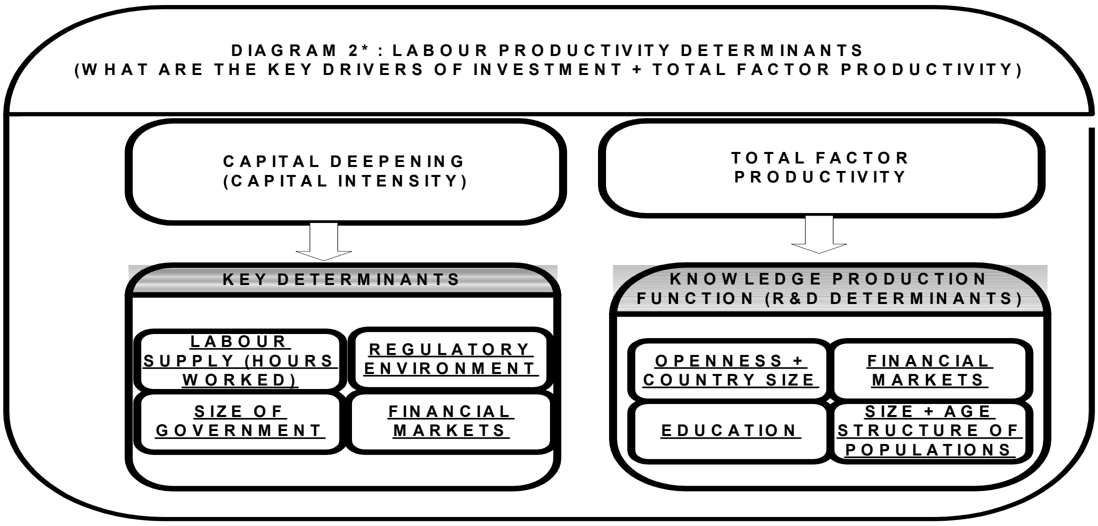
- ***R&D*** : A permanent increase in the share of R&D in GDP of 1 % point would increase the long run level of TFP by nearly 18 per cent (i.e. 0.6 of a % point on the long run growth rate of productivity).
- ***Education*** : A permanent increase of 1 year in the average education levels of the labour force would lead to a long run level effect on TFP of close to 13 per cent (i.e. 0.45 on the long run growth rate of productivity).
- ***Ageing*** : A permanent 10 % points decline in the youth dependency ratio would reduce the long run level of TFP by 6.8 per cent (i.e. 0.25 on the long run growth rate of productivity)
- ***Openness and market size*** : A permanent 10 % points increase in intra-Euro area trade would result in a long run gain in TFP of 3 per cent (i.e. 0.1 on the long run growth rate of productivity).

3. Hours Worked : A permanent 1 % increase in hours worked lowers the long run rate of productivity growth by about 0.25 percent.

4. Catching-Up : In terms of the speed of convergence, the results confirm the established literature result of a long run, annual, catching-up effect of roughly 2 per cent.

TABLE 10 : OVERVIEW OF LONG RUN EFFECTS OF LABOUR PRODUCTIVITY DETERMINANTS

MAJOR DETERMINANTS	EFFECT ON ANNUAL LABOUR PRODUCTIVITY GROWTH RATE (PERCENTAGE POINTS)
PHYSICAL INVESTMENTS + REGULATION (CAPITAL DEEPENING)	
1. Physical Investment (Permanent 1 % point increase in Investment Share)	0.05
2. Regulation (EU moving to US levels of regulation)	0.15
KNOWLEDGE INVESTMENTS (TFP)	
3. R&D (Permanent 1% point increase in R&D spending)	0.60
4. Education (Permanent 1 year increase in average education levels of labour force)	0.45
5. Ageing (Permanent 10% points decline in youth dependency ratio)	-0.25
6. Openness & Market Size (Permanent 10% points increase in intra-Euro area trade)	0.10
HOURS WORKED (CAPITAL DEEPENING)	
7. Permanent 1 % increase in Hours Worked	-0.25



* This diagram gives an overview of the ECFIN productivity model in terms of the key determinants of capital intensity and TFP. The model specifies productivity growth as being generated by 4 distinct activities, namely the investment of firms in both physical and knowledge capital, investment of households in human capital and changes in labour supply. As discussed in the text and Annex 1, the separate analysis of investment showed clearly that the variables used in the aggregate productivity regression affected different types of investment in very different ways. In addition, the separation into gross fixed capital formation and R&D also indicated both a physical investment and a TFP channel to labour productivity. Both components are manifestly closely linked, and interact with each other in influencing labour productivity, with knowledge investment simply being an input into the overall investment process in an economy. In overall terms, consistent with the neoclassical growth framework, the ECFIN model predicts that the level of labour productivity is influenced positively via knowledge production and the investment rate, and with a negative effect from growth in the labour input (as measured by hours worked). A fourth factor, to be considered, would be the potential for catching-up.

SECTION 4 : PRACTICAL APPLICATIONS OF ANALYTICAL FRAMEWORK

The present section provides a number of examples of how this framework can be used to further our understanding of past (Sub-section 4.1) and future (Sub-section 4.2) labour productivity developments.

4.1 HISTORICAL ANALYSES : WERE THE LATE 1990S EXCEPTIONAL IN TERMS OF ICT AND LABOUR MARKET TRENDS ? : Here we assess two questions which have emerged in the previous sections. Firstly, how large a role did ICT technologies play in explaining the growth rate differentials which were experienced and secondly to what extent was the slowdown in productivity growth in Europe simply a reflection of the higher employment content of growth.

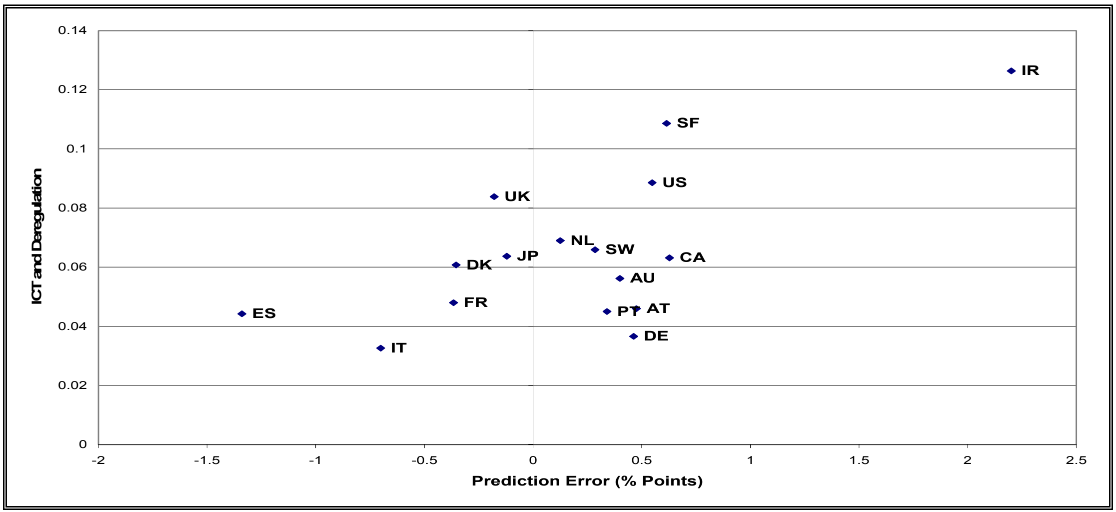
ROLE OF ICT IN THE 1990S *:* Since the mid 1990s changed patterns and rankings of countries in terms of productivity/TFP growth have been increasingly observed. Relative productivity growth seems strongly related to the degree to which countries have been producing, or investing, in ICT. Given that the knowledge production function does not explicitly capture these ICT effects, how can we reconcile this with the observed developments? There are four possibilities:

- ***Hypothesis 1:*** The knowledge generating factors as identified by the knowledge production function, namely R&D and human capital investment can explain the international TFP growth patterns since the mid 1990s.
- ***Hypothesis 2:*** There is a large industry specific element which plays a role. Countries with high ICT industry shares have benefited from the positive productivity shocks taking place in these industries. Alternatively those countries which are high ICT users have benefited from technological spillovers.
- ***Hypothesis 3:*** It is true that the ICT revolution was industry specific, but it was not confined to a specific country. With high capital mobility, those countries which offered attractive investment locations in terms of flexible labour and goods markets and/or young labour forces which were open to the adoption of new technologies, benefited most from the ICT boom.
- ***Hypothesis 4:*** Both industry specialisation (Hypothesis 2) as well as flexibility in the adoption of new technologies (Hypothesis 3) have interacted positively.

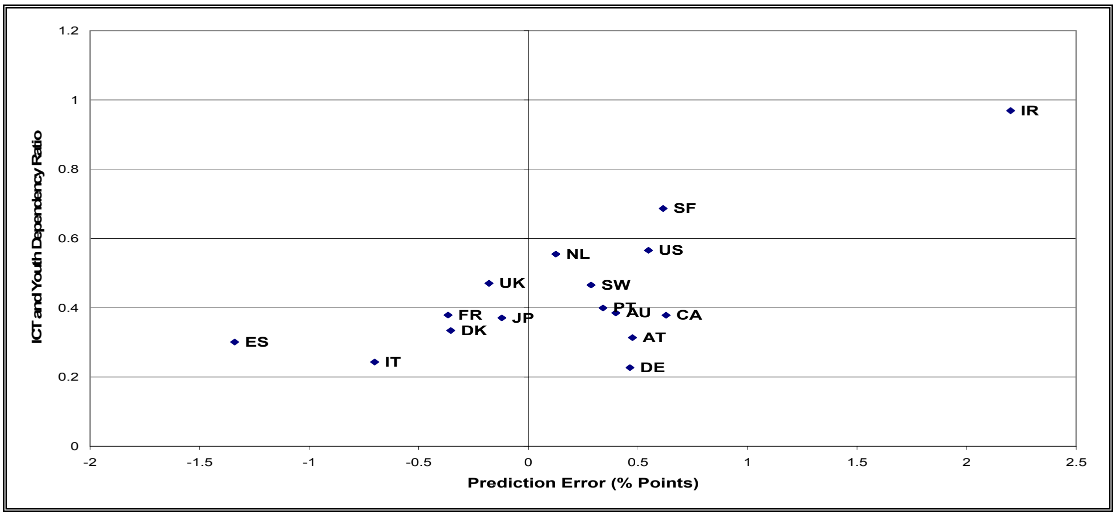
ASSESSING THE 4 HYPOTHESES (SEE TABLE A2.1 IN ANNEX 1) *:* The empirical analysis conducted in Annex 1 is based on explaining the prediction errors for the late 1990s of the knowledge production function (i.e. did the model under- or over-predict TFP per hour growth rates over the period and what can explain these prediction errors). It turns out that hypothesis 4 offers the best explanation for the cross country variation of prediction errors. As can be seen clearly from Graphs 14 and 15, there is a strong relationship between the ICT production share of a country (which is the best measure of its degree of industry specialisation), when interacted with either the regulatory burden or the age of the labour force, and the size of the deviation of actual

TFP growth from the predicted growth rate.[36] This supports the interpretation whereby countries, some of which are in the EU, which have low regulatory burdens and a comparatively young labour force (creating favourable conditions in terms of technology adoption), have been better able to exploit the technological developments occurring in the mid-1990s compared with other countries and have consequently gained in terms of higher TFP growth. In relative terms, with a strong correlation between the ICT production share and TFP growth, the analysis also indicates that industry specialisation (Hypothesis 2) is probably more important than the degree of regulation and the age of the labour force (Hypothesis 3) in explaining the TFP prediction errors. Finally, the clear patterns emerging for these prediction errors also leads one to reject Hypothesis 1.

GRAPH 14 : TFP PREDICTION ERROR CORRELATED WITH ICT PRODUCTION SHARE AND DEREGULATION



GRAPH 15 : TFP PREDICTION ERROR CORRELATED WITH ICT PRODUCTION SHARE AND YOUTH DEPENDENCY RATIO



[36] The predicted growth rate of TFP would be the rate expected on the basis of the R&D and educational inputs in the corresponding country.

LINK BETWEEN HOURS WORKED AND PRODUCTIVITY DEVELOPMENTS *:* In explaining growth patterns over the second half of the 1990s, an assessment of the short and long run effects on labour productivity of a significant boost to employment (as measured in hours worked) is important to assess the extent to which the present downturn in EU labour productivity is a permanent or a short run phenomenon. Since the mid 1990s the EU has been experiencing a trend change in labour input. While in the 1970s, 1980s and early 1990s the growth rate of the labour input was negative on average, a positive labour input growth was observed over the period 1996-2002 of 0.9 per cent on an annual average basis. According to the estimates presented in Table A4, this increase in employment growth (when compared to a hypothetical zero baseline growth) has had the effect of slowing down EU labour productivity growth by about a ¼ of a percentage point per annum over the period in question.

4.2 LISBON SCENARIO : CAN THE EU OVERTAKE THE US IN PRODUCTIVITY AND GROWTH TERMS BY 2010 ?

This section focuses on the effects of policy actions in both the TFP and capital accumulation areas aimed at boosting future EU labour productivity growth. The simulation presented here focuses, for illustrative purposes, on measures aimed at achieving the specific Lisbon target of making Europe the most competitive, knowledge based, economy in the world by 2010. Realising this ambition will require the implementation of far reaching structural reforms in a large number of the Member States. Two supply side initiatives have received a lot of media attention, namely deregulation and boosting the knowledge economy. In both cases, for simplicity, the US will be used as the benchmark:

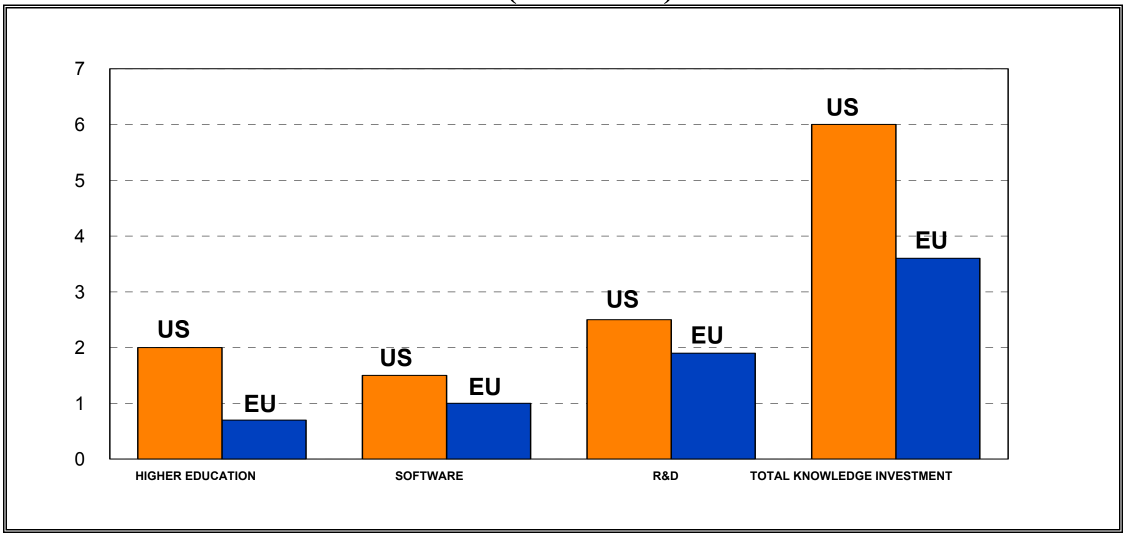
- **REGULATORY REFORM** *:* Due to significant negative effects from the regulatory framework on investment, policy makers should consider putting a greater emphasis on regulatory changes in their reform agendas. The earlier Graph 11 provided, on the basis of Fraser Institute indices[37], a quick overview at the EU level of the existing differences with the US. The Graph presented both an economy-wide deregulation index as well as one relating specifically to the capital, labour and goods markets. It is assumed that EU-US differences in terms of the overall economy-wide index are eliminated between now and 2010. As shown in Annex 1, even a relatively rapid deregulation towards US levels would not lead to sufficient productivity gains over the next 7 years to close the present efficiency gap of roughly 10 per cent with the US. Even our more favourable results (when compared to the IMF WEO (2002)) would only give a boost to the level of labour productivity of less than 0.2 annually up until 2010 under the condition that reforms are implemented quickly (see

[37] The OECD has compiled various regulatory indicators, for example measuring legal barriers to entry or administrative burdens for startups. Unfortunately these indicators are normally only available for a single year (1998) and therefore they cannot be used to explain changes in economic performance since the mid 1970s. The Fraser institute index has the advantage of having a time dimension. It is, however, possible to compare the Fraser and OECD indicators by correlating them with each other at least for the year in which both are available. In fact both indicators (see CEPR-IFS Study (2003), pp. 64) are highly negatively correlated, which should be expected since the Fraser index measures the degree of deregulation whilst the OECD indicators measure regulation. The maximum correlation is found for the OECD "administrative burdens on startups indicator" (-.57), which suggests that the Fraser index is indeed a reasonable measure for entry barriers.

Table A5). A major reason why this would not be sufficient is – according to this analysis – the limited dynamic efficiency gains of deregulation. This suggests that deregulation must be accompanied by measures which increase knowledge production.

- **KNOWLEDGE PRODUCTION** : The second element of this illustrative "Lisbon" package is action to boost TFP growth. On the TFP side, action is needed to boost investment in the knowledge economy, in terms of higher spending on third level education, software and R&D.[38] With respect to R&D, as Box 3 points out, the focus should not be on boosting public R&D spending directly, but on creating the conditions which will promote an endogenous increase in research spending.[39] The empirical analysis has identified three main channels through which this could be achieved, namely higher product market integration, education and more efficient financial markets. Market size seems to be a crucial determinant for R&D, since the development of new products typically involves large sunk costs. Since research activities are human capital intensive, education is an essential requirement for any R&D activity. Finally, more equity based financial structures seem to have promoted the "riskier" forms of investment, such as R&D, more strongly than bank based systems.

GRAPH 16 : INVESTING IN THE KNOWLEDGE ECONOMY : EU V US : 1998 (% OF GDP)



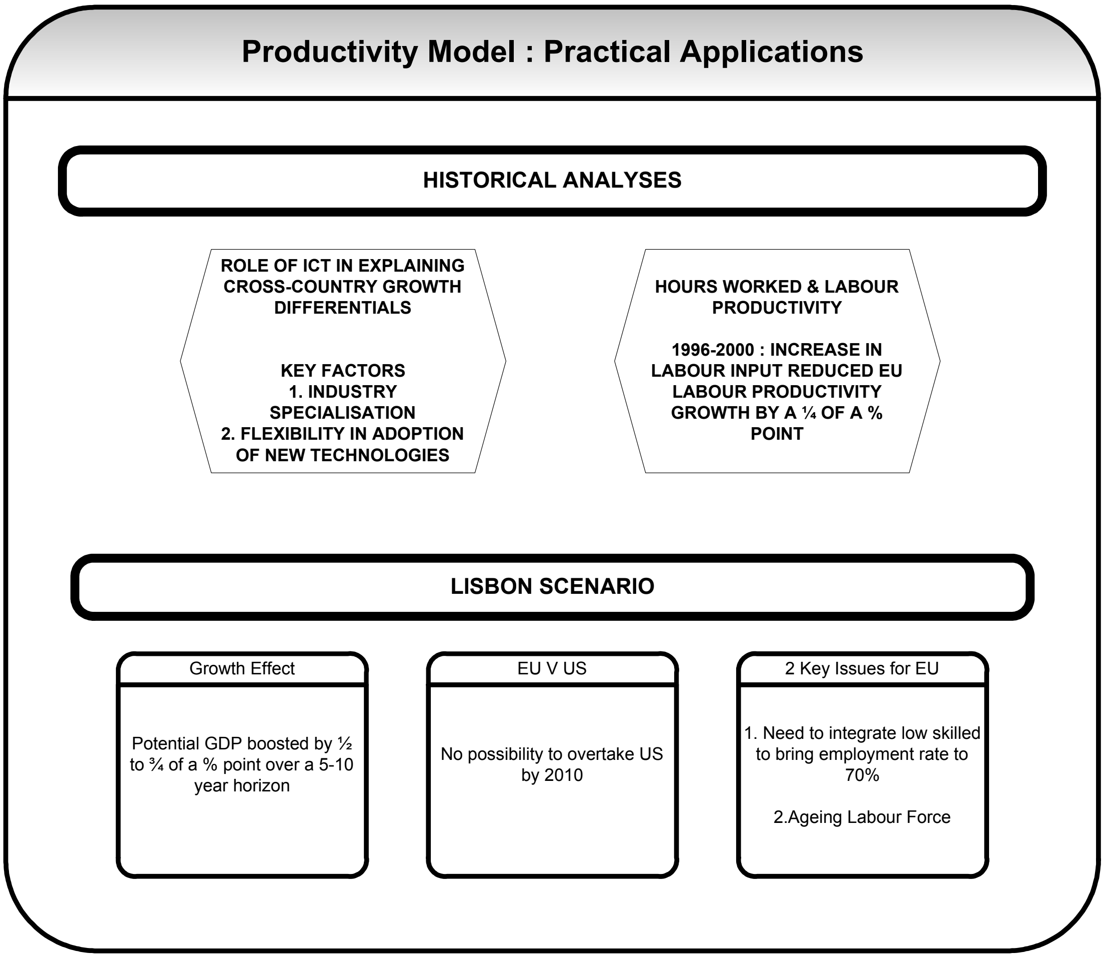
SOURCE : OECD

KEY RESULTS OF "LISBON STRATEGY" SIMULATION : The effect of introducing such a large package of supply side reforms over the coming years would be to significantly boost EU potential growth rates, on average by between ½ to ¾ of a percentage point over a 5-10 year horizon. However, even if one assumes a no-policy change scenario in the US, there is no question of the EU overtaking the US over the

[38] See OECD (2001) and Guellac and Van Pottelsberghe (2001). For a discussion on recent trends in R&D intensity, see OECD (2000) "Science and Technology Outlook".

[39] The wide variation across industries in the expected returns from R&D activities suggests that direct forms of support to specific industries should be avoided in favour of a more market-based, tax credit, approach, except in instances where potentially large social benefits can be credibly predicted.

timescale laid out by the Lisbon agenda. Apart from the time it will take from the implementation of reforms to the appearance of visible effects, there are two further obstacles to reaching the productivity target, firstly the need to integrate the predominantly low-skilled part of the EU's potential labour force to reach the Lisbon employment target of 70 per cent and secondly the continuous drag on productivity induced by Europe's ageing labour force. This "Lisbon" simulation highlights the extent of the challenge facing EU governments in their efforts to boost the supply side potential of their respective economies.

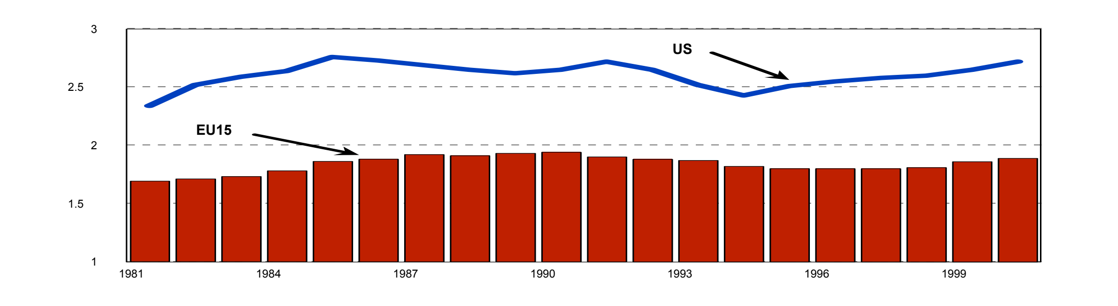


Box 3 : Some points regarding R&D spending in the EU and the US

This box discusses the issue of R&D spending and TFP growth. In our view the focus should not be on simply boosting R&D spending in the EU directly. The emphasis must be on creating the conditions which are conducive to an endogenous R&D response. This box would like to stress the following three issues :

- **1. Persistent Differential in US and EU15 expenditure levels on R&D :**

Graph A : R&D Expenditure as % of GDP : US + EU15



Source : OECD

- **2. The high risk attached to R&D Spending** : The table below shows clearly that while high R&D spending in the ICT area paid off in spectacular fashion, if one looks at other manufacturing sectors which are classified as being R&D intensive sectors, the R&D returns are of a much more subdued nature. Nevertheless R&D returns are higher in these non-ICT, R&D intensive, manufacturing sectors compared with the rest of manufacturing and it is a little unfair to compare these more mature R&D intensive industries, such as chemicals and motor vehicles with the newer ICT producing industries.

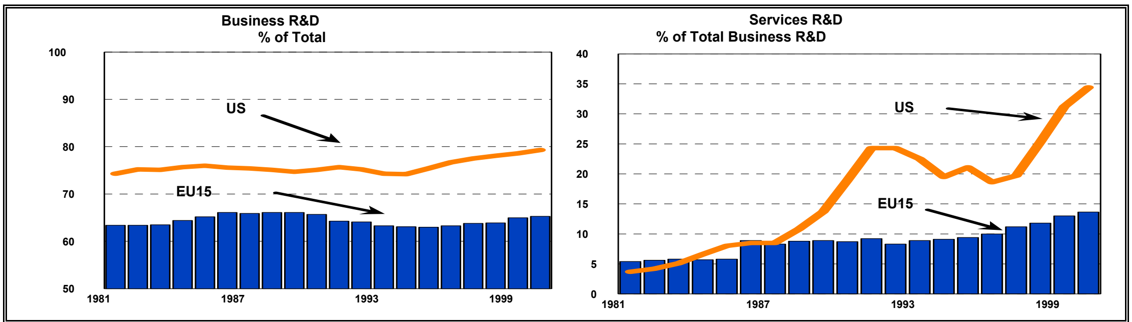
Table A : Manufacturing Industries : R&D Spending and Productivity Growth

	Average Change in Labour Productivity per Hour			Contribution to Total Change in Labour Productivity per Hour		
	1980-1990	1991-1995	1996-2000	1980-1990	1991-1995	1996-2000
1. ICT-Producing Manufacturing Industries						
EU	13.8	10.3	17.9	0.2	0.2	0.2
US	15.7	15.0	24.5	0.4	0.4	0.6
2. Non-ICT Manufacturing but R&D Intensive						
EU	3.1	4.1	2.1	0.2	0.3	0.2
US	1.6	2.2	1.8	0.1	0.2	0.1
3. Rest of Manufacturing						
EU	3.4	3.0	1.7	0.6	0.4	0.2
US	1.3	1.3	0.3	0.2	0.1	0.0

Source : DG Enterprise / Groningen Growth and Development Centre (GGDC), ECFIN calculations

- **3. Higher Share of Business Sector R&D in total Spending in the US + Sharply Rising Share of Services Sector R&D Expenditure** : The graphs below underline firstly, that the US has consistently had a much higher share of its R&D spending carried out by the business sector as opposed to the government sector and secondly that since the late 1980's there has been a large increase in the divergence between EU and US R&D spending in service industries. At the end of the 1990's between 30-35% of all R&D spending in the US has occurred in service industries, compared with a share of 10%-15% for the EU. Is there a link with the performance with the ICT-related service sector as a whole which was described in Section 2 ?

Graph B : Business Sector R&D Expenditure as % of Total
+ R&D Spending on Services as % of Total Business Sector Spending



Source : OECD

SUMMARY AND CONCLUDING REMARKS

SUMMARY

This paper has examined the evidence at both the aggregate and industry levels to assess the hypothesis that a new growth pattern has emerged in the US and a small number of the EU's Member States since the mid 1990s. More specifically, the objectives of the study were twofold:

- Firstly, to establish the stylized facts concerning growth and labour productivity, using a growth accounting approach at the aggregate and industry levels; and
- Secondly, to exploit a new framework for productivity analysis to derive policy lessons from the post-1995 growth experience which, in the context of the Lisbon policy strategy, can be harnessed to boost growth and convergence in the EU as a whole over the medium to long term.

STYLIZED FACTS : EU employment and productivity growth patterns have diverged sharply over recent years. Compared with the first half of the 1990s, the period 1996-2002 has witnessed a significant increase in the contribution of labour to EU GDP growth but unfortunately these gains have been largely offset by a reduction in the contribution from labour productivity. By comparison, over the same timeframe, the US has enjoyed a combination of strong employment increases allied to an acceleration in labour productivity.

Even allowing for the fact that employment and labour productivity trends in the EU may be negatively correlated[40], the reversal of past productivity patterns in the 1990s relative to the US has nevertheless been striking. For the first time in the post-World War II period, the EU is now on a trend productivity growth path which is lower than that of the US. Since the mid-1990s, the EU has proved incapable of arresting the long-run decline in its productivity performance whereas the US has enjoyed a notable recovery in its secular trend. Productivity per hour growth rates in the US have in fact started to recover to the rates of growth last experienced in the 1960s. While accepting that the present productivity per hour level differences between the EU and the US are still only of the order of around 10 per cent[41], on the basis of an extrapolation of present trends and policies, and mindful of the ongoing imperative to boost employment rates, the EU as a whole looks destined to experience a significant widening in its productivity gap relative to the US over the coming years.[42]

[40] ECFIN estimates that roughly a quarter of the slowdown in EU labour productivity growth over the second half of the 1990's can be attributed to the higher employment content of growth. However, no policy trade-off should be implied from this negative correlation, with action on both the employment and productivity fronts capable of being taken on a simultaneous basis. Labour market reforms aimed at boosting employment rates only lead to a temporary reduction in measured productivity growth, with no negative implications for the long-run productivity growth of the existing workforce. In addition, a higher employment rate implies an unambiguous increase in GDP per capita.

[41] This 10 per cent figure underestimates the differential since the EU has still a long way to go to reach US employment rates, which will involve the integration of a significant proportion of low skilled workers which will have negative implications for measured labour productivity, at least over the short to medium term.

[42] At the individual EU Member State level, a much more nuanced picture emerges in terms of the EU's performance relative to the US. In terms of labour productivity, over the period 1996-2000, it turns out that 7 of the EU's smaller Member States had performances which were not only well above the EU average but were

WHAT EXPLAINS THE DETERIORATION IN THE EU'S LABOUR PRODUCTIVITY TREND RELATIVE TO THE US AT THE TOTAL ECONOMY LEVEL? : The most important point to underline in terms of aggregate productivity trends is that although a number of the EU countries have performed well over the second half of the 1990s, the EU as a whole has a productivity problem relative to the US. While the sources of the deterioration in EU labour productivity are difficult to disentangle, from a purely growth accounting perspective the 1 percentage point decline in labour productivity experienced over the period 1996-2002 compared with the first half of the 1990s appears to emanate from the following factors:

- Firstly, roughly 50 per cent of the decline can be attributed to a reduction in the contribution from capital deepening. Within this category, whilst investment in IC technologies was contributing positively (but not as positively as in the US), the rest of investment performed poorly. The smaller non-ICT capital-deepening component in EU labour productivity growth appears to be due firstly to a reversal of the unfavourable capital/labour substitution of earlier periods and secondly to a more worrying downward trend in non-ICT investment rates generally (which may be linked to locational investment considerations or to adverse demographic trends). In terms of the capital/labour substitution factor, this can be seen as the flip-side of the more employment intensive growth pattern experienced over the period. As noted earlier, a move towards full employment may entail a temporary reduction in measured productivity growth, but this should not be regarded as a trade-off in any sense.
- Secondly, the remaining 50 per cent of the decline in labour productivity growth emanates from a deterioration in terms of total factor productivity. This probably should be seen as the greatest source of concern for policy makers since changes in total factor productivity are generally attributed to a more efficient resource utilisation emanating from enhanced market efficiency; from technological progress resulting from investments in human capital, R&D and information technology; or from the natural catching-up process of the less developed EU countries through increased business investment in general. Again, as with the capital deepening channel, there has been a positive contribution to EU TFP growth from ICT (but again less than in the US although the differential is not as great as with ICT investment). Consequently, the non-ICT contribution to TFP has fallen more than TFP as a whole.

also significantly higher than that of the US. 3 of the 7, namely Ireland, Finland and to a lesser extent Sweden were also capable of combining strong productivity growth with high labour utilisation rates.

WHAT HAVE WE LEARNED FROM THE INDUSTRY ANALYSIS ? : The industry decomposition added some significant new details in terms of our understanding of the sources of the EU-US labour productivity differentials. It focussed in particular on trying to decompose the overall change in productivity into the effects which can be associated with the ICT and non-ICT parts of the economy.[43] It also showed at the individual EU country level that it was the deterioration in the productivity performance of a number of the larger Member States, most notably Italy, over the second half of the 1990s, which was responsible for the deterioration in the overall EU performance.

ICT PART OF EU AND US ECONOMIES (ICT-PRODUCING AND ICT-USING INDUSTRIES) : As with the aggregate analysis, the industry breakdown showed that ICT has indeed been a significant driver of labour productivity trends in both the US and the EU. Accurately measuring the overall contribution from ICT is difficult however since it is only possible to directly measure the effect of two of the transmission channels from ICT to productivity growth, namely the effect emanating from a sharp increase in ICT investment as a share of total investment[44] and secondly the contribution from technical progress in ICT-producing industries to overall TFP growth. The effect of the third transmission channel (i.e. positive growth spillovers from ICT investments, including both embodiment and network externalities) cannot be directly measured and consequently is the subject of much controversy. On the basis of an assessment of the first two channels, it would appear that around 60 per cent of US labour productivity growth at the end of the 1990s can be attributed to ICT with a contribution of roughly 40 per cent in the case of the EU.

NON-ICT PART OF EU AND US ECONOMIES : The industry analysis re-affirmed the earlier conclusion that ICT is only part of the story behind the rising US and declining EU labour productivity trends. Given that ICT has been contributing to both capital deepening and TFP in the EU, the deterioration in EU productivity over the two halves of the 1990s has therefore occurred in the non-ICT, more traditional, industries. Since these industries accounted for around 70 per cent of total EU output in the year 2000, it is a source of deep concern that both their capital intensity and overall efficiency patterns appear to be deteriorating. In addition, these are the parts of an enlarged EU economy which are facing the greatest competitive challenges from globalisation. By contrast, for the US, the non-ICT industries showed an improving trend for both capital deepening and TFP (but not as dramatic as for the ICT-related industries), with some commentators suggesting that part of the improvement in non-ICT TFP growth may be due to positive spillover effects from ICT investments in other industries[45].

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[43] This decomposition into ICT and non-ICT industries was based on the GGDC's ICT intensity breakdown of all industries. In total 25 of the 56 industries are classified as either ICT-producing or heavy ICT-using industries, with 31 in the non-ICT part of the respective economies. In terms of shares of value added, in the year 2000, ICT intensive industries represented 37 per cent of US value added compared with 32 per cent for the EU.

[44] For example in the year 2000, ICT investment represented 30 per cent of all non-residential gross fixed capital formation in the US.

[45] It is interesting to note (see Annex 3) that productivity trends in the non-ICT intensive manufacturing industries are broadly similar in the EU and the US with both areas experiencing productivity declines. These are the parts of the EU and US economies which at the moment are facing the greatest competitive challenges from globalisation (this could soon be extended to the more traditional service industries due to the ICT and telecommunication revolutions). It is clear that the US and the EU have both been badly affected by competition from low cost producers in China, Mexico and Eastern Europe in these more traditional industries such as textiles, footwear and motor vehicle manufacturing. What is more interesting in terms of explaining

MOST IMPORTANT INDUSTRIES FROM A LABOUR PRODUCTIVITY PERSPECTIVE : In the ICT and non-ICT parts of the US and EU economies there are a total of 56 different industries but from a labour productivity growth perspective, just 5 of these industries dominate the overall patterns, with all of these industries in the ICT-producing and ICT-using areas of the respective economies.[46] Of these 5 industries, the US outperforms the EU in 4, namely in one ICT-producing manufacturing industry (i.e. semiconductors and other electronic equipment) and in 3 ICT-using service industries (i.e. wholesale trade; retail trade; and financial services). On a more encouraging note, the EU is dominant in one ICT-producing service industry, namely telecommunications. It is interesting to point out that whilst productivity in ICT-producing manufacturing industries has been growing at a significantly faster pace than the associated ICT-using service industries, it is the latter group of service industries which accounts for by far the greatest proportion of the US upsurge in productivity.[47] Some caution may therefore need to be exercised given the well-documented measurement issues in a number of these service industries.

WHAT ROLE COULD POLICIES PLAY IN FUTURE PRODUCTIVITY PATTERNS ? A 'LISBON STRATEGY' SCENARIO : Having established the stylized facts from the aggregate and industry analyses, the logical next step was to place these results into a more policy relevant context. This is particularly important given the diverse experiences of the EU's individual Member States, with many of the latter outperforming the US in terms of labour productivity over the period being discussed. The key policy question addressed was whether all the EU countries that experienced high productivity growth and the US shared certain common characteristics which could explain their superior performance. More specifically what were the channels via which the more fundamental factors driving growth (i.e. institutions, trade, market size, education and labour supply/demographics) affected investment and total factor productivity (TFP) in these countries and how did these latter two factors interact to generate labour productivity growth.

The productivity model which is developed looks at these issues and specifies productivity growth as being generated by 4 distinct activities, namely the investment of firms in both physical and knowledge capital, the investment of households in human capital formation and changes in labour supply.[48] Using this model, the analysis shows that EU-US productivity differentials can in fact be related to some fundamental structural differences at the individual country level, with five areas

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the declining EU trend is what is happening in the traditional service sectors (hotels and restaurants, transport, utilities) which still account for 30% of EU output where EU labour market reforms are having a big impact. The equivalent US industries have over the last 20 years basically registered no labour productivity growth whereas Europe was getting 1 ½ - 2 % annual productivity growth rates from these industries. Over the second half of the 1990's, however, labour market reforms in a number of EU member states have boosted the numbers of low skilled workers entering these sectors with a once-off decline in productivity.

[46] If one examines the performance of all 56 industries, the extent of the deterioration in the EU's performance over the two halves of the 1990's is striking, with 44 of the 56 industries showing a downward trend in their productivity performances over the second half of the decade.

[47] This apparent contradiction is explained by the higher share of ICT-using service industries in overall value added.

[48] The neoclassical growth model makes fairly precise quantitative predictions concerning these 4 factors, with the estimated labour productivity growth contributions from the ECFIN model being very close to those predicted by the neoclassical model.

being identified as being quantitatively important and relevant in an EU context, namely the level of regulation, the structure of financial markets, the degree of product market integration, the size of knowledge investment and the ageing of the labour force.

The "Lisbon Strategy" simulation at the end of the paper, whilst explicitly concentrating on regulatory reform and the knowledge economy, implicitly was an attempt to highlight the importance of all these five factors in determining the EU's long run growth performance and for its ambitions to outperform the US in terms of potential growth rates (thereby establishing itself as the most competitive, knowledge-based, economy in the world):

- In terms of boosting investment via regulatory reform, the "Lisbon Strategy" simulation showed that even a relatively rapid deregulation towards equivalent US levels would not lead to sufficiently large productivity gains over the next 7 years to close the present 10 per cent efficiency gap with the US. Whilst moving to US levels of regulation would lead to a 0.15 increase in the long-run (i.e. over 30 years) rate of productivity growth, the ECFIN analysis stresses that any gains from deregulation in terms of technological catching-up or from privatisations of state monopolies should be interpreted more in terms of static efficiency gains and not with the dynamic efficiency gains needed to achieve an outward shift of the "technology frontier". This suggests that deregulation, whilst crucial for investment, on its own would be insufficient to meet the EU's "Lisbon" ambitions and must therefore be accompanied by concerted efforts aimed at boosting the production of knowledge.
- In terms of the second element of the "Lisbon" package, namely action to boost TFP growth (i.e. the knowledge economy), the recent empirical growth literature emphasises knowledge and the creation of knowledge via the investment activities of firms, households and the government in both R&D and education as being essential for enhancing the level of technology in an economy. The paper points to long run productivity gains from investments in both education and R&D.[49] With respect to R&D, the paper stresses that the focus should not be on boosting R&D spending directly, but on creating the framework conditions which would promote an endogenous increase in research spending. The empirical analysis in this paper identified two main channels through which this could be achieved, namely higher product market integration (e.g. completion of the single market programme) and an investment environment which ensures the development of a more active risk capital market. However, disentangling the different transmission channels and even the direction of causality is extremely difficult. For example, while, on the one hand, a certain degree of imperfect competition may be necessary to cover the costs of knowledge intensive forms of investment such as R&D, on the other, there is increasing evidence against the view that firms enjoying significant market power plough back excess profits into higher rates of R&D and innovation. Rather it appears that a lack of competition tends to provide little incentive for firms to pursue technological innovations, slows down its

[49] For example, a permanent increase of 1 year in the average education levels of the labour force would lead to a 0.45 percentage point gain on the EU's long run rate of productivity growth. R&D is even more potent, with a permanent increase in the share of R&D in GDP of 1 percentage point leading to a 0.6 percentage point increase in the long run rate of productivity growth.

diffusion and impedes a higher variety and quality of goods and services being delivered to consumers.

Consequently, in assessing the combined effect of introducing the overall package of supply side reforms described in the "Lisbon" simulation, (i.e. deregulation, product market integration, human capital development and an investment climate conducive to the channelling of financial resources to R&D and other high risk investment domains) it is important to underline the uncertainties involved. However, on the assumption that the quantitative relationships established in the regression analysis hold, this package of supply side reforms would boost EU potential growth rates by roughly ½-¾ of a percentage point annually over a 5-10 year horizon. While this would undoubtedly represent a significant turnaround in the EU's present economic fortunes, given the extent of the present gap in performance, this package of reforms would still not be sufficient for the EU to overtake the US in productivity terms over the timescale laid out for the Lisbon agenda. Apart from the time which will need to elapse between the implementation of reforms to the appearance of visible effects, there are two further obstacles to be overcome in reaching the Lisbon-imposed productivity target, firstly the temporary trade-off faced in attaining the parallel employment target of 70 per cent and secondly the continuous drag on productivity induced by Europe's ageing labour force.

CONCLUDING REMARKS

At the moment, EU GDP per capita is at around 70 per cent of the US level, with roughly 1/3 of the gap due to productivity differentials and 2/3 due to a lower labour input (i.e. a lower employment rate and hours worked compared with the US). Consequently, improving the EU's productivity performance and raising employment are both fundamental to an increase in the long-term growth potential of the EU economy. This study has concentrated on the first aspect of this dual policy path by isolating the key drivers explaining the productivity differences between the EU and the US and by suggesting a range of policy initiatives aimed at closing the EU's productivity gap over the coming years.

The optimistic view of recent EU productivity trends is that part of the explanation for the poor performance could be adjustment lags, with perhaps the basis for future growth already firmly established due to the labour, capital and product market reforms which have already been introduced. Under this view the EU may now simply be in a transition phase whereby some of the negative effects of those reforms (e.g. a temporary decrease in productivity due to labour market changes) are visible, whilst the gains to be reaped in the future are not. The more pessimistic view (which is the one largely supported by the analysis in the present paper) is that a large number of Member States have as yet failed to recognise the extent of the reforms which need to be introduced given the challenges posed by an acceleration in the pace of technological progress, by globalisation (most recently in terms of the growing tradability of large parts of the service economy) and finally from the steady greying of EU populations.

Whilst based on a different set of indicators to those used for the present analysis, this paper's more pessimistic viewpoint would appear to be borne out by the conclusions of the 2003 / 2004 Spring Reports. Realising the difficulties of measuring progress in structural reform, the Commission and the Council devised a set of structural indicators which have become one of the main tools for assessing progress in achieving the Lisbon objectives. The last two Spring Reports presented very simple but highly informative exercises counting the frequency with which each Member State was amongst the best or worst performing Member States in the EU on each indicator. The results documented that a number of the smaller countries appeared repeatedly amongst the top performers. These are precisely the same countries that had already undertaken deep and successful reforms well before the launch of the Lisbon strategy. On the other hand, some of the larger EU Member States, came out as clear laggards with respect to structural reforms. Consequently, as underlined by the analysis in the present paper, the strong productivity (and employment) growth performances of a number of the smaller EU Member States clearly demonstrates that there is nothing inherently wrong with the policy framework established by the Lisbon reform strategy. Timely and thorough implementation of the different reform measures would appear therefore to be the real Achilles heel of this process.

To conclude, the issue of whether recent EU productivity trends are likely to be permanent or transitory was raised at the start of this study. While it is still premature to speculate as to the likely answer to this question, what can be said is that the outcome will depend on the policy choices which governments make in the policy domains outlined earlier. The present paper confirms the importance to the EU's long run productivity performance of a comprehensive reform strategy aimed at reducing the regulatory burden, further integrating markets, promoting human capital investment and enhancing the innovation potential of the economy. Implementation of such a wide-ranging reform agenda would create a more flexible, dynamic and investment-friendly business environment which together with better functioning markets, and more risk-oriented financing mechanisms, will ultimately be reflected in a significant increase in the EU-15's underlying labour productivity growth rate.

Main Conclusions

DECLINE IN EU LABOUR PRODUCTIVITY (50% DUE TO CAPITAL DEEPENING - 50% DUE TO TFP)
INCREASE IN US LABOUR PRODUCTIVITY (60% DUE TO CAPITAL DEEPENING - 40% DUE TO TFP)

ICT CONTRIBUTIONS TO LABOUR PRODUCTIVITY GROWTH

60% IN US
40% IN EU

DETERIORATION IN EU LABOUR PRODUCTIVITY DUE TO TRENDS IN NON-ICT INTENSIVE INDUSTRIES

FIVE KEY DRIVERS OF LABOUR PRODUCTIVITY

1. LEVEL OF REGULATION
2. STRUCTURE OF FINANCIAL MARKETS
3. PRODUCT MARKET INTEGRATION
4. KNOWLEDGE INVESTMENT
5. AGEING

EU WILL NOT MEET THE LISBON TARGETS ON THE BASIS OF CURRENT POLICIES

ANNEXES

ANNEX 1 : DETAILED DESCRIPTION OF ANALYTICAL FRAMEWORK

ANNEX 2 : INDUSTRY LEVEL ANALYSIS : DATA AND METHODOLOGICAL POINTS

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ANNEX 1: DETAILED DESCRIPTION OF ANALYTICAL FRAMEWORK

In the framework for the empirical analysis presented in this Annex an attempt is made to combine standard growth regressions (see, for example, Mankiw et al. (1992)) with some new developments in endogenous growth theory. Standard growth regressions treat technical progress as exogenous and they therefore miss a large part of productivity. The endogenous growth literature makes an attempt to explain technical progress as the result of human capital formation both undertaken at the household (see, for example, Lucas (1992)) and the firm level (see, for example, Romer (1990)) in the form of education and training (for households) and in the form of R&D spending (in the case of firms). This literature regards the level of technology as being (at least partly) created by a knowledge production function (see Jones (2002)).

1. THE MODEL: Output is produced via a conventional neoclassical production function. For reasons of analytical convenience and in order to be in conformity with most of the literature we assume a Cobb Douglas technology

(1a) $Y = K^{\alpha}(L * A)^{1-\alpha}$

Output is produced with capital (*K*) and labour (*L*) input which is measured in hours. Technical progress is labour augmenting. The level of technology is given by the variable *A*. The level of technology must be regarded as a summary indicator of both the knowledge accumulated in the economy and the level of efficiency in which factor inputs are used in the production process. Knowledge production is described below. With this formulation hourly labour productivity can be decomposed into a capital intensity effect and a technology component by reformulating equation (1a) as

(1b) $Y/L = (K/L)^{\alpha} A^{1-\alpha}$

Labour productivity is increased either by capital deepening (*K/L*) or by the accumulation of knowledge (*A*), with α and (1-α) being their corresponding elasticities. Both physical and human capital represent stocks which can be increased by corresponding investment activities. Physical capital (we express both physical and human capital in per hour terms) evolves according to the following capital accumulation equation

(2) $\dot{K}_L = I/L - (\delta + n)K_L$ where $K_L \equiv K/L$

where δ is the depreciation rate and *n* is the growth rate of hours worked. Crucial for physical capital is investment. In the case of knowledge capital we follow the literature and specify a knowledge production function:

(3) $\dot{A} = B\left(\frac{RD}{Y}\right)^{\gamma}\left(EDU^{\kappa} Ydeprat^{\psi}\right)A^{\phi}$

Knowledge is increased by the investment activities of households and firms. It is a positive function of the research intensity of firms as expressed by the R&D to GDP ratio (*RD/Y*) and the level of educational attainment (*EDU*) of the labour force. We correct the average level of education for the time elapsed since the knowledge was created by correcting for the age structure of the labour force. A simple index for this is the youth dependency ratio (*Ydeprat*). Under the assumption that human capital depreciates over time one would expect a younger labour force to have a higher capacity to create and absorb new ideas and technical developments.

The variable *B* captures other factors that could potentially affect efficiency. With an eye towards the variables of interest in this study, namely regulation, structure of financial markets and market size, one can argue that all of them have a potential effect on efficiency. For example, more deregulated markets which are open to foreign competition improve average efficiency by forcing low productivity firms to exit. It is however unclear whether reducing monopoly rents will also increase a firm's incentives to innovate simply because potential rents from the innovation will be lower. Increased competition via more openness may be more successful since increased market size could compensate for higher competition. Market size (i.e. scale effects) can have additional efficiency effects if there are increasing returns to production.

Likewise the structure of financial markets can affect efficiency. It has been argued recently in the literature (e.g. Levine (1992,1997)) that equity based systems may be more efficient in terms of risk sharing, information acquisition and in terms of providing management incentives. However, in contrast to this view Shleifer and Vishny (1986) regard stock markets as having detrimental effects on corporate governance.

For empirical testing we formulate the following simple specification for the efficiency term in the knowledge production function

(4) $$B = REG^{\chi} OPEN^{\phi} POP^{\varphi} FIN^{\kappa}$$

where efficiency becomes a function of measures of regulation (*REG*), market size proxied by openness (*OPEN*) and population size (*POP*) and a set of financial market indicators (*FIN*). A more precise definition of these variables will be given in the following section.

Finally, the question arises of whether an increase in the level of investment in human capital will permanently increase the growth rate of knowledge (ϕ = 1) or whether the marginal product of knowledge capital is declining (ϕ < 1). Jones (1995) argues forcefully that the stylised facts of declining TFP growth rates and rising human capital investments over the last decades is clearly more consistent with the second view.

As shown by eqs. (2) and (3), both physical and knowledge capital are driven by physical and R&D investment activities correspondingly. Thus, eventually the factors influencing investment in both forms of capital will determine the growth rate of labour productivity. Since we are interested in how regulation, the structure of financial markets, market size as well as the qualification levels of the labour force influence investment rates we postulate the following equation

(5a) $$I = iy(REG, OPEN, POP, FIN)Y$$

and

(5b) $RD = rdy(REG, OPEN, POP, FIN)Y$

Economic theory provides various justifications for these variables as possible predictors of investment rates.

Regulation: The level of regulation affects investment in various ways. First, to the extent to which regulation prevents entry, it lowers competition which in turn enables firms to earn higher marginal returns which lowers investment. Regulation can also affect the investment costs of existing firms and increases capital costs which in turn requires higher returns and leads to lower investment rates. Blanchard and Giavazzi (2002) provide a theoretical framework for a discussion of these effects.

Financial Markets: Another potentially important aspect affecting investment rates is access to finance. Allen and Gale (2000) see a special advantage of stock markets in the assessment of innovations. This suggests that stock markets should be favourable to new forms of investment (or investment undertaken by new firms) as well as R&D investment. Wachtel (2001) regards stock markets as a vehicle for fostering international portfolio and direct investment. Other authors have a more critical attitude towards stock markets, for example Levine and Zervos (1998) see improved liquidity as having negative effects on savings rates and therefore on investment.

Market size (Population, Openness): By endogenising knowledge capital, scale effects become more important. This should not have direct effects on the aggregate investment to GDP ratio but it is likely to have effects on the allocation of investment to different types. The endogenous growth literature (see Romer (1990)) especially stresses the sunk costs associated with R&D. Therefore bigger markets associated with larger national economies and more open borders should be positively correlated with R&D activities. Size effects have played a prominent role in the recent growth literature, since the size/growth link is stressed in the first generation of endogenous growth models (see Jones (2001)). There is of course a large literature which deals with the effect of openness on productivity growth, but only recently Alesina et al. (2000) have tried to look systematically into the effects of openness and country size on productivity.

Education: Since education affects the efficiency of labour it affects output and investment in the same direction and with the same intensity. Therefore it does not affect the investment rate as such. However, the composition of investment may be affected in the sense that more knowledge intensive forms of investment (ICT, software, R&D) may be complementary to the human capital endowment in the respective economy. Education may also play a role in attracting foreign direct investment.

After having established investment equations one can determine the dynamic adjustment of labour productivity to changes in fundamental economic determinants via the impact of physical and knowledge investment on their respective capital stocks. The long run level of productivity is given by

(6) $$\ln\left(\frac{Y}{L}\right)^{*} = \ln(A^{*}(..)) + \frac{\alpha}{1-\alpha}\left(iy(..) - (n + \delta + \pi)\right)$$

where $A^*(..)$ and $iy(..)$ are functions which are defined by equations (6) and (3). Since it takes time for (permanent) changes in investment to increase the stock of physical capital and knowledge, the dynamic adjustment of labour productivity to new investment levels is characterised by a process of convergence. Given the technological assumptions, with declining marginal products of physical and human capital, countries with low levels of human and physical capital endowments should grow faster. A summary measure of both forms of capital is of course labour productivity itself. The labour productivity growth regressions can be written as follows

$$(7) \qquad \dot{y}_l = \lambda(y_l^* - y_l) \text{ where } y_l \equiv \ln\left(\frac{Y}{L}\right)$$

2. Empirical Analysis and Results: The model specifies productivity growth as generated by 4 distinct activities, namely the investment of firms in both physical and knowledge capital, investment of households in human capital and changes in labour supply. The neoclassical model also weighs the contributions of these individual factors by the output elasticities of physical capital, labour and TFP. However in this section we want to go beyond pure growth accounting and ask how productivity growth at the aggregate level may be linked to the fundamental factors presented in Section 3, namely institutions, market size, demographic trends and education. The framework presented above allows for the direct estimation of these effects. It also allows us to distinguish between an investment and a TFP channel. The empirical analysis is based on a panel of 21 OECD countries over the period 1975 to 2000[50].

Growth regressions have become a standard analytical tool for structural economic analysis. Nevertheless it is important to point out some caveats, namely omitted variables and endogeneity. Firstly, the empirical analysis probably leaves out some important factors. In order to reduce the likelihood that the variables used in the regression could be interpreted as proxies for unobservables, all regressions are run with country fixed effects. Not all variables used in the regressions can be regarded as strictly exogenous. Some of the indicators used in these regressions could be endogenous. In particular this holds for the financial market indicators. We try to minimise this problem by using beginning of period values instead of period averages[51].

As discussed in Section 3, the economic determinants most relevant for this study are the degree of regulation, financial markets, market size and the human capital endowment of the labour force. Empirical proxies for these variables must be selected. It is difficult to obtain internationally comparable figures of regulation. In this study we use the Fraser index which has the advantage of being available over the whole sample period[52]. In addition we use the share of government consumption and the degree of openness as possible indicators for government involvement and

[50] Data series for the different variables used in the analysis were available, starting in the mid-1970's, for all of the EU countries, with the exception of Greece and Luxembourg. Outside the EU, comparable series were assembled for the US, Australia, Canada, Iceland, Japan, New Zealand, Norway and Switzerland. Since we are interested in medium term trends the analysis removes business cycle effects by using 5 year averages.

[51] GMM panel data estimators have been suggested (see Caselli et al. (1996)) for dealing with the endogeneity problem. However, with persistent time series, instruments can be weak and results can be severely biased in relatively small samples (see Bond et al (2001)).

[52] The OECD regulation indices are usually only available for the 1990s.

regulation. Unlike with a direct regulation index the results which are obtained with the two latter indicators are more difficult to interpret. Government consumption could also be negative for other reasons. For example, it could represent crowding out effects, but there could also be a bias due to the way in which a government's contribution to GDP is measured. Similarly a positive effect of openness could indicate both higher competition but also market size effects.

The structure of financing is captured in the regressions below by two indicators, the "volume of bank credit as a share of GDP" and an index of stock market capitalisation. In order to reduce possible problems of endogeneity with these two indicators we again use beginning of period values instead of period averages.

TABLE A1 : INVESTMENT REGRESSIONS

	GROSS FIXED CAPITAL FORMATION	FOREIGN DIRECT INVESTMENT	ICT INVESTMENT	R&D EXPENDITURE	
	(1)	(2)	(3)	(4)	(5)
1. GOVERNMENT EXPENDITURE	- 1)	- 1)	- 1)	1.18**	0.95**
2. DEGREE OF REGULATION	0.29**	3.32**	0.86**	-0.20	-0.04
3. BANK CREDIT	-0.01	-0.68**	0.16	-0.07	-
4. STOCK MARKET CAPITALISATION	0.03*	0.48**	0.13**	0.15**	-
5. OPENNESS	-3.35**	1.93	1.09	3.21*	6.87**
6. OPENNESS × SIZE	0.79**	0.16	-0.44	-0.71	-1.86**
7. POPULATION SIZE	0.97*	0.49	1.99**	1.78**	1.72**
8. EDUCATION	-0.05**	0.53**	0.002	0.02	0.13**
9. GROWTH OF WORKING AGE POPULATION	-0.04	0.13	-0.001	0.06	-0.02
COUNTRIES / OBSERVATIONS	*21/89*	*21/85*	*21/61*	*21/89*	*21/100*
*R**2*	*0.77*	*0.79*	*0.81*	*0.93*	*0.92*

Panel regression with country fixed effects.
***/**/* indicates significance at the 1/5/10% levels.
1) Government consumption is excluded from regressions (1) to (3). Collinearity between government consumption and deregulation tends to make both regressors insignificant when used simultaneously. Only results with deregulation are reported here since this indicator slightly outperforms government consumption in the regressions.

For modelling the effects of market size we follow Alesina et al (2000) and use three variables, namely openness, population size and the product between the two. The last variables capture possible non-linearities, for example that the degree of openness may be less important for large as opposed to small economies.

As a human capital indicator of the household sector we use the average years of schooling of the adult population. The data are from De la Fuente and Domenech

(2001). In order to allow depreciation of human capital we use the youth dependency ratio as an additional regressor.

Following the framework outlined above we first present results on investment rates (eqs. (5a) and (5b)). In a second step we estimate the parameters of the knowledge production function (eqs. (3) and (4)) and finally we estimate the contributions of physical and knowledge capital to labour productivity growth (eqs. (6) and (7)).

2.1 INVESTMENT: This section analyses how the investment of firms is affected by the basic growth determinants. We are especially interested in the economic determinants of physical investment versus R&D. However, one should keep in mind that within fixed capital formation important changes have taken place, with investment in ICT becoming a more important investment category. In order to understand the structural changes within aggregate investment it is therefore useful to also look at individual investment categories such as ICT. Important shifts are also occurring along another dimension. With increasing international capital mobility, foreign direct investment is becoming much more important. In a forward looking analysis it therefore seems essential to explore the specific determinants of these ICT and FDI investment categories.

Key Results from Regression Analysis: The most important result is that for all physical investment categories we find that regulation has a negative effect on investment rates. In contrast to this R&D expenditures are not affected by regulation. The first result is in conformity with the theoretical priors. There are various possible explanations for the latter result. Firstly, entry barriers may be less of a problem since R&D is probably highly concentrated amongst large incumbent firms. Secondly, certain forms of protection may actually be beneficial for R&D activities which yield risky returns. So far there is little empirical work on the relationship between investment and regulation. A more recent empirical study by Alesina et. Al. (2003) which uses OECD regulatory indices tends to support the results on physical investment rates and also finds a significantly negative impact of regulation in a panel of OECD service industries. The regression results also indicate that more stock market based financial systems tend to be more favourable to both physical and knowledge investment. It appears that equity markets are an important determinant of foreign direct investment. Given the rising importance of international capital mobility, these results suggest that the structure of financial markets may play a more important role in the future than they have played in the past. Kappler and Westerheide (2003) found similar results for a panel of OECD countries with different control variables.

A certain degree of ambiguity however remains concerning the importance of the structure of financial markets. A comparison of columns (4) and (5) shows that adding indicators of financial structure does not really improve the fit of the regression. In the absence of financial market indicators the level of education, which is an intuitively plausible explanatory variable, becomes significant. These two regression results taken together could also be interpreted as indicating that stock markets simply place a high value on the human capital endowment of firms. A causal interpretation running from the structure of financial markets to R&D expenditure would not be correct. This leads directly to a discussion of the role of education for different types of investment. Education is negatively correlated with aggregate physical investment rates but tends to be positively correlated with human capital investment. This should not be interpreted as suggesting that education is bad for physical investment. This correlation rather captures structural changes from low skilled-heavy industry production structures, with high levels of physical investment to high skilled-low capital intensity service sector production structures with low levels of physical investment. Also in the case of FDI, education is significant and positive. Internationally mobile capital seems to seek low regulation and high education environments.

2.2 KNOWLEDGE PRODUCTION: This section looks at the quantitative importance of knowledge investment measures (i.e. education and R&D investments) for TFP growth. The results are presented in two steps. Column (1) gives the standard specification of the knowledge production function, while columns (2) and (3) present slightly augmented versions where we ask whether institutional features affect the efficiency of knowledge accumulation[53]. As can be seen from column (1) all three variables have the correct sign and except for education they are significant.

Adding additional regulatory indicators improves the fit of the regression. Trade openness, corrected for country size appears to be especially important, whilst the regulatory indicator is not significant. It is interesting to observe that market size does not have an impact on TFP growth beyond its effect on R&D investment.

This suggests that there are no particular efficiency gains in production due to country size, i.e. increasing returns in production is not present in this dataset. Market size effects are largely confined to R&D investment itself (see Table A1).

Another interesting result is the strong negative effect of government consumption on TFP. However, one must be careful when interpreting this result. The way government production is measured in the national accounts could be a possible explanation for this result. Countries with a higher government share could have systematically underreported GDP, since the capital services of the government sector are not reported. Whatever interpretation is the correct one, government consumption appears to be an important control variable. This can be directly seen by looking at the consequences for the impact of education on TFP, which now becomes significant. Since there is a positive correlation between education and government expenditure, the exclusion of government consumption biases the effect of education downwards. Adding financial market measures to the regression in column (4) does not improve the fit but instead makes all the explanatory variables insignificant. This suggests that financial market measures are highly correlated with the remaining explanatory variables.

[53] All regressions have country and time fixed effects. The latter are meant to make the regressions more robust against common time trends in both the explanatory variables and TFP.

TABLE A2 : TFP / KNOWLEDGE PRODUCTION FUNCTION

	TFP	TFP	TFP	TFP
	(1)	**(2)**	**(3)**	**(4)**
1. YOUTH DEPENDENCY RATIO	0.076**	0.073**	0.048*	0.062
2. R&D EXPENDITURE	0.025**	0.022**	0.033**	0.009
3. EDUCATION	0.005	0.007	0.009*	0.01
4. DEGREE OF REGULATION		0.04	0.03	0.03
5. GOVERNMENT EXPENDITURE			-0.06**	
6. OPENNESS		0.40**	0.25*	0.24
7. OPENNESS × SIZE		-0.13**	-0.09*	-0.07
8. POPULATION		0.05	0.05	0.03
9. BANK CREDIT				-0.004
10. STOCK MARKET CAPITALISATION				0.003
11. TFP(-1)	-0.01	-0.04*	-0.07**	-.0.056*
COUNTRIES/OBSERVATIONS	21/97	21/97	21/97	21/88
R2**	.31	.40	.45	.34

(1): panel regression with country and time fixed effects
***/**/* indicates significance at the 1/5/10% levels.

The correlation is especially high with R&D expenditure and regulation. Unfortunately our analysis does not allow us to shed light on the direction of causality. Theoretically it could go in both directions. More market based financial systems could both exert pressure to increase efficiency and provide easier funding for R&D investments. But equally well the correlation could simply reflect the fact that stock markets place a high value on regulatory reforms and R&D investments.

A specific feature of these results is the insignificance of direct measures of regulation as an explanatory factor for TFP growth. The results on regulation and TFP reported here lie somewhere in the middle between a recent joint CEPR and IFS (2003) study which reports a negative association between deregulation and TFP and an OECD (Nicoletti and Scarpetta (2003)) study which finds a positive effect of deregulation on TFP. However, the results presented by the OECD are not clearcut and are open to some interpretation. The study finds that productivity gains are mostly associated with privatisations and not with levels of regulation in general. The study also finds that deregulation mostly facilitates technological catching-up but that there is little evidence that it leads to outward shifts in the technological frontier. Whether productivity gains from privatisations can be interpreted as true dynamic efficiency gains is also questionable in the light of the CEPR-IFS study which also finds productivity gains from privatisations (in network industries for example) but these are associated with reductions in employment. Thus the effect of privatisations could be temporary productivity improvements related to a reduction of economic slack in previously publicly owned companies. The fact that regulation is neither significant for R&D nor for TFP points in the direction that the link between regulation and moving the technological frontier is rather weak and an interpretation in terms of static efficiency gains is probably more appropriate.

Is the second half of the 1990s a special period for TFP growth? The second half of the 1990s differs from previous periods in various respects. First of all, some countries, in particular the US, managed an acceleration in the rate of technical progress and secondly technological convergence of the EU relative to the US came to a halt. It is by now well understood that technological developments related to the production and use of ICT are likely to be a major contributing factor. In this section an attempt is made to relate the estimates from the knowledge production function to the technological developments in the late 1990s[54]. In a very stylised manner one can formulate the following hypotheses.

Hypothesis 1: The knowledge generating factors as identified by the knowledge production function, namely R&D and human capital can explain the international growth patterns since the mid 1990s. If this hypothesis is correct, then we would expect to see no systematic variation of the regression residuals with variables relating to hypothesis (2) to (4)

Hypothesis 2: There is a large industry specific element which plays a role. Countries with high ICT industry shares have benefited from the positive productivity shocks taking place in these industries. Alternatively those countries which are high ICT users have benefited from technological spillovers. If this hypothesis is correct then one would expect the ICT production share or, in the case of spillovers, the ICT investment share to be significant.

Hypothesis 3: It is true that the ICT revolution was industry specific, but it was not confined to a specific country. With high capital mobility, those countries which offered attractive investment locations in terms of flexible labour and goods markets benefited most from the ICT boom. Alternatively it is sometimes argued that an ageing labour force would be less willing to adopt new technologies. If this is correct, then both measures of deregulation and the youthfulness of the labour force should be positively correlated with the residual.

Hypothesis 4: Both industry specialisation (hypothesis 2) as well as flexibility in adopting new technologies (hypothesis 3) have interacted positively. In this case one would expect ICT production shares and measures of deregulation and youthfulness of the labour force to interact positively.

The following Table, which summarises our analysis of the TFP residuals for 19 OECD countries over the period 1996-2000 is intended to shed some light on the relative importance of these 4 hypotheses. The most significant relationships are found for the interactions of ICT production with either demographic or regulatory indicators. This suggests that both industry specialisation as well as favourable conditions in terms of technology adoption have been important factors for TFP growth in the late 1990s. Industry specialisation does seem to play the dominant role as expressed by the high correlation between the ICT share and TFP growth[55]. There

[54] We use the knowledge production function without controls (except for country dummies) for country specific efficiency changes (column (1) in Table A2) in order to assess how much the knowledge inputs can account for changes in TFP growth in the late 1990s.

[55] Countries with high ICT production shares combined with relatively low levels of regulation (on the basis of the Fraser Institute measure), such as Ireland, Finland and the US, have outperformed countries like Spain and Italy with low ICT shares and above average levels of regulation. There is however another group of European

is little evidence of spillover effects from investment on technology which goes beyond the pure investment effect. Implicitly these results reject hypothesis (1). Notice, however, that the results are sensitive to outliers. Ireland and Spain constitute positive and negative outliers in the second half of the 1990s. Removing the two countries makes the result less significant. However, it does not change the ranking of the individual hypotheses.

2.3 COMBINING THE EFFECT OF PHYSICAL AND KNOWLEDGE CAPITAL FORMATION ON PRODUCTIVITY GROWTH: The previous two sets of regressions have shown how the basic productivity growth determinants affect physical capital formation and the creation of knowledge. This section looks at the relative contribution of these two factors to productivity growth when they are combined with two other factors, namely the growth of hours worked and the potential for catching up. As indicated above the neoclassical growth model makes fairly precise quantitative predictions concerning these four factors conditional on the choice of the output elasticity of capital and labour, which have been set to 0.35 and 0.65 respectively. This follows the standard practice of using the wage share for calibrating the output elasticity of labour (α) in the production function. A comparison of column (1) – which gives the theoretically predicted coefficients – and column (2) – which gives the estimated coefficients – shows that the estimated growth contributions of these four factors seem to be close to the predicted contributions of the neoclassical model. These results are robust to instrumenting investment in order to control for possible endogeneity (see column (3)). The last column tests whether the individual growth determinants have an independent effect on labour productivity growth not adequately captured by our theoretical framework. As can be seen when looking at column (4), no significant effect of the individual growth determinants can be detected if one accounts for the impact of these factors on either TFP or physical capital formation

TABLE A2.1: EXPLAINING THE RESIDUALS OF THE KNOWLEDGE PRODUCTION FUNCTION (1996-2000)

	Coeff.	R**2	Coeff.	R**2	Coeff.	R**2
1. ICT Production	0.26***	0.40	0.13	0.11	0.09	0.09
2. ICT Investment	-0.10	0.00	0.18	0.02	0.12	0.02
3. Deregulation	0.40*	0.15	0.25	0.01	0.15	0.07
4. Age of Labour Force	0.08**	0.27	0.04	0.07	0.02	0.03
5. ICT and Regulation	3.02***	0.44	1.67	0.16	1.09	0.12
6. ICT and Age of Labour Force	0.46***	0.53	0.29*	0.18	0.19	0.15

***/**/* indicates significance at the 1/5/10% levels.

countries consisting of Germany, Austria and Portugal which showed TFP growth rates above the rates predicted by their knowledge investment efforts despite below average performances in terms of the combined effect of ICT production shares and regulation. This could possibly be explained by their relatively timid efforts to increase the employment content of growth via labour market reforms. While the contribution of employment to growth has increased in the EU as a whole between the first and the second half of the 1990s, it has declined in Germany and Portugal, with Austria having a zero employment contribution to growth over the 1996-2000 period.

TABLE A3 : PRODUCTIVITY GROWTH REGRESSIONS (WITH CONTROLS FOR TFP)

	(1) [1]	(2)	(3)	(4)
1. INITIAL INCOME LEVEL	-0.036	-0.045**	-.042**	-0.037**
2. HOURS GROWTH (EMPLOYMENT + HOURS)	-0.019	-0.017**	-.016**	-0.017**
3. TFP GROWTH (IMPLIED LONG RUN [2])	0.036	0.044**	0.041**	0.036**
4. INVESTMENT				
4A. INVESTMENT RATE	0.019	0.017**		0.006
4B. INVESTMENT RATE (PREDICTED [3])			0.017**	
5. EDUCATION				-0.001
6. YOUTH DEPENDENCY RATIO				0.001
7. DEGREE OF REGULATION				
7A. GOVERNMENT SIZE				0.006
7B. REGULATION INDEX				0.019
8. STOCK MARKET CAPITALISATION				0.001
9. BANK CREDIT				-0.003
10. OPENNESS				0.006
11. OPENNESS * POPULATION				-0.001
12. POPULATION				0.000
NUMBER OF COUNTRIES / OBSERVATIONS		21 / 91	21/88	21 / 88
R**2		0.63	0.58	0.67

1) Coefficients as implied by the neoclassical growth model with an output elasticity of labour equal to .65.
2) Coefficients estimated from Table A2, column (3) are used to calculate A*.
3) Predicted investment rate from Table A1, column (1).
***/**/* indicates significance at the 1/5/10% levels.

3. WHAT DO THESE RESULTS IMPLY QUANTITATIVELY?: The estimates reported in the Tables above can be translated and interpreted in terms of short, medium and long run multipliers and therefore can give an indication of the magnitude of the effect of certain policies or exogenous shocks. Table A4 gives the estimated productivity growth contributions of investment in knowledge, physical investment and labour input growth. The most striking result is the large difference in the R&D multiplier relative to the physical investment multiplier. This is a fairly common result which can be found in many other studies (see, for example Grilliches (1994), Helpman and Coe. (1995) or Jones et al. (1995)). The results found in the literature suggest that the social rate of return of one unit of money spent on R&D is in the range between 25 per cent and 100 per cent. This implies that a permanent increase in the share of R&D in GDP of 1 per cent would increase the growth rate of GDP in the range between 0.25 per cent and up to 1 per cent. The results reported in the Table suggest that over a period of 25 years the average growth effect of an increase in the R&D share from currently about 2 per cent in the EU to 3 per cent could increase growth by 0.6 per cent.

However, extreme caution should be exercised when interpreting these results. One has to ask why the share of R&D spending is so low (only about 10 per cent of physical investment spending) when returns are so high? First of all, the average return compensates for substantial risks associated with R&D investment. Therefore these numbers say very little about the return that can be expected from concrete knowledge investment projects. A somewhat easier question to pose is the following: how can we explain why certain countries have a high R&D share and other countries have a low share? A look at Table A2 suggests that R&D activities require certain framework conditions. By looking at the cross-country variation of R&D spending across OECD countries one can identify clearly the following determinants, namely the level of education of the labour force and market size (proxied by openness and country size). Another possibly important variable is the structure of financial markets. If one takes these determinants into account, it is not that surprising that countries like Finland, Germany, Japan, Sweden, Switzerland and the US manage to consistently have R&D shares above 2.25 per cent These factors also provide a good explanation why countries such as Italy, New Zealand, Portugal and Spain have R&D shares of only 1 per cent or less. This suggests that any successful strategy to increase R&D spending in the second group of countries must be accompanied by measures to increase human capital endowments and by further efforts to better integrate their economies into the world market.

A permanent increase in the growth rate of hours worked, whilst keeping the investment rate as well as TFP constant, has negative effects on labour productivity. Roughly speaking, an increase in the growth rate of hours by 1 per cent lowers productivity growth by about 3 per cent in the first 10 years. The results also give a possible explanation for the trend decline in TFP and labour productivity in OECD countries.

With the fall in the birthrate in the 1970s all OECD countries have experienced a decline in the youth dependency ratio and an increase in the average age of the labour force. If it is the case that human capital depreciates then one would expect ageing of the labour force to have an effect on productivity. As our regression results suggest, this is indeed the case. Table A4 gives the results of a decline in the youth dependency ratio which is of the order of magnitude of the decline which actually occurred in OECD countries from the mid 1970s to the mid 1980s. These numbers are fairly large and would imply a decline in the growth rate of labour productivity of -0.3 per cent per annum in the last 15 years. When interpreting these numbers one must keep in mind that there is an offsetting effect on productivity growth induced by a decline in hours worked.

TABLE A4: MEDIUM AND LONG RUN EFFECTS OF KNOWLEDGE, PHYSICAL INVESTMENT AND LABOUR FORCE GROWTH ON PRODUCTIVITY (LEVEL EFFECTS)

	5 YEARS	10 YEARS	LONG RUN
1. KNOWLEDGE INCREASE IN TFP BY 1%	0.2	0.4	1.0
2. R&D Expenditure Share INCREASE BY 1% POINT	5.3	9.1	17.7
3. PHYSICAL INVESTMENT INCREASE OF INVESTMENT TO GDP RATIO BY 1% POINT	0.4	0.7	1.8
4. HOURS GROWTH PERMANENT INCREASE BY 1%	-1.5	-2.6	-7.1
5. YOUTH DEPENDENCY RATIO DECLINE BY 10% POINTS	-2.0	-3.5	-6.8

These results also give some indication of the effects of specific policy measures:

Education: The results reported here confirm the very positive effects of education spending on productivity growth.

Openness: One interesting foreign trade development is the increased openness of countries belonging to EMU. The estimates suggest that the increase in the total trade of EMU member states between the first and the second half of the 1990s may have increased productivity growth by about 0.04 % points per year.

Regulation: The results on deregulation that we obtain from the growth regressions are comparable to previous results obtained by the IMF (see Bayoumi et al. (2003) and WEO (2002)). The implied change of moving to US levels of regulation as measured by the Fraser index used in the regression would suggest an increase in long run labour productivity of about 5 per cent. The IMF study implies a long run labour productivity effect of about 3 per cent. Both in the IMF study and in the ECFIN regressions the positive effect is generated via an increase in the investment rate.

TABLE A5: EFFECT OF SOME POLICY MEASURES ON PRODUCTIVITY (LEVEL EFFECTS)

	5 Years	10 Years	Long run
1. YEARS OF EDUCATION (INCREASE BY 1 YEAR)	0.5	1.4	12.8
2. INCREASED OPENNESS (EQUIVALENT TO THE INCREASE IN EURO AREA TRADE BETWEEN 1991/1995 AND 1996/2000)	0.2	0.5	0.9
3. MOVING TO US LEVELS OF REGULATION	0.9	1.6	4.6

ANNEX 2: INDUSTRY LEVEL ANALYSIS : DATA AND METHODOLOGICAL POINTS

INDUSTRY LABOUR PRODUCTIVITY DATABASE: This database has been assembled by a team led by B. van Ark at the Groningen Growth and Development Centre (GGDC) for DG Enterprise. It consists of an industry dataset that covers the period 1979-2001 for the 15 EU Member States and for the US. Disaggregation into 56 industries is provided on the basis of the ISIC rev. 3 classification. The primary variables included are nominal value added, industry deflators, employment and hours worked per employee[56]. Constant value added and hourly productivity series are then derived (see Table B for a complete list of the hourly labour productivity growth rates of all 56 industries over the last two decades – see also Tables C, D and E for additional information).

Three methodological points need to be underlined:

- Firstly, the discussions on the emergence of a new productivity pattern linked to ICT industries ("new economy" era) have been associated with the statistical problem of correctly estimating price indices when the quality of the product is increasing rapidly (the typical case being for computer prices and other IT products). *Hedonic deflators* – based on the pricing of essential characteristics of the product – can help to overcome this and are applied by the US and a few European statistical offices. Following van Ark's approach, ECFIN have uniformly applied US deflators (instead of national ones) to sensitive industries (industries 30 to 33 incl. in the ISIC rev. 3). These are derived using a double deflation procedure (both input and output).

- Secondly, the current best practice for GDP calculations is to use chained indices like the Fisher or Törnqvist indices[57]. These indices avoid the usual problem associated with fixed-based indices (i.e. composition drift), and this is even more important when price indices vary a lot. It is, for example, a known property that the combination of the use of a Laspeyres price index and strongly declining prices (like in the IT industry) would overestimate the (value added and) productivity gains. In this study, and again following van Ark's approach, we have used Törnqvist aggregation procedures throughout. That is, the deflator of a group of industries is calculated as the geometric mean of the component industry deflators, using average nominal value added shares[58]. Or, in terms of changes in deflators (P_t) we have:

$$\Delta \ln P_t = \sum_i \tfrac{1}{2}\left(\frac{Y_{i\,t}}{Y_t} + \frac{Y_{i\,t-1}}{Y_{t-1}}\right)\Delta \ln P_{i\,t}$$

  For these two main reasons, the aggregate measures used in this study will often not correspond to official series of value added or labour productivity (see Table A for a comparison)[59].

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56 Information on compensation is also included but is not used in the present study.

57 Laspeyres indices are still however often used to calculate aggregate value added in volume.

58 This formula also corresponds to the first-order approximation of a Fisher index.

59 An additional explanation for the difference can be found in the series of 'Hours worked per Employee'. The series in the "Industry Labour Productivity Database" do not always match those at the aggregate level that

- Finally, the EU-15 total is aggregated on the basis of Euro exchange rates applied to nominal values, whilst all international comparisons are made following the conversion of the constant price series into PPS, using (fixed) 1995 conversion rates. All exchange rates are taken from ECFIN's AMECO database.

SHIFT SHARE ANALYSIS OF LABOUR PRODUCTIVITY GROWTH (SECTION 2.1): Relating the productivity growth of the overall economy to the productivity growth of the constituent industries' implies taking into account the simultaneous changes to the allocation and volume of the production factor (i.e. labour in the case of labour productivity). In the decomposition, the most important part is of course dependent on the productivity growth at the industry level that we can aggregate using the (fixed) beginning-of-period labour volumes. Another effect then involves displacements of resources amongst industries of varying productivity levels, which would result in overall productivity changes, even in the context of unchanged productivity at the industry level[60]. And finally the interaction effect would then account for labour reallocation effects amongst industries with varying productivity growth rates (typically negative, when an increase in productivity is associated with a decrease in labour use).

Formally we note, for the individual industries and for the overall economy, that (hourly) labour productivity is output (Y) divided by labour input (L):

$$LPH_{i\,t} = Y_{i\,t} / L_{i\,t}$$

$$LPH_t = Y_t / L_t = \sum_i Y_{i\,t} \Big/ \sum_i L_{i\,t}$$

The second identity is only correct when we can use simple summation to aggregate output, that is when output is expressed in nominal terms (or with the use of a fixed-based index). In this case as well, labour productivity can be written as a weighted sum of the intra-industry productivity values:

$$LPH_t = \sum_i LPH_{i\,t} \frac{L_{i\,t}}{L_t},$$

This gives, in difference terms:

$$\Delta\, LPH = \sum_i \Delta\,(LPH_i) \tfrac{L_{i\,t-1}}{L_{t-1}} + \sum_i LPH_{i\,t-1} \Delta\left(\tfrac{L_i}{L}\right) + \sum_i \Delta\,(LPH_i) \Delta\left(\tfrac{L_i}{L}\right)$$

Dividing by LPH_{t-1} to get the growth (percentage change) and rearranging the terms we get:

were used for the analysis in section 2 (source for the series at the aggregate level: GGDC and The Conference Board, Total Economy Database, July 2003, http://www.ggdc.net).

60 An historical example is the surge in overall productivity accompanying the labour force movement from the low productivity agriculture sector to the higher productivity manufacturing sector, i.e. the "Denison effect".

$$\frac{\Delta\, LPH}{LPH_{t-1}} = \sum_i \frac{\Delta\, LPH_i}{LPH_{i\,t-1}} \frac{Y_{i\,t-1}}{Y_{t-1}} + \sum_i \frac{LPH_{i\,t-1}}{LPH_{t-1}} \left(\frac{L_{i\,t}}{L_t} - \frac{L_{i\,t-1}}{L_{t-1}} \right) + \sum_i \frac{1}{LPH_{t-1}} (\Delta\, LPH_i) \Delta\!\left(\tfrac{L_i}{L}\right)$$

- The first component is the ***intra-industry effect***: i.e. the sum of industry productivity growth rates, weighted by the initial (nominal) output shares.
- The second component is the ***shift effect***: i.e. the sum of changes in input shares, weighted by the relative productivity level (i.e. the ratio of industry productivity to average productivity). This effect could also be written and decomposed as the sum of industry labour input growth rates, weighted by initial output shares, *minus* total labour input growth.
- The sign of the residual (*interaction*) component is usually negative (in the economy there is a majority of industries where the productivity change and the labour input change have opposite signs). It may however be positive when beneficial restructuring of the economy occurs (in this case most of the industries enjoying productivity growth are at the same time attracting more resources).

The decomposition described above would strictly hold only in the case of (discrete) percentage changes. The logarithmic approximation (used throughout the study) entails an error of a magnitude often comparable to the interaction effect. We have however defined the intra-industry effect and the shift effect analogously to the discrete case. A corresponding decomposition for the continuous time assumption can be found in Nordhaus (2002), who has also shown that when "old-fashioned" price index methods are used (i.e. not the Törnqvist method, as explained above), one should add to the decomposition an additional term accounting for the drift in prices.

SPECIFIC INDUSTRY CONTRIBUTION TO TOTAL LABOUR PRODUCTIVITY PER HOUR (LPH) GROWTH (SECTION 2.2): To calculate the contribution of specific industries to overall LPH growth, we take advantage of the fact that the intra-industry effect is the dominant effect, and that, for the period and countries under consideration, the shift (and interaction) effects are minimal.

The figures in the Tables should therefore be understood in the following way:

- The contribution to labour productivity per hour (LPH) growth from any group or sub-group of industries are calculated using a method compatible with the Törnqvist price index.
- The contribution to LPH growth from any group or sub-group of industries includes therefore the possible reallocation effects amongst industries belonging to that group or subgroup.
- The contribution from individual industries can clearly not include any reallocation effects. They are simply the product of that industry's productivity growth rate and of the (nominal) value added share of that industry at the beginning of the period.
- As a result, the contribution to LPH growth from a group or subgroup of industries would only equal the sum of the contributions of the component

industries, if there were no changes in the volume of labour input. Conversely, any differences, apart from rounding and approximation, suggest a shift effect.

ICT CONTRIBUTION TO LABOUR PRODUCTIVITY GROWTH (CAPITAL DEEPENING AND TFP) (SECTION 2.3): This sub-section relies on a different data set, the "Industry Growth Accounting Database", which has also been assembled by the GGDC for DG Enterprise. Disaggregated data on capital, allowing for a complete growth decomposition into labour, capital and TFP contributions is only available for 5 countries (the US, Germany, the UK, France and the Netherlands) and for a 26-sector decomposition of total output. The time span of the data is unchanged (1979-2001). In addition, information on ICT related investment (software, computing and communications equipment) and on labour quality is also available at the industry level in this dataset.

Based on this information set, a comprehensive measure of the ICT contribution to overall productivity growth can be tentatively derived, that would encompass both the TFP growth linked to ICT production, and the diffusion of ICT to the rest of the economy through investment in ICT capital. The accounting equation for productivity growth becomes[61]

$$\begin{aligned} g(Y/L) = {} & (1-\alpha)(1-\eta)\left[g(K_{nonICT}) - g(L)\right] \\ & + (1-\alpha)\eta\left[g(K_{ICT}) - g(L)\right] \\ & + g(TFP_{ICT\ ind})\frac{Y_{ICT\ ind}}{Y_{tot}} \\ & + g(TFP_{other\ ind})\frac{Y_{tot} - Y_{ICT\ ind}}{Y_{tot}} \end{aligned}$$

with $g(Y/L)$, $g(L)$, $g(K_{nonICT})$ and $g(K_{ICT})$ denoting the growth of, respectively, output, hourly labour input, non-ICT capital and ICT capital. α is the wage share and η the share of capital expenditures devoted to ICT investment.

The second term is the part of capital deepening coming from investment in ICT capital (defined as software, computing and communications equipment).

The third term in the equation measures the contribution to technical progress stemming from ICT industries. For this database "Electrical and Electronic Equipment; Instruments" and "Communications" are the two ICT producing industries (out of a total of 26 industries). Their contribution is weighted on the basis of nominal value added taken from the "Industry Labour Productivity Database", using matching industries with codes 30 to 33 and 64 (ISIC rev. 3 classification).

Summing up these components, we can obtain a ratio showing the importance of ICT (both the productivity gains linked to ICT production and to the diffusion of ICT

[61] Using standard conventions and assumptions and a modified production function to include ICT capital: $Y = L^{\alpha}\left(K_{ICT}^{\eta} K_{nonICT}^{1-\eta}\right)^{1-\alpha} A$

investment throughout the economy) to overall, economy-wide, productivity growth. Since the absolute figures that can be derived for labour productivity growth on the basis of this limited dataset are different from those obtained from the official national accounts data used in Section 1, we have applied the ratio of ICT's contribution to labour productivity growth at the industry level to the official productivity figures given in Section 1.

TABLE A : US + EU HOURLY LABOUR PRODUCTIVITY : A COMPARISON OF THE AGGREGATES FROM THE ECONOMY-WIDE AND INDUSTRY DATASETS

	US		EU	
	NATIONAL ACCOUNTS	INDUSTRY AGGREGATE – TOTAL ECONOMY	NATIONAL ACCOUNTS	INDUSTRY AGGREGATE – TOTAL ECONOMY
1981-1990	1.4	1.1	2.2	2.4
1991-1995	1.0	1.1	2.4	2.3
1996-2000	1.6	2.3	1.6	1.6

SOURCE : AMECO, GGDC AND OWN CALCULATIONS

Table B Hourly Labour Productivity Growth Rates 1981-2000, US and EU15 (Average Annual % Change)

	1981-1990		1991-1995		1996-2000	
	US	EU	US	EU	US	EU
Agriculture	4.6	4.9	2.2	5.2	10.4	4.2
Forestry	8.2	4.1	-9.7	3.2	4.6	2.9
Fishing	-1.2	2	-11.3	1.4	12.8	0.3
Mining and quarrying	4.4	3.4	5.1	13	0.4	3.4
Food, drink & tobacco	0.6	2.7	3.6	2.6	-6	0.4
Textiles	3.4	2.9	2.1	3.1	2.6	2.2
Clothing	3.1	2.7	4.6	2.3	4.3	2.4
Leather and footwear	3.4	4.5	0.2	3.1	3.3	0.9
Wood & wood products	2.3	-3	-0.9	2.6	2.9	2.6
Pulp, paper & paper products	1.9	3.9	-0.1	3.4	1.7	3.2
Printing & publishing	-1.1	2.6	-2.9	2.1	0.7	2.2
Mineral oil refining, coke & nuclear fuel	9.4	-4.8	5.5	5.2	4.5	-1.1
Chemicals	4.8	5.4	3	6.4	2.4	4.2
Rubber & plastics	3.9	2.8	4.3	2.7	4.7	1.5
Non-metallic mineral products	2.3	3.5	2.3	3.1	1.2	1.7
Basic metals	0.3	4.6	3.6	6.1	2.1	1.9
Fabricated metal products	2	2.4	2.9	2.5	1	1.1
Mechanical engineering	-0.3	2.1	0.3	2.8	-0.1	1.3
Office machinery	27.5	26.3	28.5	28	53.4	48.1
Insulated wire	4.5	5.9	2.4	7.4	5.5	-1.4
Other electrical machinery	0.7	3	1.1	1.3	-1.3	2.1
Electronic valves and tubes	23.3	22.6	38.2	35.6	52.9	57.3
Telecommunication equipment	19.7	20.3	4.8	5.1	0.6	1.4
Radio and television receivers	9.4	11.8	-5.3	-0.8	-5.7	-5
Scientific instruments	2.4	2.5	-4.7	-3.1	-4.9	-7
Other instruments	4.7	6	2.3	6.8	7.1	5.4
Motor vehicles	0.8	4.4	3.8	3.3	1.2	1
Building and repairing of ships and boats	4.3	5.4	-4.4	1.8	2.6	1.2
Aircraft and spacecraft	1.2	4.9	-1.1	3.4	1.5	1.6
Railroad and other transport equipment	4.7	3.6	-2.4	4.6	3.2	3
Furniture & miscellaneous manufacturing	3.1	1.8	1.1	1.3	3.6	1.8
Electricity, gas and water supply	1.3	3.3	1.8	3.7	2.3	6
Construction	-0.4	1.8	0.4	1	-0.1	0.2
Sales and repair of motor vehicles	-0.1	1.7	-2.4	2.2	-1.8	0.8
Wholesale trade and commission trade	2.8	2.2	2.9	3.3	8.3	2
Retail trade and repairs	3.1	2	2	1.7	6.6	1.6
Hotels & catering	-0.8	-0.7	-1	-0.6	0.2	-0.8
Inland transport	1.5	2.7	1	3.1	1.2	2.3
Water transport	0.4	3.8	0.7	5.7	2.9	2.4
Air transport	1.2	3.7	2	9	4.6	5
Supporting transport activities	-0.9	3.4	-0.8	3.6	4.6	1.6
Communications	1	5	2.4	6.3	5.9	10
Financial intermediation	0.1	2.4	1	1	3.9	4.8
Insurance and pension funding	-5.1	2.7	2.5	1.1	1.1	-0.7
Auxiliary financial services	1.1	1.1	3.1	0.4	9.9	0.2
Real estate activities	0.2	-0.8	1.6	-0.1	1.2	-0.5
Renting of machinery and equipment	-1.5	2.2	8.2	2.9	4.3	2.3
Computer and related activities	5.8	0.7	2.4	1.1	-5.8	2.4
Research and development	3.3	3.5	0	-0.4	1.3	-0.9
Legal, technical and advertising	-1.2	0.3	-0.9	0.4	-0.3	0.8
Other business activities	0.3	-0.3	-0.7	0.8	-0.1	-1.2
Public administration	0.7	1	0.2	1.3	0.9	1
Education	-0.2	0.1	0.3	1	-2.4	0.4
Health and social work	-1.7	0.3	-1.8	1.2	-0.3	0.8
Other services	0.2	0.3	0.6	0.7	-2.1	0.3
Private households with employed persons	2.5	-4.6	2.3	-0.5	0.7	-0.1
Total Economy	**1.1**	**2.4**	**1.1**	**2.3**	**2.3**	**1.6**

	1991-1995		1996-2000	
	US	EU	US	EU
Number of Industries experiencing a productivity deceleration	27	23	21	44
(% Share of Total)	(48)	(41)	(38)	(79)
Number of Industries experiencing a productivity acceleration	29	33	35	12
(% Share of Total)	(52)	(59)	(63)	(21)

Source : Own Calculations and GGDC

Table C. Individual Industry Contributions to Hourly Labour Productivity Growth Rates in US and EU15 (1981-2000)

	1981-1990		1991-1995		1996-2000		EU15 Productivity level relative to US		
	US	EU	US	EU	US	EU	1980	1990	2000
Agriculture	0.11	0.19	0.04	0.15	0.16	0.10	57.0	58.8	50.2
Forestry	0.01	0.02	-0.01	0.01	0.00	0.01	108.5	72.1	126.2
Fishing	0.00	0.00	0.00	0.00	0.00	0.00	126.2	174.7	176.0
Mining and quarrying	0.17	0.07	0.10	0.12	0.00	0.03	81.7	73.6	127.6
Food, drink & tobacco	0.01	0.08	0.07	0.07	-0.11	0.01	62.1	76.9	101.0
Textiles	0.02	0.03	0.01	0.02	0.01	0.01	119.5	115.7	114.5
Clothing	0.02	0.02	0.01	0.03	0.01	0.01	97.1	89.0	86.6
Leather and footwear	0.01	0.01	0.00	0.01	0.00	0.00	71.1	69.0	67.5
Wood & products of wood and cork	0.02	0.02	-0.02	0.01	-0.01	0.01	56.3	57.7	92.4
Pulp, paper & paper products	0.02	0.03	0.00	0.02	0.01	0.02	61.5	75.3	96.6
Printing & publishing	-0.01	0.03	-0.04	0.03	0.01	0.03	60.0	87.0	120.5
Mineral oil refining, coke & nuclear fuel	0.07	-0.04	0.03	0.02	0.02	0.00	387.5	93.8	69.6
Chemicals	0.09	0.12	0.06	0.14	0.05	0.09	52.9	56.5	73.5
Rubber & plastics	0.02	0.03	0.03	0.03	0.03	0.01	139.6	125.0	98.2
Non-metallic mineral products	0.02	0.04	0.01	0.03	0.01	0.02	84.7	96.3	102.4
Basic metals	0.01	0.06	0.03	0.06	0.02	0.02	57.5	88.0	98.4
Fabricated metal products	0.04	0.05	0.04	0.05	0.01	0.02	74.8	77.6	76.2
Mechanical engineering	-0.01	0.06	0.01	0.07	0.00	0.03	67.2	85.6	103.8
Office machinery	0.18	0.09	0.16	0.10	0.23	0.12	99.6	88.3	66.0
Insulated wire	0.01	0.01	0.00	0.01	0.00	0.00	63.6	73.2	66.6
Other electrical machinery and aparatus nec	0.01	0.04	0.01	0.01	-0.01	0.02	66.7	84.4	100.9
Electronic valves and tubes	0.09	0.04	0.22	0.05	0.46	0.10	50.8	47.4	52.1
Telecommunication equipment	0.07	0.06	0.02	0.02	0.00	0.00	75.0	79.8	84.2
Radio and television receivers	0.01	0.03	0.00	0.00	0.00	-0.01	55.6	70.4	91.6
Scientific instruments	0.02	0.01	-0.03	-0.01	-0.03	-0.03	93.3	94.3	92.0
Other instruments	0.01	0.01	0.00	0.01	0.01	0.01	32.5	36.9	42.4
Motor vehicles	0.01	0.07	0.03	0.05	0.02	0.02	48.6	69.7	67.2
Building and repairing of ships and boats	0.01	0.01	-0.01	0.00	0.00	0.00	72.2	80.6	102.4
Aircraft and spacecraft	0.01	0.01	-0.01	0.01	0.01	0.00	46.7	67.6	84.8
Railroad equipment and transport equipment ne	0.00	0.01	0.00	0.01	0.00	0.00	70.9	63.8	90.0
Furniture, miscellaneous manufacturing; recycli	0.02	0.02	0.01	0.01	0.02	0.01	98.8	87.3	80.6
Electricity, gas and water supply	0.03	0.08	0.05	0.09	0.06	0.14	58.2	71.5	94.3
Construction	-0.02	0.13	0.02	0.06	0.00	0.01	72.8	91.2	95.1
Sale, maintenance and repair of motor vehicles	0.00	0.03	-0.02	0.04	-0.01	0.02	66.5	79.9	115.3
Wholesale trade and commission trade, except	0.17	0.10	0.16	0.16	0.47	0.10	107.4	101.5	75.9
Retail trade, except of motor vehicles and moto	0.21	0.10	0.13	0.08	0.43	0.07	88.6	79.8	61.4
Hotels & catering	-0.02	-0.02	-0.02	-0.02	0.00	-0.02	175.6	177.7	172.6
Inland transport	0.04	0.08	0.02	0.08	0.02	0.06	87.2	98.2	114.9
Water transport	0.00	0.02	0.00	0.02	0.00	0.01	73.2	103.4	129.2
Air transport	0.01	0.01	0.02	0.03	0.04	0.02	88.8	113.7	164.7
Supporting and auxiliary transport activities; act	0.00	0.04	0.00	0.04	0.02	0.02	46.4	71.3	76.8
Communications	0.03	0.10	0.05	0.14	0.14	0.24	48.9	72.5	107.9
Financial intermediation, except insurance and	0.00	0.09	0.03	0.04	0.15	0.19	75.0	94.6	99.1
Insurance and pension funding, except compuls	-0.06	0.02	0.03	0.01	0.02	-0.01	52.7	115.2	98.5
Activities auxiliary to financial intermediation	0.01	0.00	0.05	0.00	0.18	0.00	57.7	57.7	30.9
Real estate activities	0.02	-0.06	0.17	-0.01	0.12	-0.05	138.8	125.2	105.3
Renting of machinery and equipment	0.00	0.01	0.04	0.03	0.03	0.02	173.0	251.6	174.8
Computer and related activities	0.02	0.00	0.03	0.01	-0.08	0.03	144.0	87.0	123.1
Research and development	0.01	0.01	0.00	0.00	0.01	0.00	113.8	115.6	101.9
Legal, technical and advertising	-0.04	0.01	-0.04	0.01	-0.01	0.03	80.5	94.4	106.9
Other business activities, nec	0.01	-0.01	-0.02	0.02	0.00	-0.03	100.5	94.9	96.8
Public administration and defence; compulsory	0.07	0.07	0.02	0.09	0.08	0.07	54.0	55.8	59.3
Education	-0.01	0.01	0.01	0.05	-0.12	0.02	115.3	119.0	142.1
Health and social work	-0.09	0.02	-0.13	0.07	-0.02	0.05	61.4	75.2	92.2
Other community, social and personal services	0.00	0.01	0.02	0.03	-0.05	0.01	96.4	97.5	110.3
Private households with employed persons	0.01	-0.01	0.00	0.00	0.00	0.00	174.4	86.0	71.8
Sum of the intra-industry effects	1.43	2.08	1.37	2.23	2.41	1.64			
Total Economy	**1.13**	**2.39**	**1.08**	**2.29**	**2.30**	**1.62**			

Source: Own calculations and GGDC

Individual industry contributions are obtained by the multiplication of the specific industry growth rate of labour productivity by the share of that industry in nominal value added. Industries in shaded areas experience a growing contribution to total economy labour productivity growth rate (by comparison to the previous period). The sum of the individual industry contributions gives the intra-industry effect (with no reallocation of labour), while the total economy figure is the sum of intra-industry and reallocation effects.

Table D. Contributions to Total Hours Worked change in US and EU15 (1981-2000)

	1981-1990		1991-1995		1996-2000		EU15 Hours worked level relative to US		
	US	EU	US	EU	US	EU	1980	1990	2000
Agriculture	-0.05	-0.36	0.02	0.00	-0.01	-0.12	384.4	304.4	207.4
Forestry	0.00	-0.01	0.00	0.00	0.00	-0.01	414.2	390.3	234.0
Fishing	0.01	0.00	-0.01	0.00	-0.01	0.00	145.8	85.2	97.3
Mining and quarrying	-0.04	-0.04	-0.03	0.00	-0.01	-0.01	100.2	84.8	57.2
Food, drink & tobacco	0.00	-0.04	0.00	0.00	0.01	0.00	236.7	208.5	190.1
Textiles	-0.01	-0.06	0.00	0.00	-0.03	-0.02	212.9	162.0	146.2
Clothing	-0.03	-0.03	-0.02	0.00	-0.05	-0.04	184.6	188.6	204.5
Leather and footwear	-0.01	-0.02	0.00	0.00	-0.01	-0.01	407.2	497.2	604.8
Wood & products of wood and cork	0.01	-0.02	0.01	0.00	0.01	0.00	144.5	113.4	90.4
Pulp, paper & paper products	0.00	-0.01	0.00	0.00	-0.01	0.00	114.1	93.7	90.1
Printing & publishing	0.03	0.00	0.00	0.00	-0.01	-0.01	133.7	104.3	95.7
Mineral oil refining, coke & nuclear fuel	0.00	0.00	0.00	0.00	0.00	0.00	118.2	107.4	103.6
Chemicals	0.00	-0.02	-0.01	0.00	0.00	-0.01	184.5	168.2	143.4
Rubber & plastics	0.02	0.00	0.02	0.00	0.00	0.01	159.8	133.5	119.9
Non-metallic mineral products	-0.01	-0.03	0.00	0.00	0.01	0.00	258.3	239.8	198.6
Basic metals	-0.04	-0.05	-0.01	0.00	0.00	-0.01	151.2	150.7	109.0
Fabricated metal products	-0.02	-0.04	0.01	0.00	0.02	0.01	219.6	205.1	173.2
Mechanical engineering	-0.03	-0.03	0.01	0.00	0.00	0.00	165.3	170.4	135.8
Office machinery	-0.01	0.00	-0.01	0.00	-0.01	0.00	47.7	66.4	81.2
Insulated wire	0.00	0.00	0.00	0.00	0.00	0.00	152.5	151.5	142.6
Other electrical machinery and aparatus nec	-0.01	-0.01	-0.01	0.00	0.00	0.00	209.6	216.4	219.5
Electronic valves and tubes	0.01	0.00	0.00	0.00	0.01	0.00	73.6	52.5	45.4
Telecommunication equipment	0.00	-0.01	0.00	0.00	0.01	0.00	93.8	72.0	60.5
Radio and television receivers	0.00	0.00	0.00	0.00	0.00	0.00	315.5	379.0	289.3
Scientific instruments	0.00	0.00	-0.02	0.00	0.00	0.00	71.7	65.7	72.0
Other instruments	-0.01	-0.01	0.00	0.00	0.00	0.00	186.1	224.7	259.8
Motor vehicles	0.01	-0.03	0.03	0.00	0.01	0.02	283.9	216.1	153.7
Building and repairing of ships and boats	0.00	-0.02	0.00	0.00	0.00	0.00	211.5	143.8	123.5
Aircraft and spacecraft	0.01	0.00	-0.08	0.00	0.00	0.01	52.9	42.7	58.0
Railroad equipment and transport equipment ne	-0.01	0.00	0.00	0.00	0.01	0.00	206.3	239.0	106.9
Furniture, miscellaneous manufacturing; recycli	0.01	-0.02	0.00	0.00	0.01	0.00	201.3	165.9	142.6
Electricity, gas and water supply	0.01	0.00	0.00	0.00	-0.01	-0.03	153.6	131.4	104.9
Construction	0.12	-0.04	0.01	0.00	0.27	0.06	201.0	156.0	118.7
Sale, maintenance and repair of motor vehicles	0.03	0.01	0.01	0.00	0.02	0.04	417.9	307.9	260.3
Wholesale trade and commission trade, except	0.08	0.02	0.04	0.00	0.08	0.07	96.1	88.7	83.3
Retail trade, except of motor vehicles and moto	0.15	0.04	0.10	0.00	0.11	0.09	105.5	96.7	90.4
Hotels & catering	0.20	0.07	0.12	0.00	0.15	0.11	77.7	69.2	66.9
Inland transport	0.00	0.00	0.06	0.00	0.05	0.00	156.0	154.7	110.0
Water transport	0.00	-0.01	0.00	0.00	0.00	0.00	201.2	139.4	105.8
Air transport	0.03	0.00	0.03	0.00	0.01	0.01	63.9	34.7	31.0
Supporting and auxiliary transport activities; act	0.01	0.00	0.01	0.00	0.01	0.05	962.1	534.9	455.7
Communications	0.00	0.00	0.01	0.00	0.04	0.01	126.6	127.0	98.0
Financial intermediation, except insurance and	0.04	0.03	-0.01	0.00	0.03	0.00	116.0	111.0	101.6
Insurance and pension funding, except compuls	0.02	0.01	0.01	0.00	0.01	0.00	58.8	57.7	53.0
Activities auxiliary to financial intermediation	0.04	0.01	0.03	0.00	0.05	0.02	77.2	62.4	55.5
Real estate activities	0.03	0.02	0.01	0.00	0.03	0.02	65.5	74.4	79.8
Renting of machinery and equipment	0.01	0.01	0.00	0.00	0.01	0.01	99.9	74.8	81.0
Computer and related activities	0.03	0.02	0.05	0.00	0.12	0.08	189.7	110.6	80.2
Research and development	0.01	0.00	0.01	0.00	0.01	0.01	142.2	100.2	88.5
Legal, technical and advertising	0.15	0.08	0.05	0.00	0.17	0.13	90.0	82.3	87.1
Other business activities, nec	0.14	0.08	0.16	0.00	0.26	0.21	146.8	101.2	90.0
Public administration and defence; compulsory	0.06	0.06	-0.04	0.00	0.02	-0.02	119.7	120.4	118.3
Education	0.15	0.06	0.07	0.00	0.19	0.05	85.2	79.7	72.4
Health and social work	0.30	0.12	0.27	0.00	0.21	0.12	118.0	95.9	85.7
Other community, social and personal services	0.09	0.09	0.07	0.00	0.12	0.12	150.2	146.2	138.2
Private households with employed persons	-0.01	0.03	-0.01	0.00	-0.01	0.03	88.6	183.7	272.8
Total Economy	**1.77**	**0.08**	**1.05**	**-0.01**	**2.06**	**1.08**	141.7	119.7	103.9

Source: Own calculations and GGDC

Individual industry contributions are obtained by the multiplication of the specific industry growth rate of labour input by the share of that industry in total hours worked.

Table E. Contributions to total VA growth rate in US and EU15 (1981-2000)

	1981-1990		1991-1995		1996-2000		EU15 VA level relative to US		
	US	EU	US	EU	US	EU	1980	1990	2000
Agriculture	0.07	0.04	0.06	0.01	0.15	0.04	207.7	175.5	97.6
Forestry	0.00	0.01	-0.01	-0.01	0.00	0.00	828.6	690.6	296.8
Fishing	0.00	0.00	-0.01	0.00	0.00	0.00	259.4	339.7	166.5
Mining and quarrying	0.05	-0.03	0.02	0.03	-0.03	0.00	69.3	62.1	57.1
Food, drink & tobacco	0.01	0.04	0.07	0.04	-0.10	0.01	203.6	183.9	136.7
Textiles	0.02	-0.01	0.01	-0.02	-0.01	0.00	209.0	203.7	135.1
Clothing	0.00	0.00	0.00	-0.01	-0.01	-0.01	169.9	192.4	138.0
Leather and footwear	0.00	0.00	0.00	-0.01	-0.01	0.00	324.9	405.1	346.8
Wood & products of wood and cork	0.02	0.00	-0.01	0.01	0.00	0.01	105.8	104.1	78.1
Pulp, paper & paper products	0.02	0.02	0.00	0.01	0.00	0.02	104.9	102.1	78.2
Printing & publishing	0.02	0.03	-0.04	0.01	0.00	0.02	132.1	118.1	91.1
Mineral oil refining, coke & nuclear fuel	0.06	-0.07	0.02	0.00	0.01	-0.01	166.5	78.2	77.4
Chemicals	0.08	0.10	0.05	0.07	0.04	0.07	162.8	132.6	90.6
Rubber & plastics	0.04	0.03	0.04	0.02	0.03	0.02	212.0	186.6	109.4
Non-metallic mineral products	0.01	0.02	0.01	0.01	0.01	0.02	234.9	285.9	163.6
Basic metals	-0.05	0.01	0.02	0.00	0.02	0.00	103.2	166.2	106.9
Fabricated metal products	0.02	0.02	0.04	0.01	0.03	0.03	168.3	189.4	114.8
Mechanical engineering	-0.04	0.03	0.02	-0.02	0.00	0.03	158.4	179.8	123.6
Office machinery	0.17	0.09	0.14	0.08	0.21	0.12	67.0	72.3	47.9
Insulated wire	0.00	0.01	0.00	0.01	0.00	0.00	142.5	138.3	85.0
Other electrical machinery and aparatus nec	0.00	0.02	0.00	-0.01	-0.01	0.02	190.5	230.4	200.6
Electronic valves and tubes	0.09	0.03	0.23	0.05	0.49	0.10	55.4	30.9	21.2
Telecommunication equipment	0.08	0.06	0.02	0.00	0.01	0.01	104.0	73.2	47.0
Radio and television receivers	0.01	0.02	0.00	-0.01	-0.01	-0.01	218.2	329.5	250.5
Scientific instruments	0.02	0.01	-0.05	-0.02	-0.03	-0.03	91.8	78.4	60.5
Other instruments	0.00	0.01	-0.01	0.00	0.01	0.01	84.7	102.6	103.8
Motor vehicles	0.02	0.04	0.07	0.00	0.04	0.05	217.0	229.1	90.6
Building and repairing of ships and boats	0.00	0.00	-0.01	0.00	0.00	0.00	239.7	179.8	114.5
Aircraft and spacecraft	0.02	0.01	-0.10	-0.01	0.01	0.01	49.2	39.5	48.3
Railroad equipment and transport equipment ne	0.00	0.00	0.00	0.00	0.01	0.00	178.0	210.8	87.2
Furniture, miscellaneous manufacturing; recycli	0.03	0.01	0.01	0.00	0.03	0.01	200.5	163.0	98.0
Electricity, gas and water supply	0.06	0.08	0.05	0.02	0.02	0.06	133.2	114.5	78.9
Construction	0.08	0.09	0.03	-0.02	0.19	0.05	182.6	168.3	86.7
Sale, maintenance and repair of motor vehicles	0.02	0.04	-0.01	0.02	0.00	0.05	389.0	291.2	240.9
Wholesale trade and commission trade, except	0.26	0.13	0.20	0.13	0.55	0.18	96.3	107.1	66.3
Retail trade, except of motor vehicles and moto	0.31	0.12	0.19	0.07	0.50	0.12	88.9	88.7	56.1
Hotels & catering	0.06	0.04	0.02	0.00	0.05	0.05	128.7	132.6	95.3
Inland transport	0.04	0.07	0.07	0.04	0.07	0.06	132.5	176.0	106.8
Water transport	0.00	0.00	0.00	0.01	0.01	0.00	186.2	183.2	114.0
Air transport	0.05	0.01	0.04	0.03	0.05	0.04	67.1	57.1	49.6
Supporting and auxiliary transport activities; act	0.01	0.04	0.01	0.04	0.02	0.06	627.0	445.8	341.9
Communications	0.03	0.11	0.07	0.09	0.21	0.24	94.6	118.8	79.9
Financial intermediation, except insurance and	0.05	0.14	0.01	0.02	0.21	0.19	188.0	146.4	63.5
Insurance and pension funding, except compuls	-0.05	0.03	0.03	0.00	0.04	0.00	71.8	93.4	40.3
Activities auxiliary to financial intermediation	0.06	0.02	0.08	0.01	0.26	0.02	55.9	41.9	23.5
Real estate activities	0.26	0.21	0.23	0.17	0.36	0.16	98.2	98.9	76.7
Renting of machinery and equipment	0.02	0.03	0.04	0.03	0.05	0.07	236.1	220.7	144.5
Computer and related activities	0.07	0.04	0.10	0.05	0.11	0.14	179.5	109.0	70.8
Research and development	0.02	0.02	0.00	0.00	0.02	0.00	182.8	148.6	77.8
Legal, technical and advertising	0.11	0.12	0.01	0.11	0.17	0.19	118.1	97.3	81.5
Other business activities, nec	0.13	0.08	0.11	0.09	0.18	0.15	153.5	114.2	76.7
Public administration and defence; compulsory	0.14	0.13	-0.03	0.07	0.11	0.05	93.2	85.1	60.1
Education	0.08	0.06	0.05	0.07	0.00	0.06	128.6	115.6	84.6
Health and social work	0.13	0.12	0.08	0.15	0.14	0.14	122.1	96.3	69.1
Other community, social and personal services	0.06	0.08	0.06	0.07	0.02	0.10	184.1	171.8	118.9
Private households with employed persons	0.00	0.00	0.00	0.01	0.00	0.01	143.5	187.2	165.6
Sum of the intra-industry effects	2.78	2.38	2.07	1.51	4.25	2.72			
Total Economy	**2.78**	**2.38**	**2.07**	**1.51**	**4.25**	**2.72**	129.8	121.2	79.5

Source: Own calculations and GGDC

Individual industry contributions are obtained by the multiplication of the specific industry growth rate of value added by the share of that industry in nominal VA.

ANNEX 3 : INDUSTRY LEVEL ANALYSIS

GRAPHICAL PRESENTATION OF CONTRIBUTIONS TO HOURLY LABOUR PRODUCTIVITY, EMPLOYMENT AND OUTPUT TRENDS[62] IN THE EU AND THE US

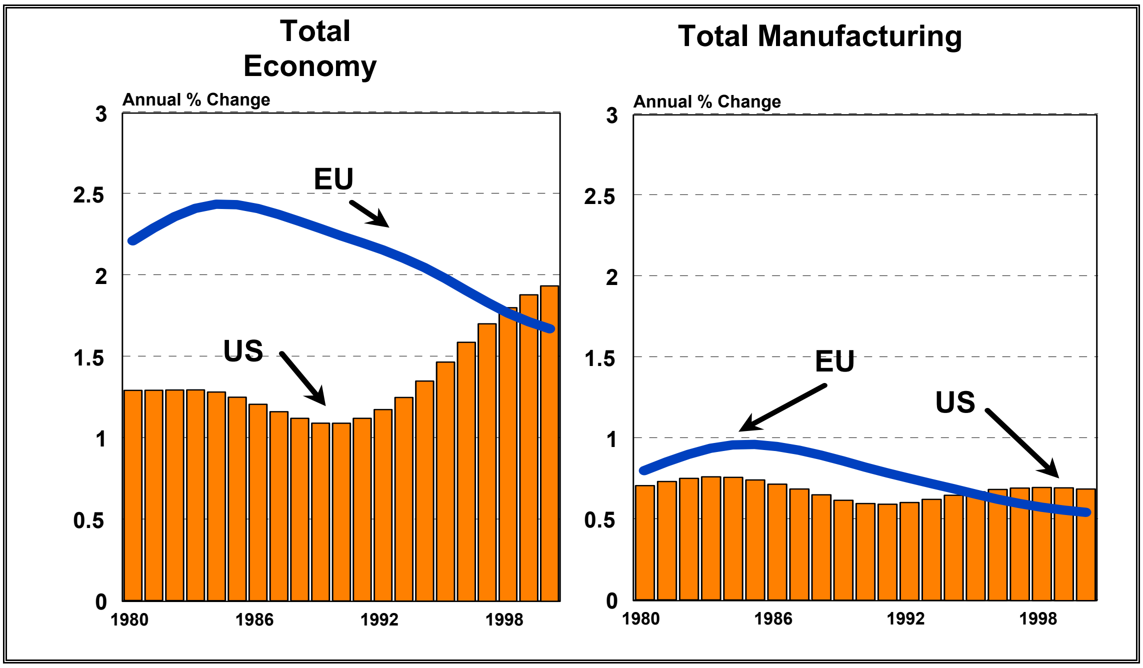
(1980-2000)

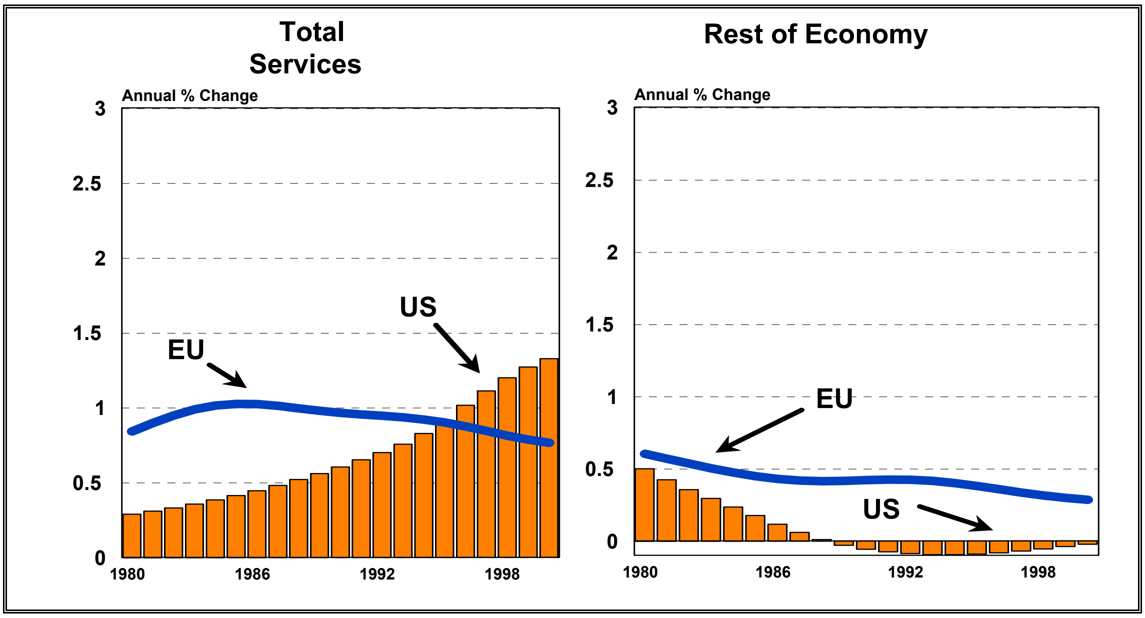
[62] Trends are calculated using a HP filter which can result in some beginning / end-of-sample bias. The end-of-sample bias has been effectively dealt with by extending the series to 2005. Some care must still however be taken in interpreting the patterns in the earlier years of the sample.

1. CONTRIBUTIONS TO THE TOTAL CHANGE IN HOURLY LABOUR PRODUCTIVITY

(COMPARISON OF EU AND US TRENDS : 1980-2000)

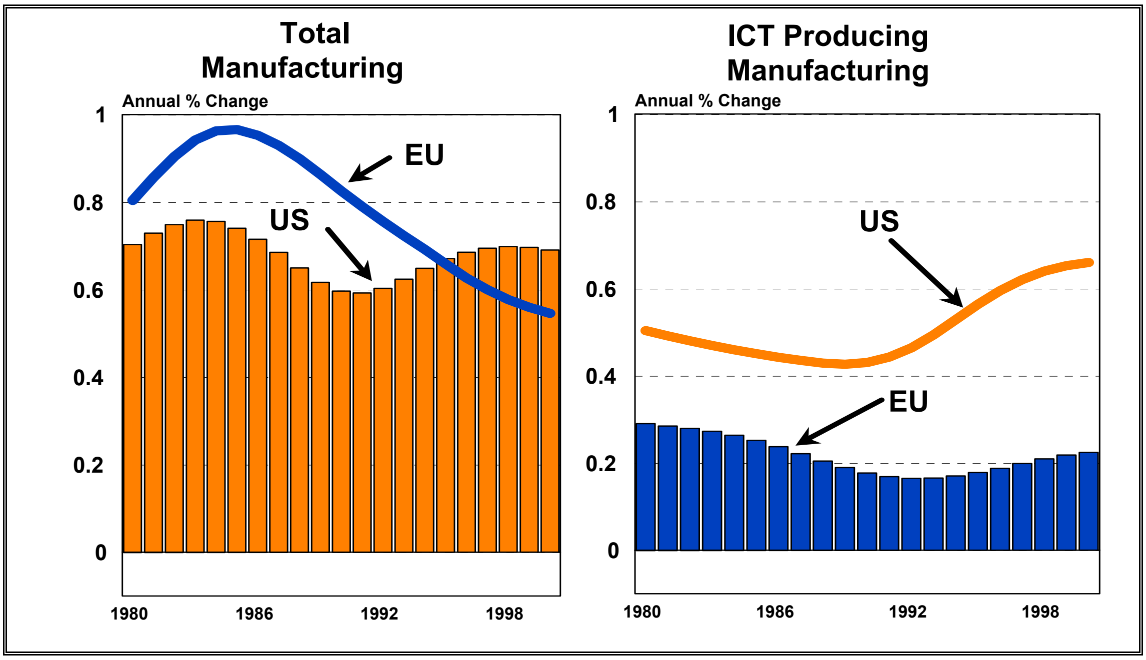
CONTRIBUTIONS TO THE TOTAL CHANGE IN LABOUR PRODUCTIVITY PER HOUR - BREAKDOWN INTO MANUFACTURING, PRIVATE SERVICES AND REST OF ECONOMY (PRIMARY INDUSTRIES + PUBLIC SERVICES) *

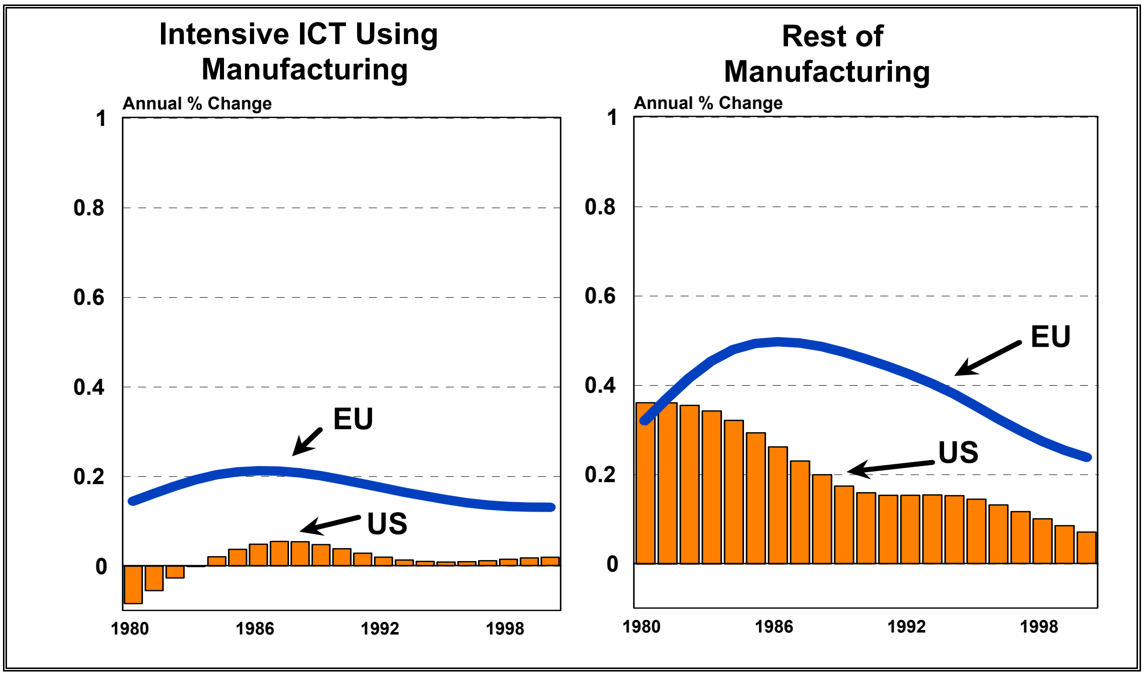




** The graphs show the contribution to the total change in labour productivity per hour i.e. the combined effect of labour productivity growth and the output shares of the respective industries. The graphs have all the same scale and are additive (i.e. manufacturing + services + rest of economy = total economy).*

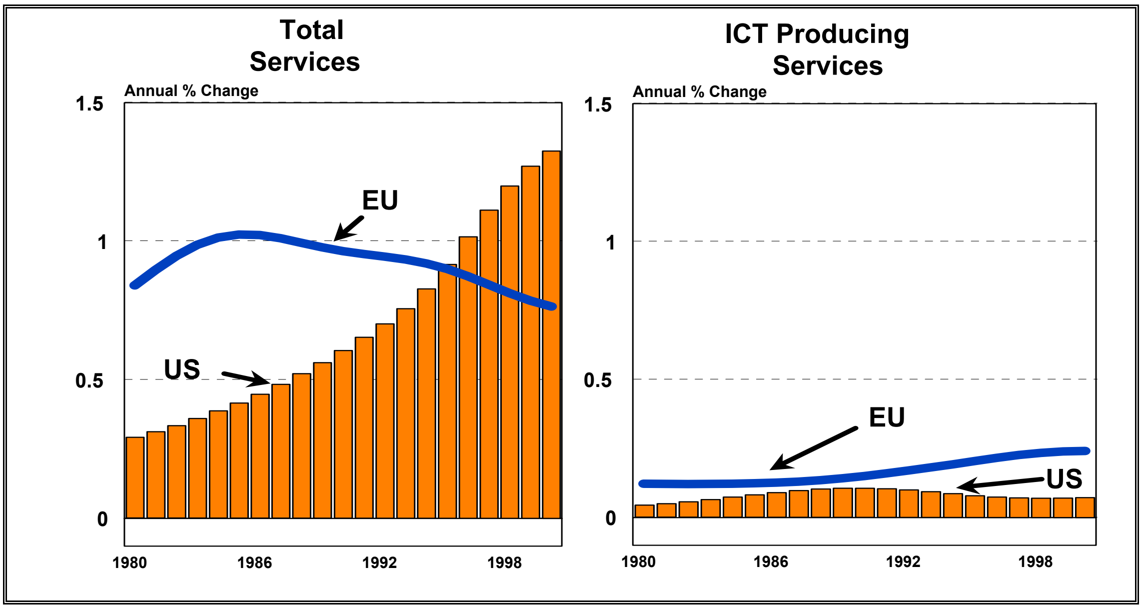
CONTRIBUTIONS TO TOTAL CHANGE IN LABOUR PRODUCTIVITY PER HOUR IN THE MANUFACTURING SECTOR (BREAKDOWN INTO ICT PRODUCING, ICT USING AND REST OF MANUFACTURING)*

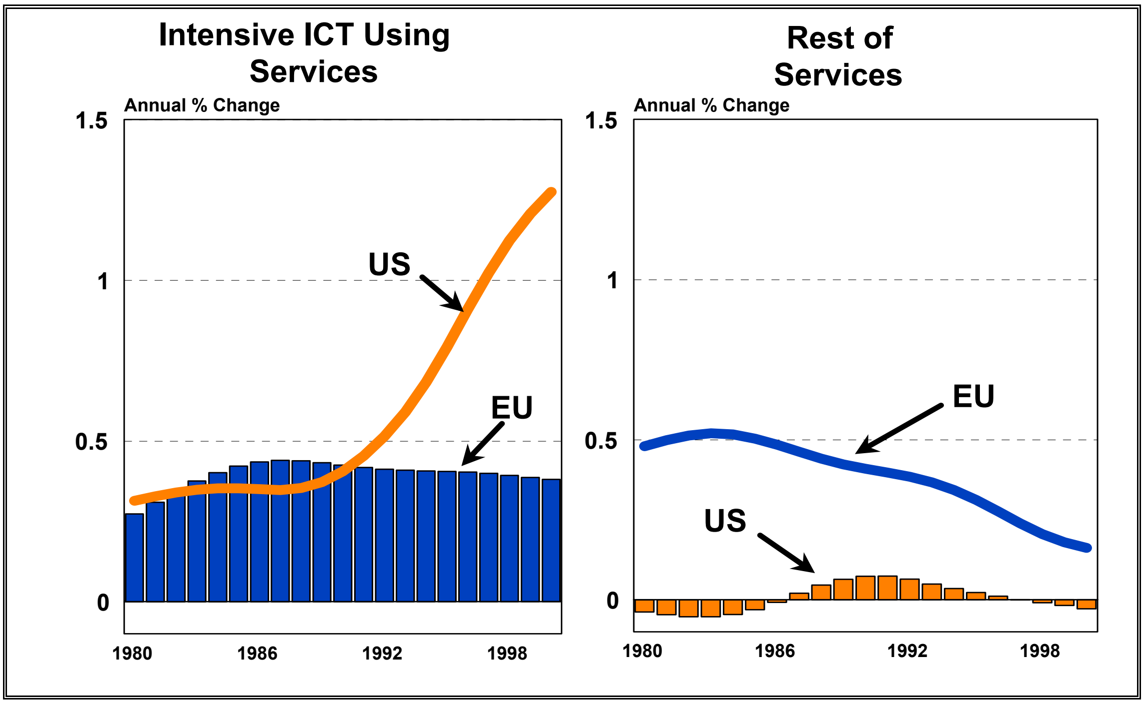




** The graphs show the contribution to the total change in labour productivity per hour in the manufacturing sector i.e. the combined effect of labour productivity growth and the output shares of the respective industries. The graphs have all the same scale and are additive (i.e. ICT producing + ICT using + rest of manufacturing = total manufacturing).*

CONTRIBUTIONS TO TOTAL CHANGE IN LABOUR PRODUCTIVITY PER HOUR IN THE SERVICES SECTOR (BREAKDOWN INTO ICT PRODUCING, ICT USING AND REST OF SERVICES)*



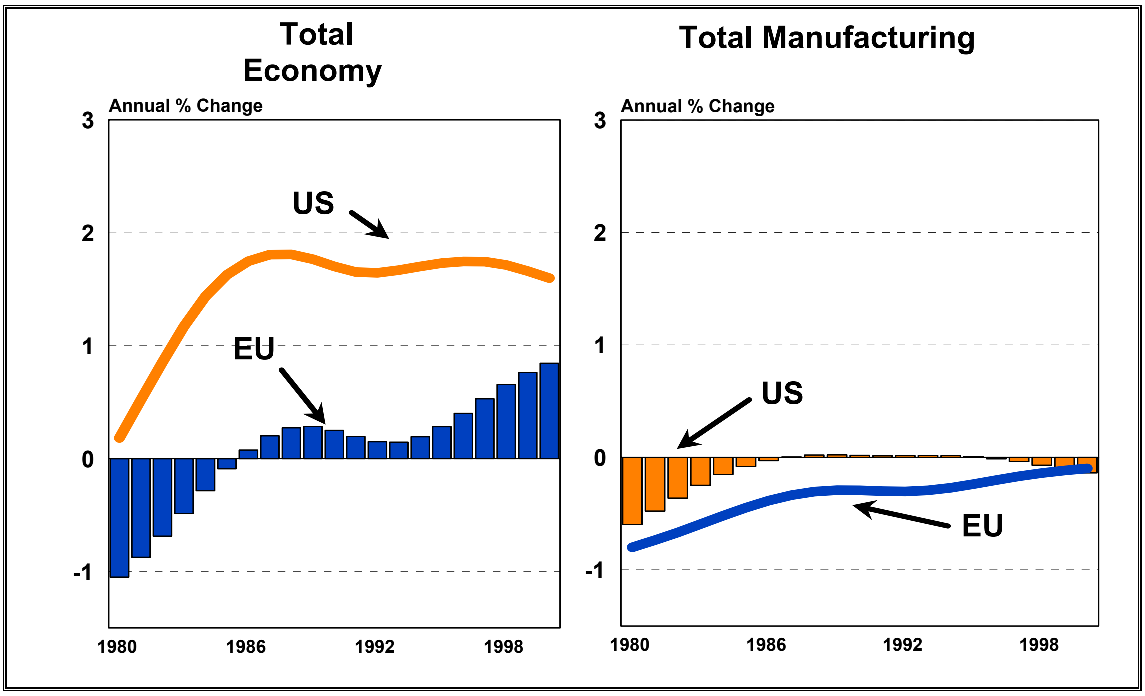


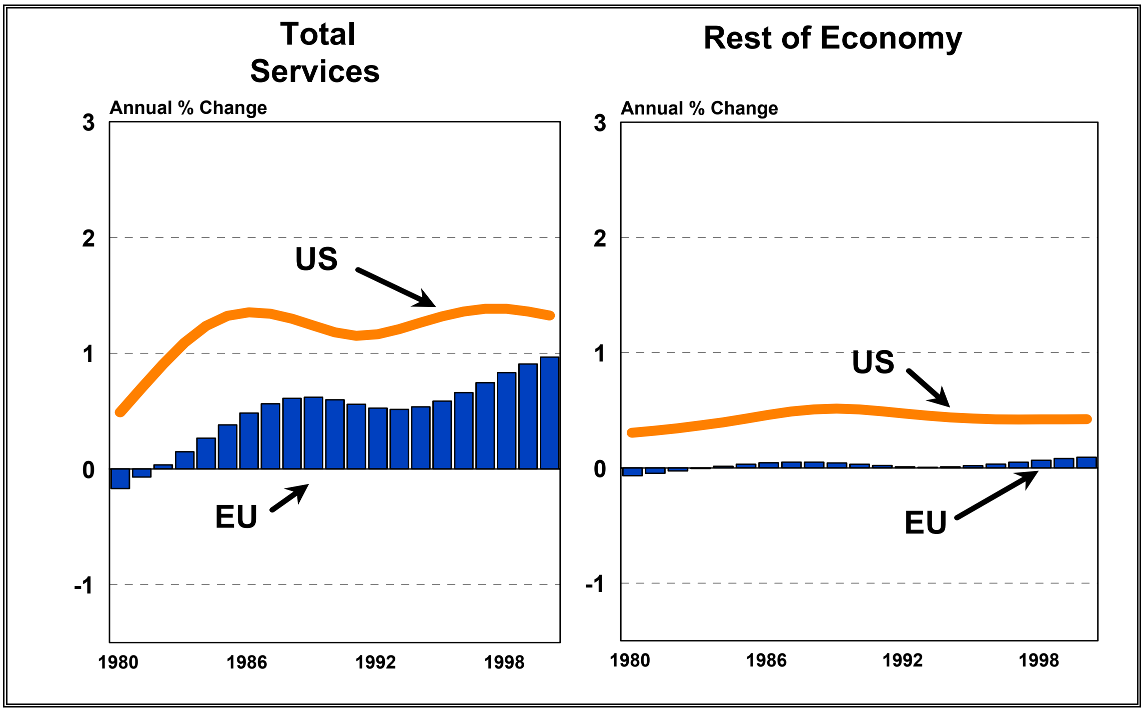
** The graphs show the contribution to the total change in labour productivity per hour in the services sector i.e. the combined effect of labour productivity growth and the output shares of the respective industries. The graphs have all the same scale and are additive (i.e. ICT producing + ICT using + rest of services = total services).*

2. CONTRIBUTIONS TO THE TOTAL CHANGE IN EMPLOYMENT (HOURS WORKED)

(COMPARISON OF EU AND US TRENDS : 1980-2000)

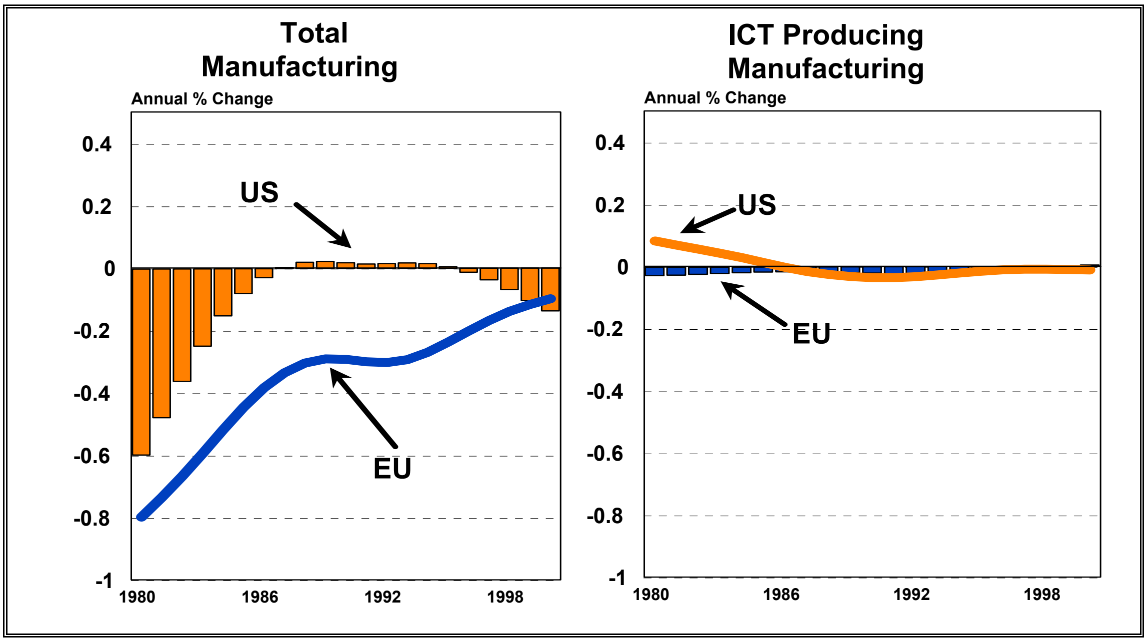
CONTRIBUTIONS TO THE TOTAL CHANGE IN EMPLOYMENT (HOURS WORKED) - BREAKDOWN INTO MANUFACTURING, PRIVATE SERVICES AND REST OF ECONOMY (PRIMARY INDUSTRIES + PUBLIC SERVICES) *

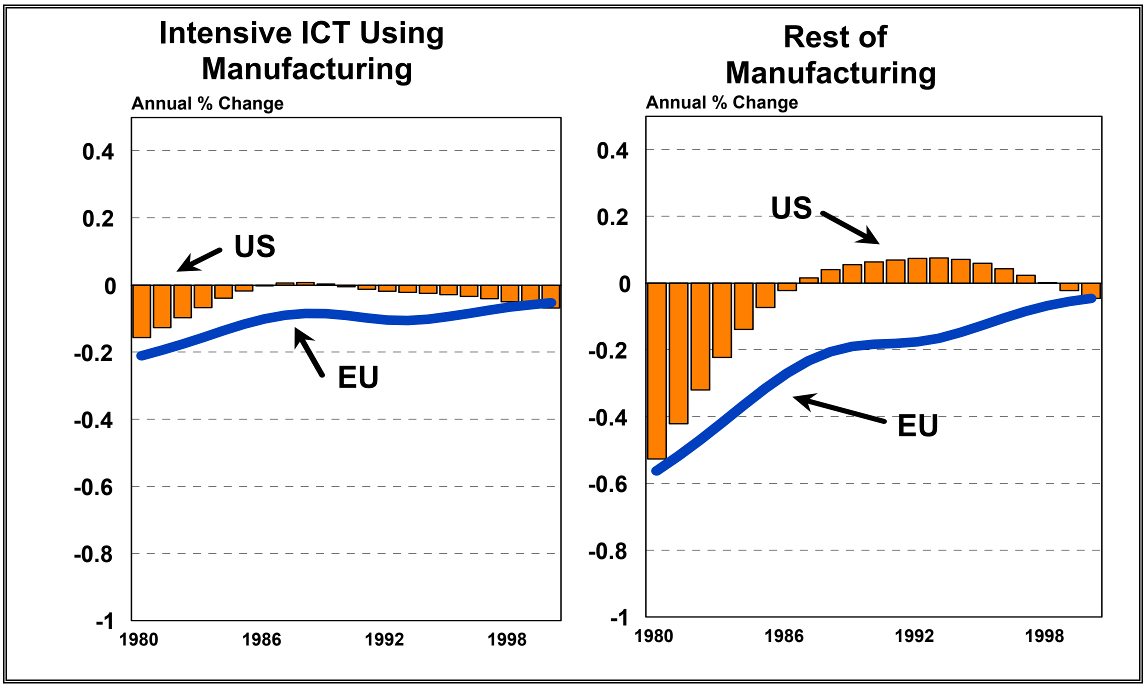




****** *The graphs show the contribution to the total change in employment i.e. the combined effect of employment growth and the output shares of the respective industries. The graphs have all the same scale and are additive (i.e. manufacturing + services + rest of economy = total economy).***

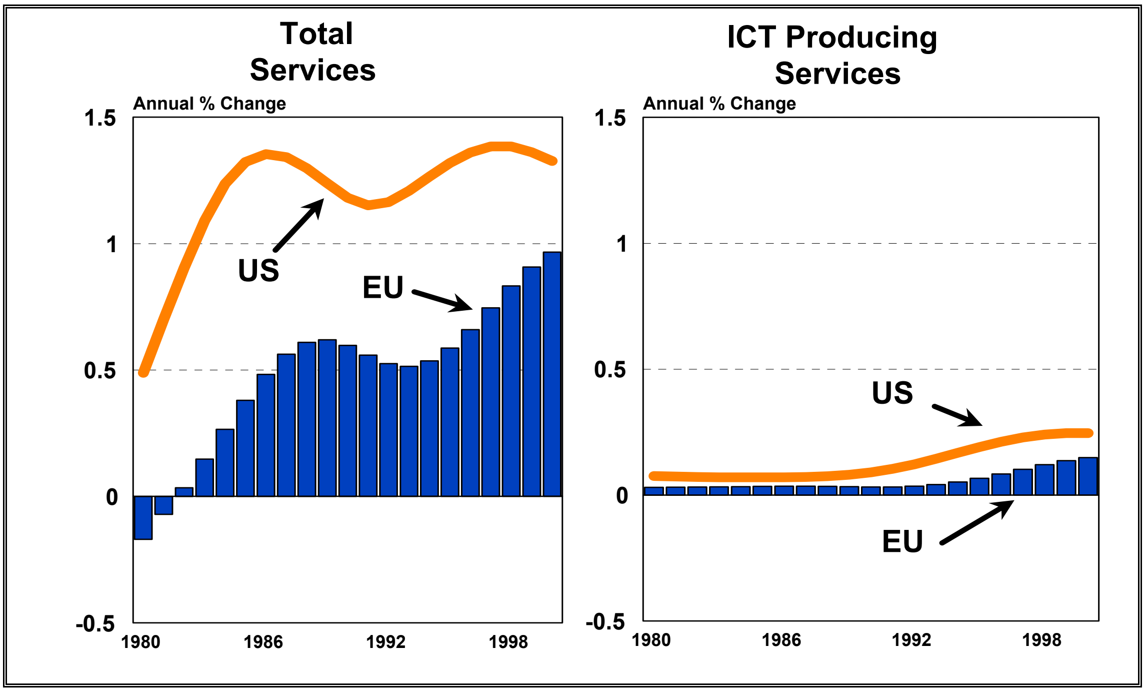
CONTRIBUTIONS TO TOTAL CHANGE IN EMPLOYMENT (HOURS WORKED) IN THE MANUFACTURING SECTOR (BREAKDOWN INTO ICT PRODUCING, ICT USING AND REST OF MANUFACTURING)*

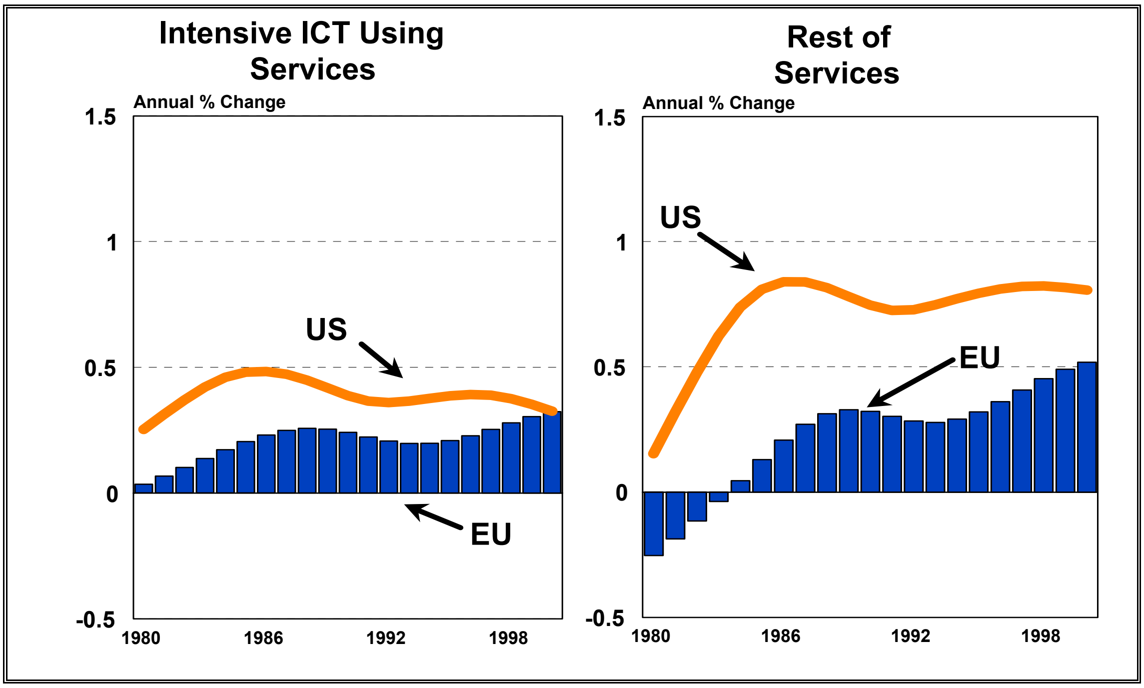




** The graphs show the contribution to the total change in employment in the manufacturing sector i.e. the combined effect of employment growth and the output shares of the respective industries. The graphs have all the same scale and are additive (i.e. ICT producing + ICT using + rest of manufacturing = total manufacturing).*

CONTRIBUTIONS TO TOTAL CHANGE IN EMPLOYMENT (HOURS WORKED) IN THE SERVICES SECTOR
(BREAKDOWN INTO ICT PRODUCING, ICT USING AND REST OF SERVICES)*



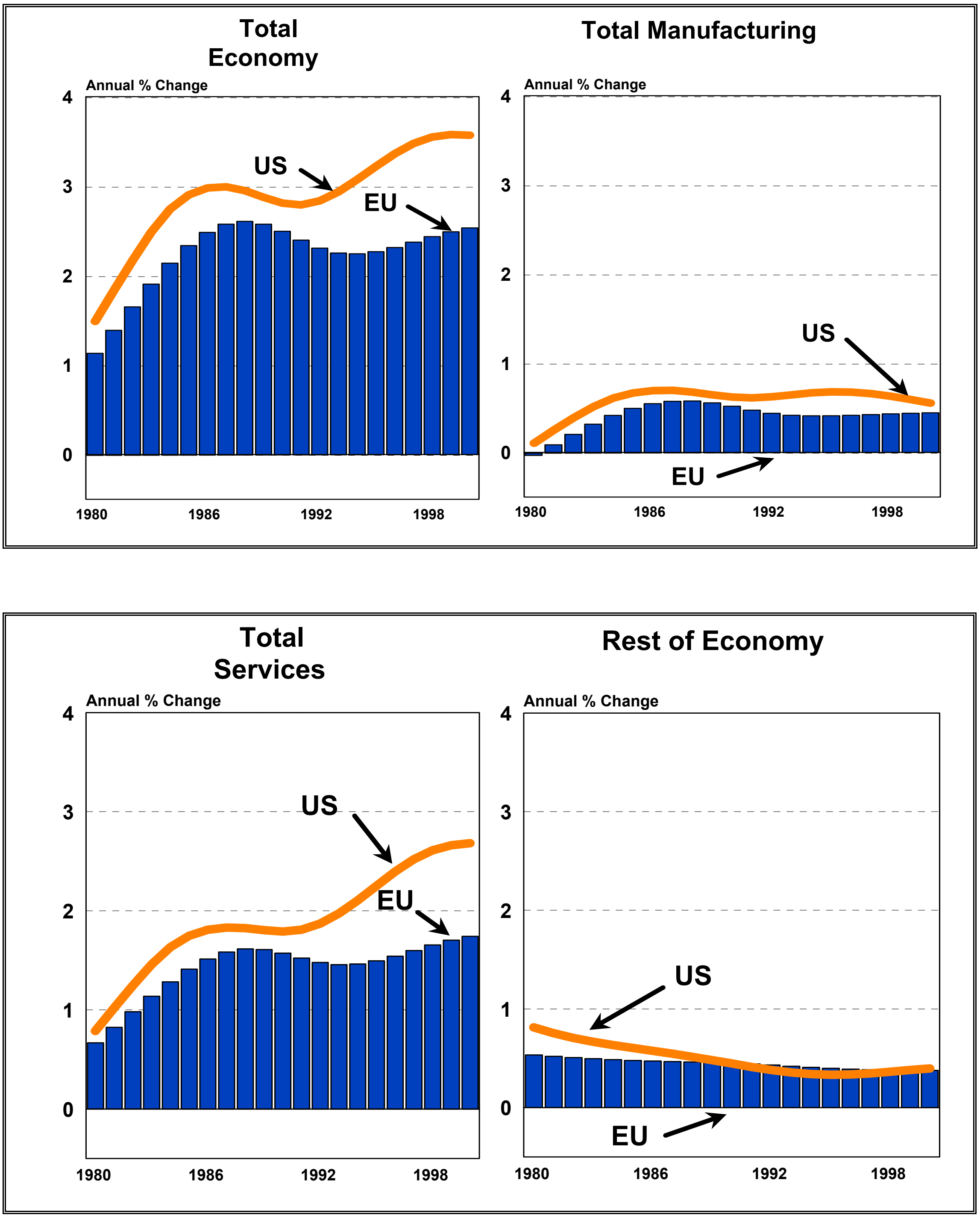


** The graphs show the contribution to the total change in employment in the services sector i.e. the combined effect of employment growth and the output shares of the respective industries. The graphs have all the same scale and are additive (i.e. ICT producing + ICT using + rest of services = total services).*

CONTRIBUTIONS TO THE TOTAL CHANGE IN OUTPUT (VALUE ADDED)

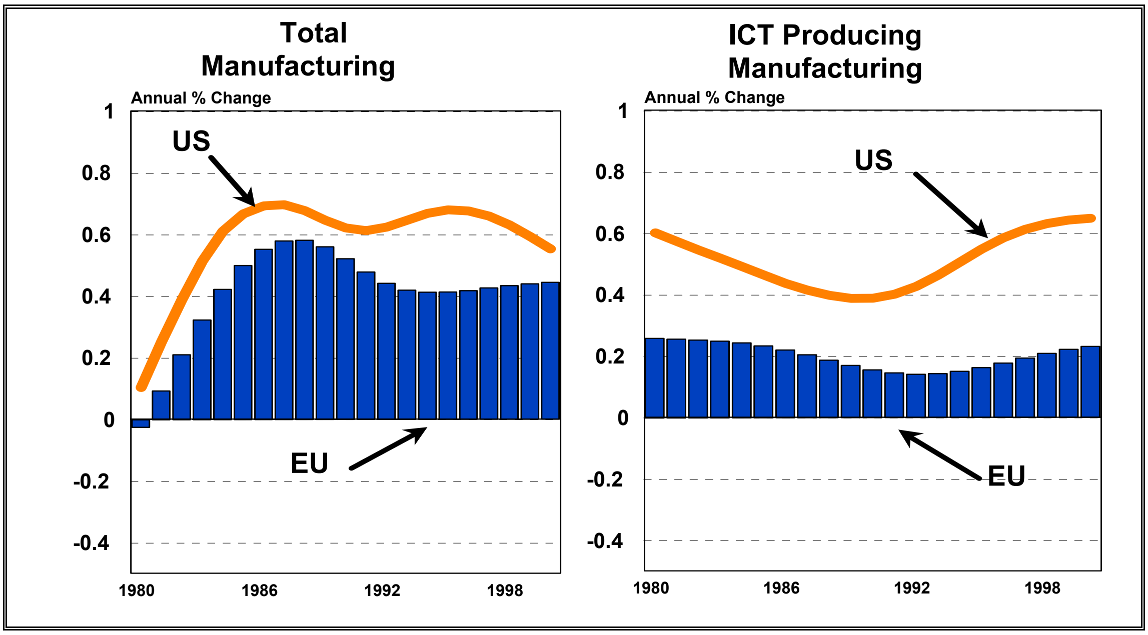
(COMPARISON OF EU AND US TRENDS : 1980-2000)

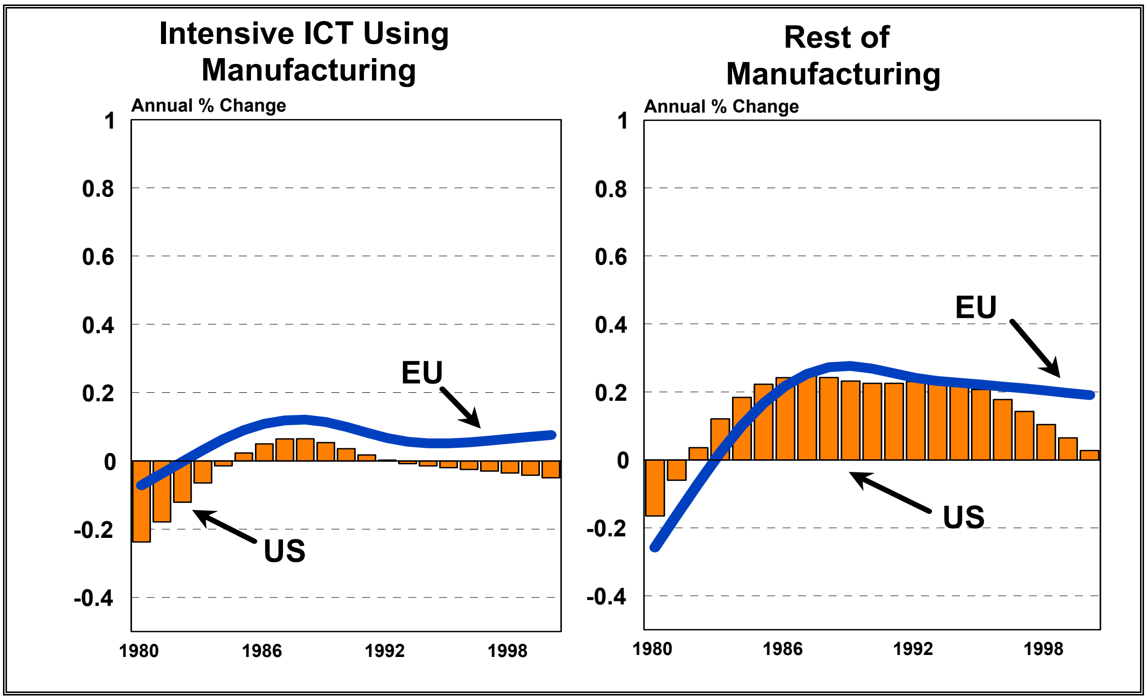
CONTRIBUTIONS TO THE TOTAL CHANGE IN OUTPUT (VALUE ADDED) - BREAKDOWN INTO MANUFACTURING, PRIVATE SERVICES AND REST OF ECONOMY (PRIMARY INDUSTRIES + PUBLIC SERVICES) *



** The graphs show the contribution to the total change in output i.e. the combined effect of output growth and the output shares of the respective industries. The graphs have all the same scale and are additive (i.e. manufacturing + services + rest of economy = total economy).*

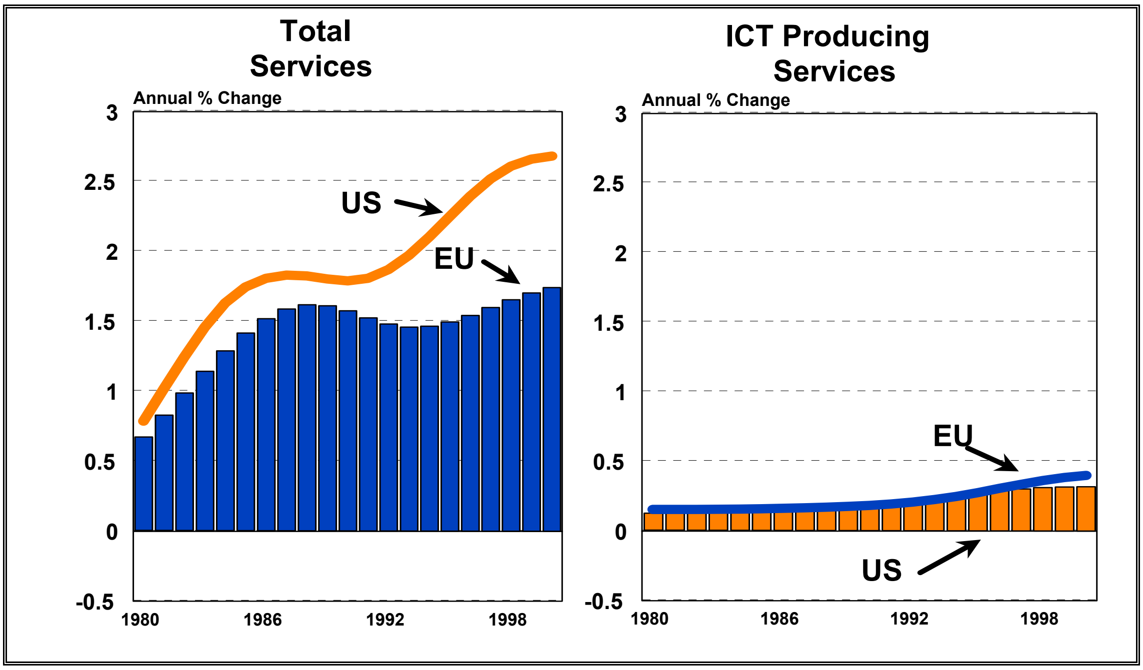
CONTRIBUTIONS TO TOTAL CHANGE IN OUTPUT (VALUE ADDED) IN THE MANUFACTURING SECTOR (BREAKDOWN INTO ICT PRODUCING, ICT USING AND REST OF MANUFACTURING)*

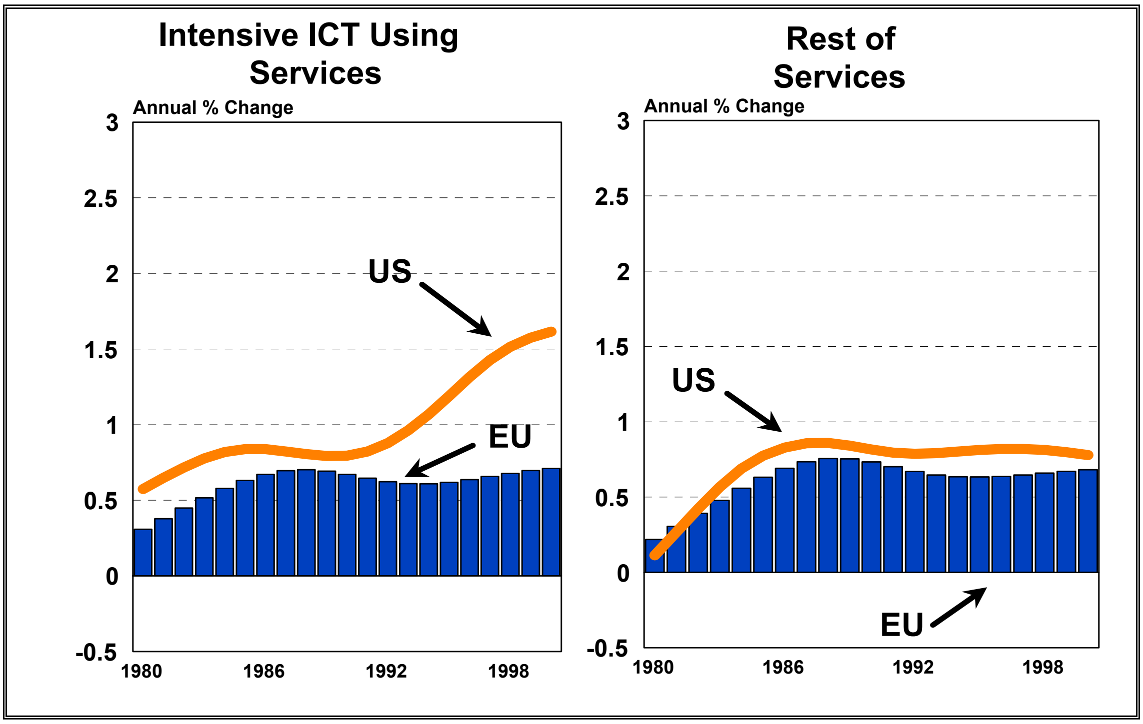




** The graphs show the contribution to the total change in output in the manufacturing sector i.e. the combined effect of output growth and the output shares of the respective industries. The graphs have all the same scale and are additive (i.e. ICT producing + ICT using + rest of manufacturing = total manufacturing).*

CONTRIBUTIONS TO TOTAL CHANGE IN OUTPUT (VALUE ADDED) IN THE SERVICES SECTOR
(BREAKDOWN INTO ICT PRODUCING, ICT USING AND REST OF SERVICES)*





** The graphs show the contribution to the total change in output in the services sector i.e. the combined effect of output growth and the output shares of the respective industries. The graphs have all the same scale and are additive (i.e. ICT producing + ICT using + rest of services = total services).*

ANNEX 4 : INDUSTRY LEVEL ANALYSIS : DATA FOR THE INDIVIDUAL EU MEMBER STATES

		Hourly Labour Productivity			Value added share			Contribution to total Hourly Labour Productivity growth		
	country	growth 1980-1990	growth 1990-1995	growth 1995-2000	1980	1990	1995	1980-1990	1990-1995	1995-2000
TOTAL ECONOMY	Belgium	2.6%	2.5%	2.2%	1	1	1	2.6%	2.5%	2.2%
	Denmark	2.2%	1.9%	1.4%	1	1	1	2.2%	1.9%	1.4%
	Germany	2.1%	2.4%	2.0%	1	1	1	2.1%	2.4%	2.0%
	Greece	1.0%	0.8%	2.6%	1	1	1	1.0%	0.8%	2.6%
	Spain	3.1%	1.7%	0.5%	1	1	1	3.1%	1.7%	0.5%
	France	3.0%	1.5%	1.4%	1	1	1	3.0%	1.5%	1.4%
	Ireland	4.5%	4.1%	7.6%	1	1	1	4.5%	4.1%	7.6%
	Italy	2.1%	2.3%	0.7%	1	1	1	2.1%	2.3%	0.7%
	Luxembourg	3.7%	2.2%	1.5%	1	1	1	3.7%	2.2%	1.5%
	Netherlands	2.3%	1.4%	1.3%	1	1	1	2.3%	1.4%	1.3%
	Austria	2.8%	3.8%	2.7%	1	1	1	2.8%	3.8%	2.7%
	Portugal	3.1%	2.1%	3.0%	1	1	1	3.1%	2.1%	3.0%
	Finland	3.1%	2.9%	2.2%	1	1	1	3.1%	2.9%	2.2%
	Sweden	1.6%	2.0%	2.1%	1	1	1	1.6%	2.0%	2.1%
	UK	2.1%	3.1%	2.2%	1	1	1	2.1%	3.1%	2.2%
	EU15	2.4%	2.3%	1.6%	1	1	1	2.4%	2.3%	1.6%
	USA	1.1%	1.1%	2.3%	1	1	1	1.1%	1.1%	2.3%
NON-FARM-BUSINESS	Belgium	3.5%	2.5%	2.8%	0.71	0.75	0.74	2.5%	1.9%	2.1%
	Denmark	2.1%	1.6%	1.9%	0.68	0.69	0.69	1.4%	1.1%	1.3%
	Germany	2.4%	2.5%	2.3%	0.76	0.77	0.77	1.8%	1.9%	1.7%
	Greece	1.2%	0.4%	3.1%	0.72	0.70	0.70	0.9%	0.3%	2.2%
	Spain	3.2%	1.8%	0.0%	0.73	0.73	0.74	2.4%	1.3%	0.0%
	France	3.2%	1.8%	1.3%	0.75	0.75	0.73	2.4%	1.4%	1.0%
	Ireland	4.6%	4.5%	8.4%	0.71	0.71	0.71	3.3%	3.2%	6.0%
	Italy	2.3%	2.5%	0.6%	0.77	0.76	0.77	1.7%	1.9%	0.4%
	Luxembourg	3.6%	2.1%	1.6%	0.82	0.81	0.82	3.0%	1.7%	1.3%
	Netherlands	3.0%	1.3%	1.7%	0.64	0.69	0.71	1.9%	0.9%	1.2%
	Austria	3.3%	3.9%	3.1%	0.74	0.75	0.75	2.4%	2.9%	2.4%
	Portugal	2.9%	2.0%	3.3%	0.71	0.72	0.71	2.1%	1.4%	2.3%
	Finland	3.4%	4.3%	2.1%	0.72	0.71	0.72	2.5%	3.0%	1.5%
	Sweden	2.2%	3.0%	1.7%	0.68	0.70	0.72	1.5%	2.1%	1.2%
	UK	2.9%	3.3%	2.6%	0.72	0.75	0.74	2.1%	2.5%	1.9%
	EU15	2.7%	2.5%	1.7%	0.74	0.75	0.75	2.0%	1.8%	1.3%
	USA	1.6%	1.7%	3.1%	0.72	0.72	0.73	1.1%	1.2%	2.3%
REST	Belgium	0.7%	2.5%	0.9%	0.29	0.25	0.26	0.2%	0.6%	0.2%
	Denmark	2.5%	2.6%	0.6%	0.32	0.31	0.31	0.8%	0.8%	0.2%
	Germany	1.2%	2.3%	1.0%	0.24	0.23	0.23	0.3%	0.5%	0.2%
	Greece	0.5%	1.4%	1.0%	0.28	0.30	0.30	0.1%	0.4%	0.3%
	Spain	3.0%	1.4%	1.0%	0.27	0.27	0.26	0.8%	0.4%	0.3%
	France	2.5%	1.5%	1.3%	0.25	0.25	0.27	0.6%	0.4%	0.3%
	Ireland	4.3%	2.9%	2.7%	0.29	0.29	0.29	1.2%	0.8%	0.8%
	Italy	1.4%	1.8%	0.7%	0.23	0.24	0.23	0.3%	0.4%	0.2%
	Luxembourg	4.0%	2.6%	0.6%	0.18	0.19	0.18	0.7%	0.5%	0.1%
	Netherlands	1.2%	1.6%	0.4%	0.36	0.31	0.29	0.4%	0.5%	0.1%
	Austria	1.7%	3.6%	1.0%	0.26	0.25	0.25	0.4%	0.9%	0.3%
	Portugal	3.4%	2.6%	1.9%	0.29	0.28	0.29	1.0%	0.7%	0.6%
	Finland	2.2%	0.9%	1.3%	0.28	0.29	0.28	0.6%	0.3%	0.4%
	Sweden	0.5%	0.1%	2.7%	0.32	0.30	0.28	0.2%	0.0%	0.7%
	UK	0.4%	2.7%	1.2%	0.28	0.25	0.26	0.1%	0.7%	0.3%
	EU15	1.6%	2.0%	1.1%	0.26	0.25	0.25	0.4%	0.5%	0.3%
	USA	0.2%	-0.3%	-0.1%	0.28	0.28	0.27	0.0%	-0.1%	0.0%

		Hourly Labour Productivity			Value added share			Contribution to total Hourly Labour Productivity growth		
	country	growth 1980-1990	growth 1990-1995	growth 1995-2000	1980	1990	1995	1980-1990	1990-1995	1995-2000
MANUFACTURING	Belgium	6.0%	3.4%	4.2%	0.23	0.22	0.20	1.4%	0.8%	0.8%
	Denmark	2.1%	3.0%	2.9%	0.19	0.17	0.17	0.4%	0.5%	0.5%
	Germany	2.6%	3.0%	2.0%	0.30	0.28	0.23	0.8%	0.8%	0.4%
	Greece	0.5%	2.2%	2.4%	0.18	0.16	0.13	0.1%	0.3%	0.3%
	Spain	5.9%	3.8%	0.7%	0.26	0.19	0.19	1.5%	0.7%	0.1%
	France	2.9%	3.5%	3.3%	0.25	0.20	0.18	0.7%	0.7%	0.6%
	Ireland	11.3%	8.6%	17.3%	0.22	0.28	0.30	2.5%	2.4%	5.2%
	Italy	3.9%	3.6%	1.1%	0.29	0.23	0.22	1.1%	0.9%	0.2%
	Luxembourg	4.7%	5.0%	2.7%	0.22	0.20	0.13	1.0%	1.0%	0.4%
	Netherlands	4.5%	4.0%	2.0%	0.18	0.19	0.18	0.8%	0.7%	0.3%
	Austria	4.6%	5.5%	5.0%	0.24	0.22	0.20	1.1%	1.2%	1.0%
	Portugal	3.0%	2.9%	5.6%	0.23	0.21	0.20	0.7%	0.6%	1.1%
	Finland	5.3%	5.7%	4.2%	0.27	0.22	0.25	1.5%	1.3%	1.0%
	Sweden	3.9%	4.3%	1.7%	0.22	0.20	0.22	0.9%	0.9%	0.4%
	UK	5.8%	4.8%	2.9%	0.27	0.23	0.21	1.6%	1.1%	0.6%
	EU15	3.9%	3.7%	2.6%	0.26	0.23	0.21	1.0%	0.9%	0.5%
	USA	3.6%	3.6%	4.6%	0.22	0.19	0.18	0.8%	0.7%	0.8%
ICTproducing MANU	Belgium	15.4%	7.1%	6.3%	0.01	0.01	0.01	0.2%	0.1%	0.1%
	Denmark	11.3%	7.4%	3.2%	0.01	0.01	0.01	0.1%	0.1%	0.0%
	Germany	10.2%	5.6%	12.2%	0.02	0.02	0.01	0.2%	0.1%	0.2%
	Greece	21.2%	11.7%	7.3%	0.00	0.00	0.00	0.1%	0.0%	0.0%
	Spain	21.2%	11.0%	13.0%	0.01	0.01	0.01	0.2%	0.1%	0.1%
	France	13.5%	8.2%	12.2%	0.02	0.02	0.01	0.3%	0.1%	0.2%
	Ireland	29.5%	19.6%	44.2%	0.02	0.04	0.06	0.5%	0.8%	2.5%
	Italy	17.7%	7.3%	5.2%	0.01	0.01	0.01	0.2%	0.1%	0.1%
	Luxembourg	11.3%	-6.4%	1.6%	0.00	0.00	0.00	0.0%	0.0%	0.0%
	Netherlands	10.0%	5.0%	-1.5%	0.02	0.02	0.01	0.2%	0.1%	0.0%
	Austria	16.3%	8.0%	9.2%	0.01	0.02	0.02	0.2%	0.1%	0.1%
	Portugal	24.4%	22.0%	10.8%	0.01	0.01	0.01	0.2%	0.1%	0.1%
	Finland	21.8%	8.7%	12.8%	0.01	0.01	0.02	0.2%	0.1%	0.3%
	Sweden	18.1%	7.4%	-5.6%	0.02	0.02	0.02	0.3%	0.1%	-0.1%
	UK	21.3%	21.3%	24.3%	0.02	0.02	0.02	0.4%	0.3%	0.4%
	EU15	13.9%	9.6%	17.1%	0.02	0.02	0.01	0.2%	0.2%	0.2%
	USA	16.2%	16.4%	26.0%	0.02	0.03	0.03	0.4%	0.4%	0.7%
ICTusing MANU	Belgium	4.1%	4.0%	4.8%	0.05	0.05	0.04	0.2%	0.2%	0.2%
	Denmark	1.2%	2.6%	1.3%	0.07	0.07	0.06	0.1%	0.2%	0.1%
	Germany	1.6%	1.6%	2.3%	0.10	0.10	0.07	0.2%	0.2%	0.2%
	Greece	0.7%	0.9%	2.8%	0.06	0.06	0.04	0.0%	0.1%	0.1%
	Spain	4.7%	2.7%	1.7%	0.06	0.05	0.04	0.3%	0.1%	0.1%
	France	3.0%	3.0%	2.2%	0.08	0.06	0.05	0.2%	0.2%	0.1%
	Ireland	5.6%	6.2%	13.9%	0.06	0.06	0.07	0.3%	0.4%	1.0%
	Italy	2.0%	4.1%	1.5%	0.10	0.07	0.07	0.2%	0.3%	0.1%
	Luxembourg	5.4%	1.2%	-2.8%	0.03	0.04	0.03	0.2%	0.0%	-0.1%
	Netherlands	4.0%	2.9%	2.9%	0.05	0.05	0.05	0.2%	0.2%	0.1%
	Austria	4.3%	3.6%	4.8%	0.06	0.06	0.05	0.3%	0.2%	0.3%
	Portugal	1.8%	3.6%	3.9%	0.05	0.05	0.05	0.1%	0.2%	0.2%
	Finland	4.8%	4.9%	1.5%	0.09	0.08	0.07	0.4%	0.4%	0.1%
	Sweden	1.7%	4.4%	1.4%	0.07	0.06	0.06	0.1%	0.3%	0.1%
	UK	4.7%	2.6%	0.7%	0.08	0.07	0.07	0.4%	0.2%	0.1%
	EU15	2.8%	2.6%	2.0%	0.08	0.07	0.06	0.2%	0.2%	0.1%
	USA	0.8%	-0.6%	1.4%	0.07	0.06	0.05	0.1%	0.0%	0.1%
nonICT MANU	Belgium	5.9%	2.9%	3.9%	0.17	0.17	0.15	1.0%	0.5%	0.6%
	Denmark	1.7%	2.7%	3.9%	0.11	0.10	0.10	0.2%	0.3%	0.4%
	Germany	2.3%	3.5%	0.7%	0.18	0.16	0.14	0.4%	0.6%	0.1%
	Greece	-0.3%	2.5%	1.9%	0.12	0.10	0.08	0.0%	0.2%	0.2%
	Spain	5.4%	3.7%	-0.1%	0.18	0.14	0.14	1.0%	0.5%	0.0%
	France	1.4%	3.2%	2.6%	0.16	0.13	0.12	0.2%	0.4%	0.3%
	Ireland	9.4%	6.3%	9.9%	0.15	0.17	0.18	1.4%	1.1%	1.7%
	Italy	3.7%	3.2%	0.5%	0.18	0.15	0.14	0.7%	0.5%	0.1%
	Luxembourg	4.6%	6.4%	4.2%	0.19	0.16	0.10	0.9%	1.0%	0.4%
	Netherlands	3.9%	4.3%	2.2%	0.12	0.12	0.12	0.5%	0.5%	0.2%
	Austria	3.5%	6.0%	4.6%	0.17	0.14	0.13	0.6%	0.8%	0.6%
	Portugal	2.3%	1.8%	5.8%	0.17	0.15	0.14	0.4%	0.3%	0.8%
	Finland	4.5%	5.6%	2.4%	0.18	0.14	0.16	0.8%	0.8%	0.4%
	Sweden	2.9%	3.8%	2.9%	0.13	0.13	0.14	0.4%	0.5%	0.4%
	UK	4.5%	3.9%	1.2%	0.17	0.14	0.13	0.8%	0.5%	0.1%
	EU15	3.2%	3.6%	1.6%	0.17	0.14	0.13	0.5%	0.5%	0.2%
	USA	2.4%	2.6%	0.6%	0.13	0.10	0.11	0.3%	0.3%	0.1%

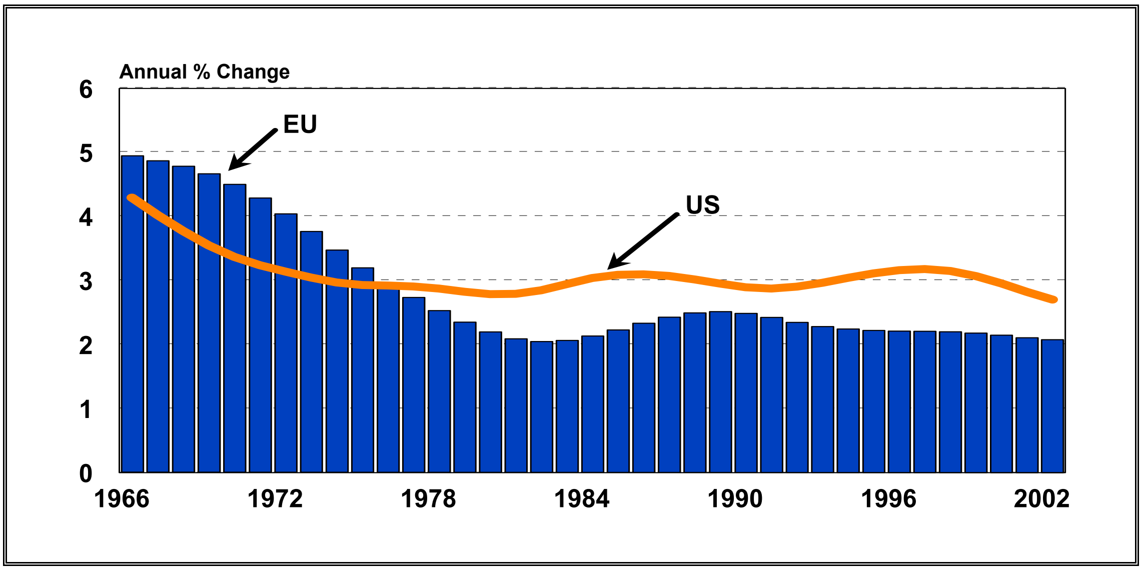
	country	Hourly Labour Productivity growth 1980-1990	Hourly Labour Productivity growth 1990-1995	Hourly Labour Productivity growth 1995-2000	Value added share 1980	Value added share 1990	Value added share 1995	Contribution to total Hourly Labour Productivity growth 1980-1990	Contribution to total Hourly Labour Productivity growth 1990-1995	Contribution to total Hourly Labour Productivity growth 1995-2000
SERVICES	Belgium	2.3%	2.1%	2.3%	0.48	0.52	0.54	1.1%	1.1%	1.2%
	Denmark	2.0%	1.2%	1.3%	0.50	0.52	0.52	1.0%	0.6%	0.7%
	Germany	2.2%	1.9%	2.3%	0.46	0.49	0.54	1.0%	0.9%	1.2%
	Greece	1.3%	-0.6%	3.0%	0.54	0.54	0.57	0.7%	-0.3%	1.7%
	Spain	1.9%	1.1%	-0.3%	0.47	0.54	0.56	0.9%	0.6%	-0.1%
	France	3.3%	1.2%	0.6%	0.50	0.55	0.55	1.6%	0.6%	0.3%
	Ireland	0.9%	1.8%	3.1%	0.49	0.43	0.41	0.4%	0.8%	1.3%
	Italy	1.2%	1.9%	0.2%	0.48	0.53	0.55	0.6%	1.0%	0.1%
	Luxembourg	3.2%	1.4%	1.2%	0.60	0.61	0.69	1.9%	0.9%	0.8%
	Netherlands	2.4%	0.3%	1.6%	0.46	0.50	0.53	1.1%	0.2%	0.9%
	Austria	2.5%	3.1%	2.4%	0.50	0.53	0.55	1.2%	1.6%	1.3%
	Portugal	2.7%	1.3%	2.1%	0.49	0.52	0.51	1.3%	0.7%	1.1%
	Finland	2.4%	3.6%	1.1%	0.45	0.49	0.47	1.1%	1.7%	0.5%
	Sweden	1.3%	2.5%	1.7%	0.46	0.50	0.50	0.6%	1.2%	0.9%
	UK	1.7%	2.9%	2.7%	0.45	0.52	0.53	0.7%	1.5%	1.4%
	EU15	2.0%	1.9%	1.4%	0.47	0.52	0.54	1.0%	1.0%	0.7%
	USA	0.8%	1.0%	2.7%	0.49	0.53	0.54	0.4%	0.5%	1.5%
ICTproducing SVCES	Belgium	4.1%	2.0%	8.6%	0.02	0.03	0.03	0.1%	0.1%	0.3%
	Denmark	5.1%	7.7%	6.4%	0.02	0.03	0.03	0.1%	0.3%	0.2%
	Germany	4.6%	6.3%	12.7%	0.03	0.03	0.04	0.1%	0.2%	0.4%
	Greece	4.3%	3.9%	7.5%	0.03	0.03	0.03	0.1%	0.1%	0.2%
	Spain	2.6%	1.8%	2.5%	0.02	0.02	0.03	0.0%	0.0%	0.1%
	France	5.6%	1.3%	5.3%	0.03	0.03	0.04	0.2%	0.0%	0.2%
	Ireland	0.0%	10.9%	2.9%	0.06	0.05	0.04	0.0%	0.5%	0.1%
	Italy	3.2%	5.6%	6.1%	0.02	0.03	0.03	0.1%	0.2%	0.2%
	Luxembourg	6.9%	8.8%	4.4%	0.03	0.04	0.05	0.2%	0.3%	0.2%
	Netherlands	2.1%	1.4%	4.3%	0.02	0.03	0.03	0.0%	0.0%	0.1%
	Austria	4.1%	6.3%	2.0%	0.02	0.03	0.03	0.1%	0.2%	0.1%
	Portugal	9.3%	8.1%	6.0%	0.02	0.02	0.03	0.1%	0.2%	0.2%
	Finland	4.2%	3.8%	7.5%	0.02	0.03	0.03	0.1%	0.1%	0.2%
	Sweden	3.6%	6.2%	4.3%	0.03	0.03	0.04	0.1%	0.2%	0.2%
	UK	3.7%	6.2%	5.6%	0.03	0.04	0.04	0.1%	0.2%	0.2%
	EU15	4.1%	4.8%	6.8%	0.03	0.03	0.03	0.1%	0.2%	0.2%
	USA	2.1%	2.4%	0.8%	0.03	0.03	0.04	0.1%	0.1%	0.0%
ICTusing SVCES	Belgium	2.1%	3.0%	0.5%	0.24	0.28	0.29	0.5%	0.9%	0.2%
	Denmark	2.8%	0.6%	3.5%	0.19	0.21	0.20	0.5%	0.1%	0.7%
	Germany	2.3%	2.9%	2.2%	0.17	0.18	0.20	0.4%	0.5%	0.4%
	Greece	-0.5%	-2.1%	3.7%	0.15	0.15	0.17	-0.1%	-0.3%	0.6%
	Spain	1.9%	-1.0%	0.2%	0.16	0.18	0.18	0.3%	-0.2%	0.0%
	France	4.3%	0.9%	0.9%	0.18	0.21	0.20	0.8%	0.2%	0.2%
	Ireland	1.9%	-0.4%	2.5%	0.21	0.22	0.21	0.4%	-0.1%	0.5%
	Italy	0.5%	2.2%	1.5%	0.20	0.22	0.22	0.1%	0.5%	0.3%
	Luxembourg	3.1%	2.2%	1.8%	0.35	0.28	0.36	1.1%	0.6%	0.6%
	Netherlands	2.5%	0.4%	2.5%	0.19	0.21	0.23	0.5%	0.1%	0.6%
	Austria	3.2%	3.7%	2.8%	0.20	0.22	0.22	0.6%	0.8%	0.6%
	Portugal	2.8%	0.1%	1.6%	0.25	0.27	0.25	0.7%	0.0%	0.4%
	Finland	3.4%	0.5%	3.3%	0.15	0.17	0.15	0.5%	0.1%	0.5%
	Sweden	2.4%	2.3%	3.4%	0.15	0.18	0.17	0.4%	0.4%	0.6%
	UK	2.1%	2.4%	4.5%	0.16	0.19	0.20	0.3%	0.5%	0.9%
	EU15	2.2%	1.8%	2.1%	0.18	0.20	0.21	0.4%	0.4%	0.4%
	USA	1.6%	1.6%	5.3%	0.21	0.23	0.25	0.3%	0.4%	1.3%
nonICT Services	Belgium	2.2%	1.1%	3.6%	0.22	0.21	0.22	0.5%	0.2%	0.8%
	Denmark	1.3%	0.7%	-0.9%	0.28	0.28	0.29	0.4%	0.2%	-0.2%
	Germany	1.9%	0.6%	1.1%	0.27	0.28	0.30	0.5%	0.2%	0.3%
	Greece	2.2%	0.0%	2.3%	0.36	0.36	0.37	0.8%	0.0%	0.8%
	Spain	1.8%	2.1%	-1.0%	0.30	0.34	0.35	0.6%	0.7%	-0.3%
	France	2.5%	1.4%	-0.2%	0.29	0.30	0.31	0.7%	0.4%	-0.1%
	Ireland	-0.4%	2.7%	3.5%	0.23	0.16	0.16	-0.1%	0.4%	0.6%
	Italy	1.7%	1.5%	-1.6%	0.25	0.28	0.30	0.4%	0.4%	-0.5%
	Luxembourg	3.0%	0.8%	-0.1%	0.23	0.29	0.28	0.7%	0.2%	0.0%
	Netherlands	2.3%	0.2%	0.3%	0.25	0.26	0.27	0.6%	0.1%	0.1%
	Austria	1.8%	2.3%	2.1%	0.28	0.28	0.30	0.5%	0.7%	0.6%
	Portugal	2.0%	1.9%	2.2%	0.22	0.22	0.23	0.4%	0.4%	0.5%
	Finland	1.8%	5.4%	-0.3%	0.28	0.29	0.29	0.5%	1.6%	-0.1%
	Sweden	0.4%	2.5%	0.3%	0.27	0.29	0.29	0.1%	0.7%	0.1%
	UK	1.2%	3.0%	1.0%	0.26	0.30	0.29	0.3%	0.9%	0.3%
	EU15	1.7%	1.7%	0.2%	0.27	0.29	0.30	0.5%	0.5%	0.1%
	USA	-0.2%	0.2%	0.3%	0.25	0.27	0.26	0.0%	0.1%	0.1%

Annex 5 : Total Economy Level Analysis : Labour Productivity Per Person Employed

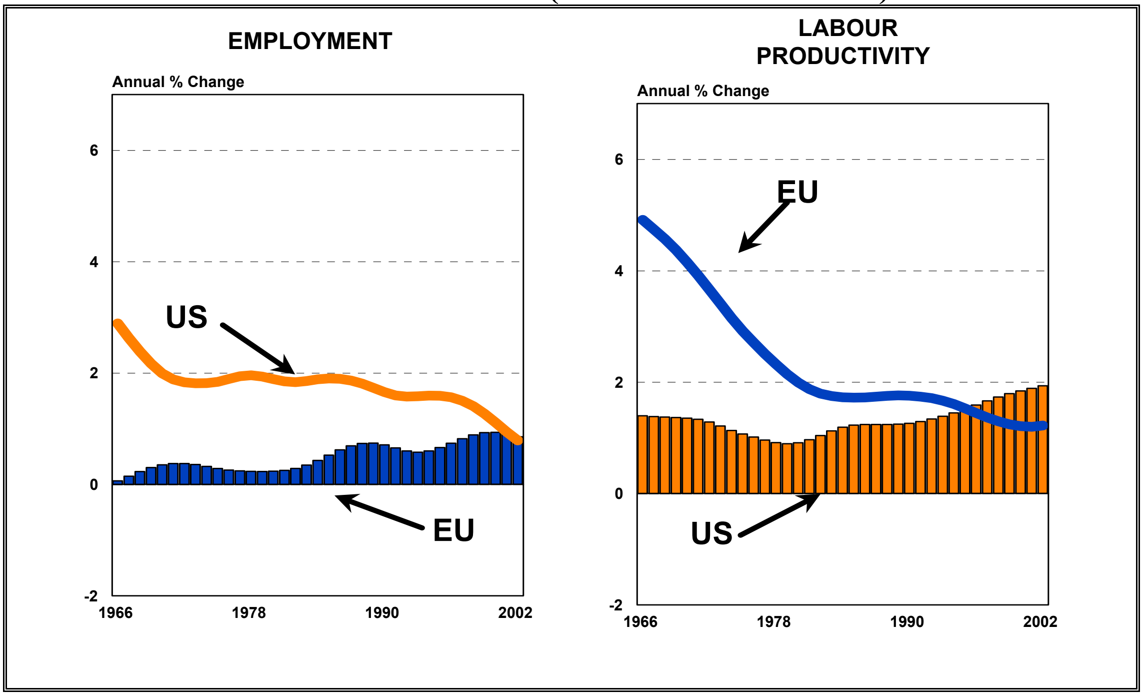
Table 1 : Decomposition of US and EU15 average GDP Growth Rates

	1966-1970	1971-1980	1981-1990	1991-1995	1996-2000	1996-2002
US						
GDP	3.4	3.2	3.1	2.4	4.0	3.2
Employment	2.4	2.1	1.8	1.1	2.0	1.3
Labour Productivity (Per Person Employed)	1.0	1.1	1.3	1.3	2.0	1.9
(TFP)	*(0.7)*	*(0.8)*	*(1.1)*	*(0.9)*	*(1.5)*	*(1.2)*
(Capital Deepening)	*(0.3)*	*(0.3)*	*(0.2)*	*(0.3)*	*(0.5)*	*(0.7)*
EU15						
GDP	5.0	3.2	2.4	1.7	2.6	2.2
Employment	0.3	0.3	0.7	-0.2	1.4	1.2
Labour Productivity (Per Person Employed)	4.7	2.9	1.7	1.9	1.2	1.0
(TFP)	*(3.2)*	*(1.8)*	*(1.1)*	*(1.0)*	*(0.9)*	*(0.7)*
(Capital Deepening)	*(1.5)*	*(1.1)*	*(0.6)*	*(0.9)*	*(0.3)*	*(0.3)*

Graph 1 : Trend GDP Growth



Graph 2 : Breakdown of Trend GDP into Trend Employment + Trend Labour Productivity (per Person Employed)



Graph 3 : Breakdown of Trend Labour Productivity (per Person Employed) into Capital Deepening and TFP

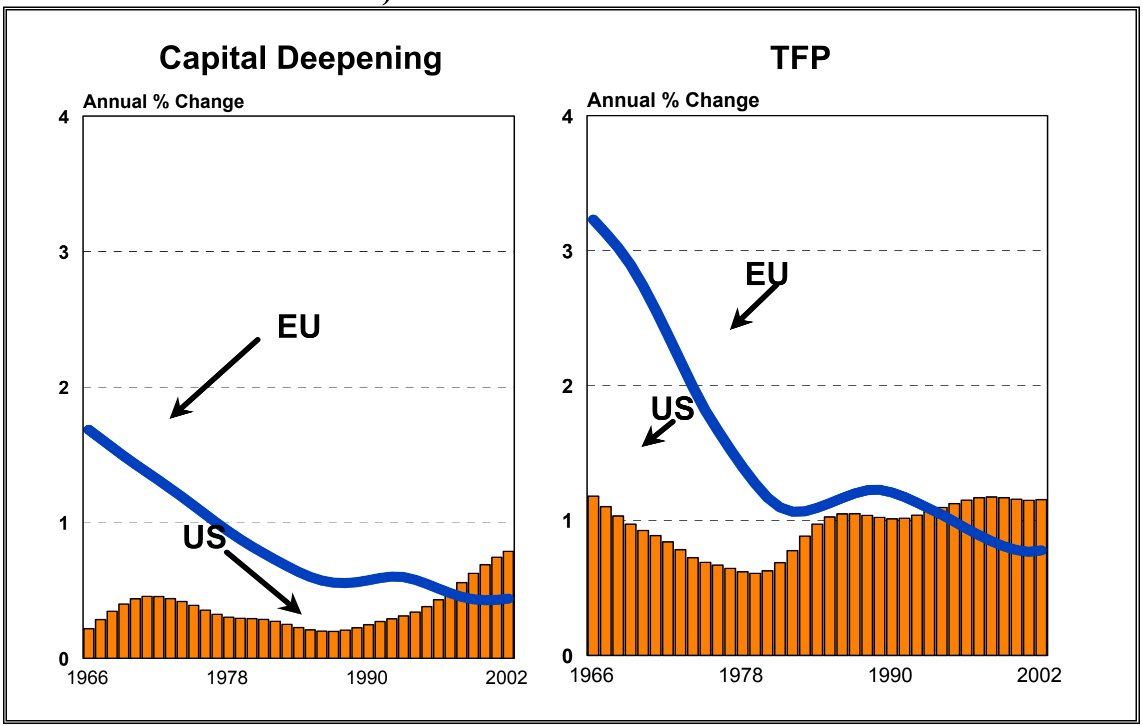


TABLE 2 : DECOMPOSITION OF AVERAGE GDP GROWTH RATES	1981-1990	1991-1995	1996-2000	1996-2002
BELGIUM				
GDP	2.0	1.6	2.7	2.1
EMPLOYMENT	0.1	0.5	1.2	1.0
LABOUR PRODUCTIVITY*	1.9	1.0	1.5	1.1
DENMARK				
GDP	1.6	2.0	2.7	2.3
EMPLOYMENT	0.3	0.0	1.1	0.7
LABOUR PRODUCTIVITY	1.2	2.0	1.6	1.6
GERMANY				
GDP	2.3	1.6	1.8	1.4
EMPLOYMENT	1.0	1.9	0.7	0.5
LABOUR PRODUCTIVITY	1.3	-0.3	1.1	0.9
GREECE				
GDP	0.7	1.2	3.4	3.5
EMPLOYMENT	1.0	0.6	0.6	0.3
LABOUR PRODUCTIVITY	-0.3	0.7	2.8	3.2
SPAIN				
GDP	2.9	1.5	3.8	3.3
EMPLOYMENT	1.1	-0.3	2.9	2.6
LABOUR PRODUCTIVITY	1.8	1.8	0.8	0.7
FRANCE				
GDP	2.4	1.1	2.6	2.4
EMPLOYMENT	0.3	-0.1	1.4	1.3
LABOUR PRODUCTIVITY	2.1	1.2	1.3	1.0
IRELAND				
GDP	3.5	4.6	9.3	8.3
EMPLOYMENT	-0.2	1.9	5.5	4.6
LABOUR PRODUCTIVITY	3.7	2.7	3.8	3.7
ITALY				
GDP	2.2	1.3	1.9	1.7
EMPLOYMENT	0.6	-0.6	1.0	1.2
LABOUR PRODUCTIVITY	1.7	1.8	0.9	0.5
NETHERLANDS				
GDP	2.2	2.1	3.6	2.8
EMPLOYMENT	1.1	1.3	2.6	2.2
LABOUR PRODUCTIVITY	1.1	0.8	1.1	0.6
AUSTRIA				
GDP	2.4	2.0	2.7	2.2
EMPLOYMENT	0.2	0.2	0.6	0.5
LABOUR PRODUCTIVITY	2.2	1.9	2.1	1.7
PORTUGAL				
GDP	3.2	1.7	3.8	3.0
EMPLOYMENT	0.2	-0.6	1.9	1.6
LABOUR PRODUCTIVITY	3.0	2.2	1.9	1.4
FINLAND				
GDP	3.1	-0.6	4.7	3.7
EMPLOYMENT	0.5	-3.7	2.2	1.8
LABOUR PRODUCTIVITY	2.6	3.1	2.5	1.9
SWEDEN				
GDP	2.2	1.3	3.2	2.7
EMPLOYMENT	0.7	-2.1	0.8	0.9
LABOUR PRODUCTIVITY	1.4	3.4	2.4	1.9
UK				
GDP	2.6	1.7	2.9	2.6
EMPLOYMENT	0.7	-1.0	1.3	1.1
LABOUR PRODUCTIVITY	1.9	2.7	1.5	1.5

*** Labour productivity per person employed (labour productivity per hour worked figures are given in Table 3 in the main text).**

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