Adjustment in EMU

A model-based analysis of country experiences

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Abstract

The paper uses a two-country-three-sector DSGE model to analyse adjustment in the Euro area. In particular we distinguish between tradeables and non tradeables and further disaggregate non tradeables into housing and services. We analyse the experience of six countries which have shown strong divergences within EMU, namely Germany, Ireland, Italy, the Netherlands, Portugal and Spain. We find that to a large extent, the diverging growth and inflation developments and current account shifts can be attributed to one-off adjustment to EMU which broadly seems to have run its course. The absence of an exchange risk premium in EMU allows an increase in capital mobility resulting in a lower correlation between domestic savings and investment. Country specific shocks to TFP, the labour market and housing investment also play a role for explaining the persistence of output and inflation divergences in EMU. Due to the absence of risk premia, investment – and especially housing investment - responds strongly to exogenous shocks.

Preliminary version. We are indebted to our colleagues in DG ECFIN for many helpful discussions. The views expressed in this paper are those of the authors and should not be interpreted as those of the European Commission.

Contents

1. Introduction

Experience within euro-area countries since 1999 may provide some insights into the functioning of economic adjustment dynamics in the monetary union. Since the beginning of the third stage of EMU, economic developments in the euro area have differed markedly amongst Member States. In particular, growth and inflation differences have been persistent thus affecting competitiveness and monetary conditions in the Member States. Another remarkable development in the early years of EMU is the emergence of substantial and persistent current account imbalances.

Both the issue of inflation differentials and the issue of current account imbalances have attracted considerable research interest. For example Lopez Salido et al. (2004) make an attempt to explain inflation in Spain, while Blanchard et al. (2002) as well as Fagan et al. (2005) focus on the current account. A comprehensive survey of the issues and research results is provided by P. R. Lane (2006). The research undertaken so far has identified some crucial shocks and transmission mechanisms which could explain the two phenomena. In particular, distinguishing between developments in the tradeable- and non-tradeablesectors appears crucial to understand inflation persistence and the abolition of currency risk premia and increased capital mobility seems to have been an important driving force behind the current account dynamics.

This paper analyses adjustment dynamics in the euro area on the basis of a dynamic stochastic general equilibrium (DSGE) model (details of the model are provided in Box 1 and in an annex at the end of this review). This framework allows us to assess shocks that trigger adjustment dynamics and to pinpoint which factors determine the speed of adjustment and the risk of overshooting. The analysis applies to both adjustment in the euro area on entry and adjustment in the euro area in its steady state. In particular, at entry, countries with high nominal growth rates have to adjust to low interest rates and high capital inflows requiring an adjustment towards a new equilibrium through the rebalancing of domestic and external demand. In the steady state, similar dynamics may prevail, in response to asymmetric shocks and domestic developments.

Firstly, some stylised facts are identified in a selection of euro-area countries that have experienced significant deviations of key macroeconomic variables from euro-area aggregates. We then use these stylized facts to identify various shocks that are exogenous to the model. These include: entry-level shocks such as the convergence of exchange rate risk premia, the misalignment of entry parities and the further integration of financial markets; and such "steady-state" shocks as debt ceilings, the growth rate of the population (especially growth in the household formation age groups), productivity growth (especially TFP), shifts in the structural employment rate, and shifts in preferences from tradeable to non-tradeables (services, housing). On the basis of the identified shocks, the model simulates actual developments in the six selected Member States, thereby providing insights into adjustment dynamics in the euro area.

The countries that we consider are: Germany, Spain, Ireland, Italy, the Netherlands and Portugal. The Netherlands and Portugal, in particular, experienced high growth and overheating pressures towards the end of the 1990s and early 2000s. The subsequent slowdown was characterised by a drop in inflation, downward revisions of potential growth and a marked deterioration in the budgetary position. Other Member States have not seen a similar reversal in their economic fortunes. In Spain, economic growth and inflation continue to be above the euro-area average. These developments have been paralleled by high wage growth, booming asset prices and credit growth and deteriorating current account balances. The experience of Germany in the euro area has been characterised by a protracted period of slow growth. This period of slow growth and lacklustre domestic demand has been accompanied by low inflation and wage growth and the regaining of competitiveness. Italy can be considered the “odd man out” with a continuous loss in competitiveness coinciding with slow growth.

2. Analysing the characteristics of adjustment in EMU

2.1 Origins of diverging economic developments

The model simulations allow us to systematically analyse the possible origins of sustained differences in inflation and growth developments in the euro area. Several origins of diverging developments are considered. They can be related to structural factors unrelated to EMU, or be the result of one-off adjustment effects caused by the adaptation to the monetary union. A third possible source of divergences could be related to the internal dynamics in the monetary union at its steady state.

Sustained differences in growth performance existed before the creation of monetary union and, to a large extent, they can be expected to boil down to dissimilar supply conditions. As such, they do not hamper the smooth functioning of the monetary union. Labour supply can differ, for example due to the effects of ageing or immigration. Productivity growth in a Member State can deviate substantially from the euro-area average due to catching-up effects, structural reforms, differences in market development, sectoral specialisation and flexibility, etc. As long as actual output in all Member States is close to potential, albeit at rather different levels, or if the output gap is similar in all Member States, the monetary stance will be more or less appropriate in all Member States and the different economic developments can be considered broadly unrelated to monetary union. The degree to which

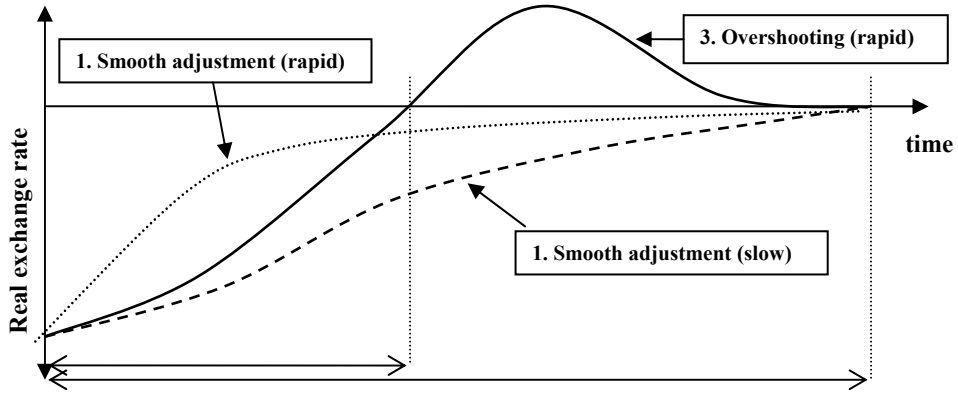
shocks induce economic adjustment depends crucially on their impact on productivity, relative prices (terms of trade) and wages. These factors largely determine the internal economic equilibrium and competitiveness vis-à-vis other Member States. Several causes of aggregate competitiveness disturbances requiring adjustment may be identified[1]. Some may be considered as one-off effects and are induced by entry into the monetary union such as disequilibrium in initial exchange rate parities and the initial interest rate shock. Others may occur in EMU, for example due to common external shocks with different effects in the Member States due to differences in industrial structure and sectoral specialisation[2], or to differences in geographical compositions of the trading partners. Movements in critical domestic variables may also lead to a need for adjustment in EMU.

2.2 Factors determining the characteristics of adjustment

In a further step, the DSGE model is used to investigate the determinants of smooth adjustment. The adjustment of key macroeconomic variables to their 'equilibrium' levels can follow different patterns. Three main questions can be addressed by the model. What determines the pace and amplitude of the adjustment process? Under what conditions is there a risk of overshooting of equilibrium levels, leading to increased volatility? How long might it take for the adjustment to work itself out?

In this context, the role of structural factors, such as the sensitivity of investment and consumption to the real interest rate and to relative price developments; the effects of market functioning (adjustment costs), fiscal policy and asset markets (housing), the myopic behaviour of economic agents (habit persistence), and financial constraints can all be assessed.

Graph 1: Rapid and slow adjustment and overshooting[3]



2.3 The DSGE model

A two-country-three-sector model is used that distinguishes between tradeables and non-tradeables. The tradeable sector consists of agriculture and manufacturing, while the non-tradeable sector is composed of construction and services. The model is a so called New-Keynesian-DSGE model[4]. Consistent with the empirical evidence, we have introduced a number of nominal and real rigidities[5]. This makes the model partly forward and partly backward looking. The model can be calibrated to various country pairs. In the simulations below, one country is analysed

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See Deroose, Langedijk, Roeger (2004) for an elaborate analysis of origins of asymmetric shocks in EMU. European Economy (1990) also provides a thorough overview of origins of idiosyncratic disturbances.

2 Differences in *industrial* structure may expose Member States differently to sectoral price and demand developments and sectoral competition from inside or outside the monetary union. When the industrial structure deviates strongly between Member States and a Member State has a high degree of sectoral specialisation, the equilibrium real exchange rate may be affected if relative prices between sectors change. While real productivity is unaffected, the relative price change alters the value productivity in the sector. While each worker may produce the same output as before, the value of this output is reduced. Thereby equilibrium wages are reduced. Real wages have to decline to the new level of marginal value productivity, while sectoral adjustment takes place. The effects depend on the (perceived) persistence of the price shock.

3 The deviation from the equilibrium real exchange rate could represent for example entry of the euro area at an undervalued real exchange rate. It could also represent any idiosyncratic supply–type shock that changes the real exchange rate or the equilibrium real exchange rate, requiring adjustment. Several causes for aggregate competitiveness disturbances vis-à-vis euro-area competitors requiring adjustment may be identified: disequilibrium in initial parities; differences in industrial structure; world trade and currency developments in a context of differences in geographical compositions of the trading partners; and movements in critical domestic variables.

4 See for instance Smets and Wouters (2003).

5 Parameter values are taken from a DSGE model that was estimated for the euro area by Ratto, Roeger and In't Veld (2006).

while the second country represents the aggregate of the rest of the euro area. The model is calibrated so as to respect the relative sizes of the countries.

In the short run nominal rigidities are important in the model, while in the medium and long run prices and wages adjust. For each permanent and temporary shock the model reaches a long run equilibrium position that is consistent with external and internal balance. Internal balance is characterised by a constant employment rate and a constant ratio of consumption to GDP (savings rate), while external balance is characterised by a constant (not necessarily zero) ratio of net foreign assets to GDP and a constant real exchange rate.

Given the asymmetric house price developments in various Member States, the model has been extended further by disaggregating the non-tradeable sector into construction and "other" non-tradeables and by separating investment into housing and non-housing investment. In addition, in order to analyse structural changes in mortgage markets (possibly related to EMU), special emphasis has been devoted to modelling the financial constraints of the household sector. To this end, the household sector has been divided into credit and non credit-constrained parts[6], which allows consideration of the effects of loosening credit constraints on the demand for housing.

Box: Inflation differentials and investment in the DSGE model

In a monetary union, with interest rates targeted at the union's average economic conditions, investment in individual member states could potentially respond strongly to domestic demand shocks. An increase in domestic inflation could boost domestic investment because of lower real interest rates. This mechanism could transform temporary demand shocks into long investment induced cycles. An often used counterargument is that with a monetary union, the relevant real rate for investors is not necessarily the national rate but the union average real rate.

Here we describe how investment is modelled in the DSGE model. In the model, sectoral investment differs according to the degree to which sectors are exposed to foreign competition and to the mix of domestic and foreign capital used in their production. In other words, the investment decision is based on demand and cost factors and relative prices have different effects on both components entering the investment decision. While it is true that higher inflation can (under certain conditions, see below) lower capital costs for firms if the nominal interest rate stays constant, DSGE models also stress a demand (or competitiveness effect) for investment. Besides capital costs, in their investment decisions, profit maximising firms take into account the evolution of their own output price relative to those of their (foreign) competitors over the lifetime of the investment project, since this relative price determines current and expected demand. Since higher domestic inflation worsens the competitive condition of domestic firms, the demand effect works in the opposite direction to that of the cost effect. It can be a powerful stabilising force especially if the elasticity of substitution between domestic and foreign goods is high. Obviously, the demand effect is most effective in the tradeable sector while it is much weaker in the non tradeable sector (including housing). In the DSGE model used for this analysis the following distinction is made between the tradeable and non tradeable sectors concerning their exposure to foreign competition and to the composition of investment.

Composition of investment (costs):

It is assumed that investment in the non-tradeable sector is largely domestically produced. Housing investment is undertaken by a domestic construction sector. The tradeable sector uses both domestic and imported investment goods. Four factors determine the capital costs of a firm:

1. Physical rate of depreciation.
2. Corporate taxes.
3. Real interest rate: nominal interest rate minus the expected capital gain, expressed by the expected inflation rate of the capital aggregate used by the specific firm.
4. The price of the investment good relative to the producer price of the investing firm.

Suppose the composition of investment of a particular sector *s* in country *c* is made up of a composite good of the currency union with shares proportional to the size of the union members, then the relevant real interest rate would be the nominal interest rate minus the expected inflation rate of investment goods in the currency union. However, even in this particular case, domestic inflation would still lower real capital costs, because the firm when making an investment decision also looks at the price of its output relative to the price of the investment good. In the model it is assumed that the tradeable sector uses both domestic and imported investment goods. However, there is a home bias in the composition of investment and therefore domestic inflation has a larger weight than inflation in the rest of the euro area (RoEA) in the inflation term used for the investment rule. For the non tradeable sector, it is assumed that all investment is domestic (in particular for housing). Therefore, the real interest rate for investment in the non tradeable sector is defined as the union-wide nominal rate minus the expected inflation in the non tradeable sector.

Exposure to competition (demand):

[6] In standard macro models (like QUEST, for example) households are usually divided into liquidity- and non-liquidity- constrained households. Liquidity constrained households do not borrow at all but only consume current income. Housing investment is not modelled as a decision of the household sector but is part of the corporate investment decision. In this model we derive a housing investment equation explicitly from a decision problem of the household sector. Also, we allow all households to be able to borrow but assume that a fraction of households are credit constrained in the sense that existing collateral, in the form of the stock of housing wealth, puts a limit on the amount of period t borrowing. The price of housing consists of the price of land and the price of the house construction.

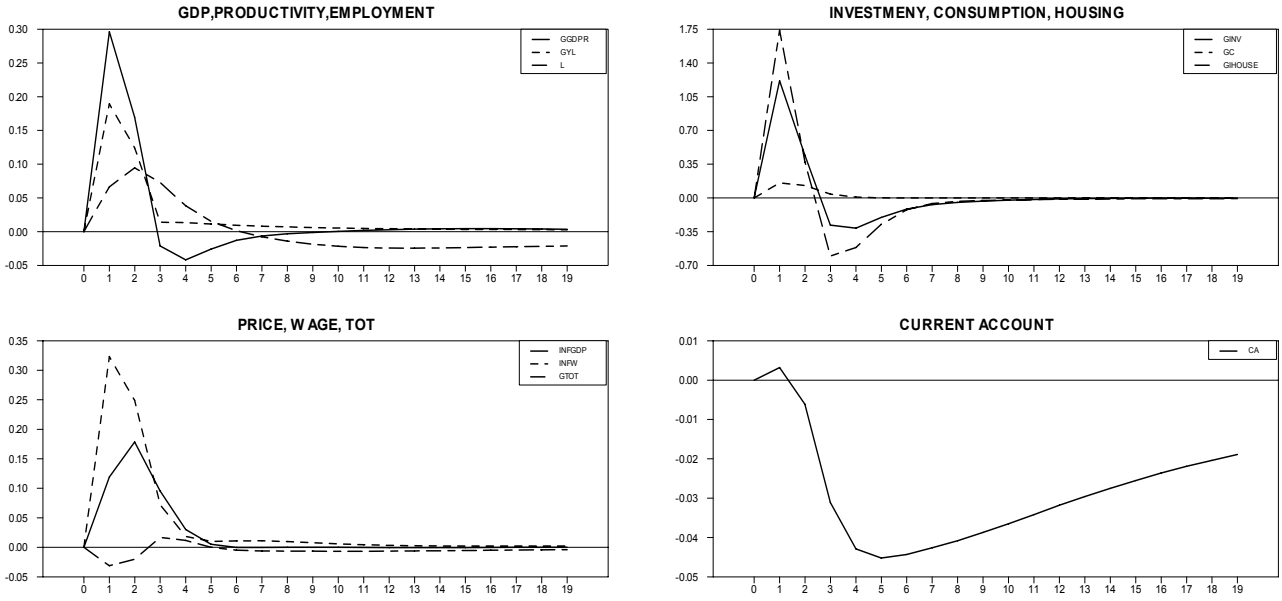
Domestic firms in the tradeable sector are exposed to competition from foreign firms in the tradeable sector. Here we assume a high elasticity of substitution (between 2.5 and 7.0) between domestic and foreign tradeables. The domestic tradeable sector is also exposed to competition from domestic non tradeables to the extent that domestic households and firms regard tradeable and non tradeable goods as substitutes. Following the literature, we impose a low elasticity of substitution of 0.4. As a mirror image, firms in the non tradeable sector are exposed to (weak) competition from the tradeable sector.

As a result of these assumptions the model predicts that investment in the non tradeable sector should respond more strongly to demand shocks than investment in the tradeable sector.

Standard simulations

This section presents some standard simulation results for the type of exogenous shocks that have been important for the euro-area economies in recent years. Some of the idiosyncratic shocks are related to the establishment of the euro area, such as the elimination of currency risk premia (ES, PT, IT, IE) and the further integration of financial markets, but also increased trade, which is likely to have enhanced competition in the tradeable sector. However, euro-area members were also exposed to other important idiosyncratic structural changes. Some countries in the euro area experienced: idiosyncratic shocks to TFP in both the tradeable (IE, IT) and non-tradeable sectors (DE, ES, PT), population/immigration shocks (ES, IR), labour supply shocks (DE, ES, IE), investment shocks (DE) and shifts in the composition of demand (more demand for non tradeables) (ES, PT) and fiscal policy shocks (NL, IT).

Graph S1: Increase of tradeable sector TFP by 1% (for one year)



Notes: all variables are expressed in terms of deviations form baseline. The time interval on the horizontal axis is a year.
GGDPR: Growth rate of real GDP; GC: Growth rate of private consumption;
GYL: growth rate of labour productivity; INFPGDP: Inflation (GDP deflator); INFW: Wage inflation;
L: Employment rate; GINV: Growth rate of investment; GTOT: growth of terms of trade;
CA: current account as a percentage of GDP

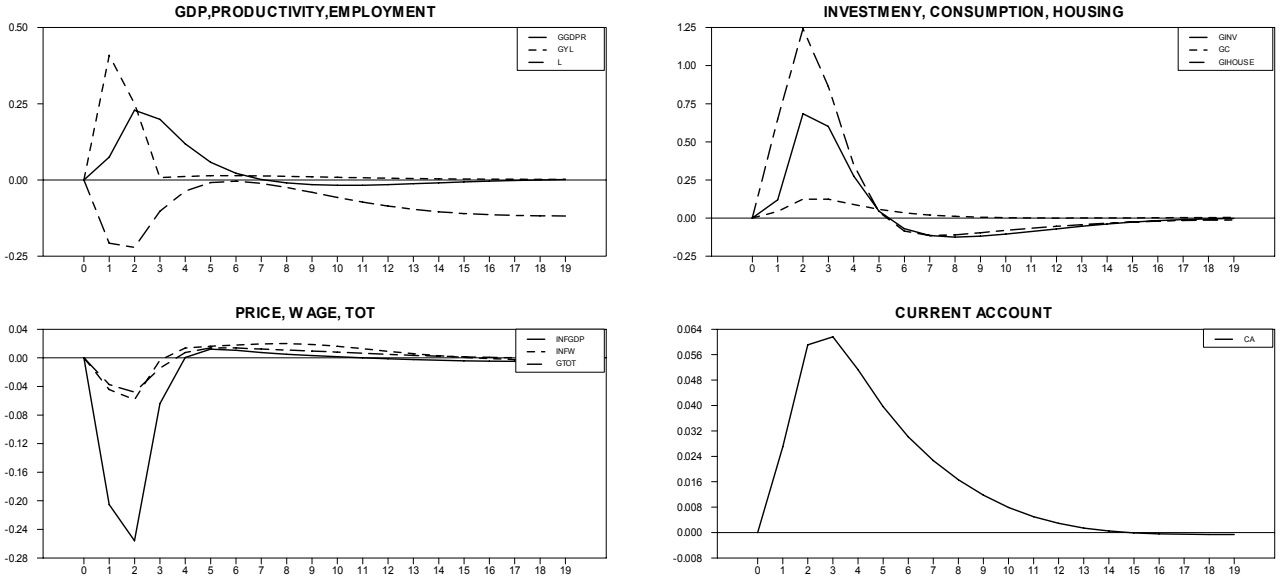
Graph S.1 shows the Balassa-Samuelson effect, namely the effect of an increase in the growth rate of TFP in the tradeable sector of 1% over one year, i.e. a permanent increase in the level of TFP in the tradeable sector[7]. A shock to technical progress has a GDP growth effect extending over 2 years. GDP growth returns to the baseline, but, investment growth falls below the baseline. The overshooting of investment is due to an interest rate effect as the increase in tradeable TFP growth increases inflation and lowers the real interest rate. Among the investment components, it is housing investment that responds most vigorously to the shock. This is because the real interest rate for housing investment declines most strongly. Why is inflation generated with a positive TFP shock? The TFP shock in the tradeable sector leads to lower costs and higher wages in the tradeable sector. Both effects roughly

[7] A catching-up economy is hit by a sequence of positive TFP shocks. A single shock is given in the illustration to reveal the dynamic adjustment patterns more clearly.

compensate for one another and there is no effect on tradeable prices. Labour mobility across sectors exerts upward pressure on wages in the non-tradeable sector, which leads to rising inflation for non tradeables. The inflation in the non tradeable sector is also the reason for an increase in non-tradeable (especially housing) investment.

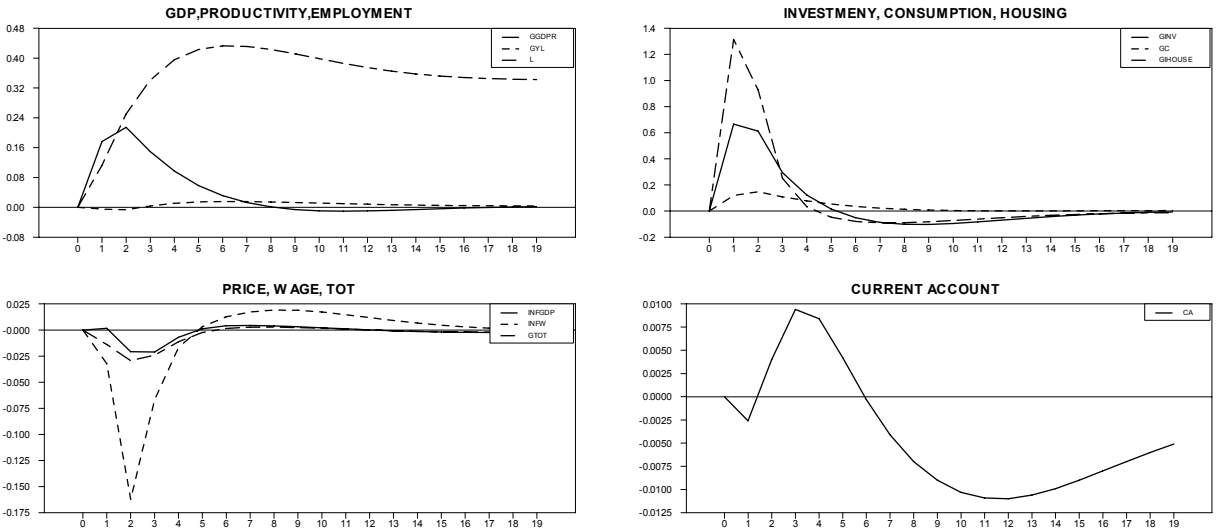
Since the price of non-tradeables rises, overall inflation increases, but tradeable-goods inflation does not rise. Nevertheless, there is a small deterioration of the current account due to an income effect. Even a temporary shock has some persistent price effects. Both price and wage inflation diverge over a period of 4 years.

Graph S2: Increase of non-tradeable TFP by 1.0% in the first year



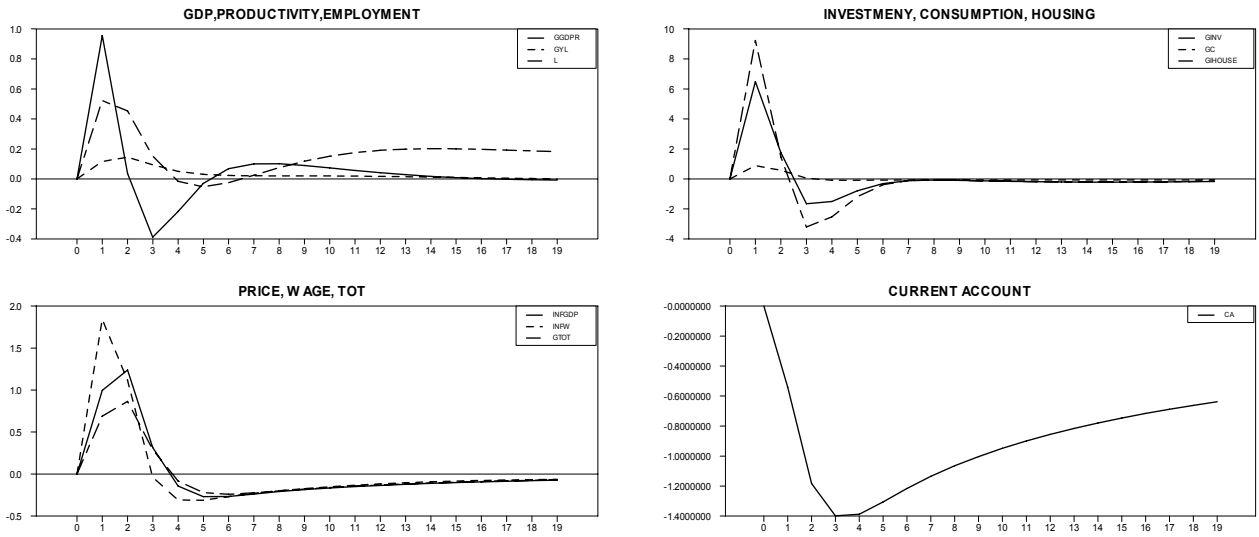
The positive TFP shock in the non-tradeable sector increases GDP and investment growth over a period of 5 years. In contrast to the positive productivity shock in the tradeable sector, this shock is not inflationary. In fact, lower costs in non tradeables translate into lower prices (so that nominal wages remain unchanged). However, price stickiness in the non-tradeable sector prevents prices from falling sufficiently. This induces a lack of demand and firms respond to this by lowering employment which also prevents wages from rising. Both Portugal and Spain have shown below average TFP growth in the non tradeable sector, which explains some of the inflation divergence.

Graph S3: Labour supply permanent shock of +0.5 percentage points



A labour market reform shock – modelled by a downward shift in the wage setting rule – leads to a gradual decrease in wage inflation (nominal and real). However, this effect is only temporary and reverses after 5 years. But there is a permanent increase in employment. Both effects together lead to a permanent increase in wage income. Interestingly, this leads to a relatively strong increase in housing investment. Notice that ES and IE, as well as NL have experienced a housing boom associated with a declining structural rate of unemployment.

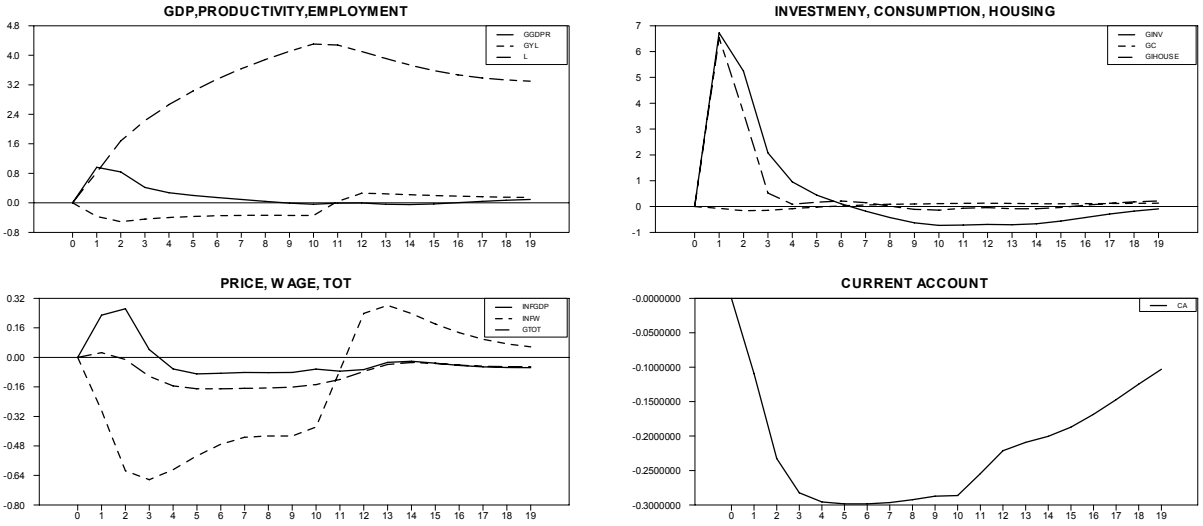
Graph S4: Risk premium reduction by 0.5 of a percentage point



One of the most important effects associated with entry into the euro area was the elimination of exchange rate risk premia in countries like Ireland, Italy, Portugal and Spain. It is modelled as permanent reduction of the risk premium in one period (in fact, in the euro area, it was a gradual decline in two to three years preceding EMU). A conservative estimate suggests an effect on real interest rates of -0.5 percentage points. It has a rather strong effect on investment, and especially on non-tradeableinvestment (housing). Another interesting feature is the strong increase of consumption. Notice also, in contrast to investment which shows a pattern of overshooting (positive growth rates followed by negative growth rates), the level of consumption remains high over a longer period. It is especially this feature which induces long-lasting current account deterioration. What explains the difference between the consumption and the investment response? The reduction in the risk premium leads to higher investment as the economy adjusts to higher aggregate capital intensity. Once the adjustment to higher capital intensity is completed investment falls back to previous levels. Thus a reduction in the risk premium only has a short- to medium-term effect on investment with the adjustment period depending on adjustment rigidities. For consumption, the permanent income model predicts a longer lasting effect. Because the reduction of real interest rates increases the present discounted value of income it becomes easier for the household to borrow against future income. This raises the level of consumption. An interesting feature of this experiment is the order of magnitude of the current account deficit, which is up by more than 1 percentage point for several years following the decline in the risk premium. A change in the currency risk premium with entry into EMU is therefore a primary candidate for explaining why the current account balance deteriorated strongly in Ireland, Italy, Portugal and Spain and - as a mirror image - improved in Germany.

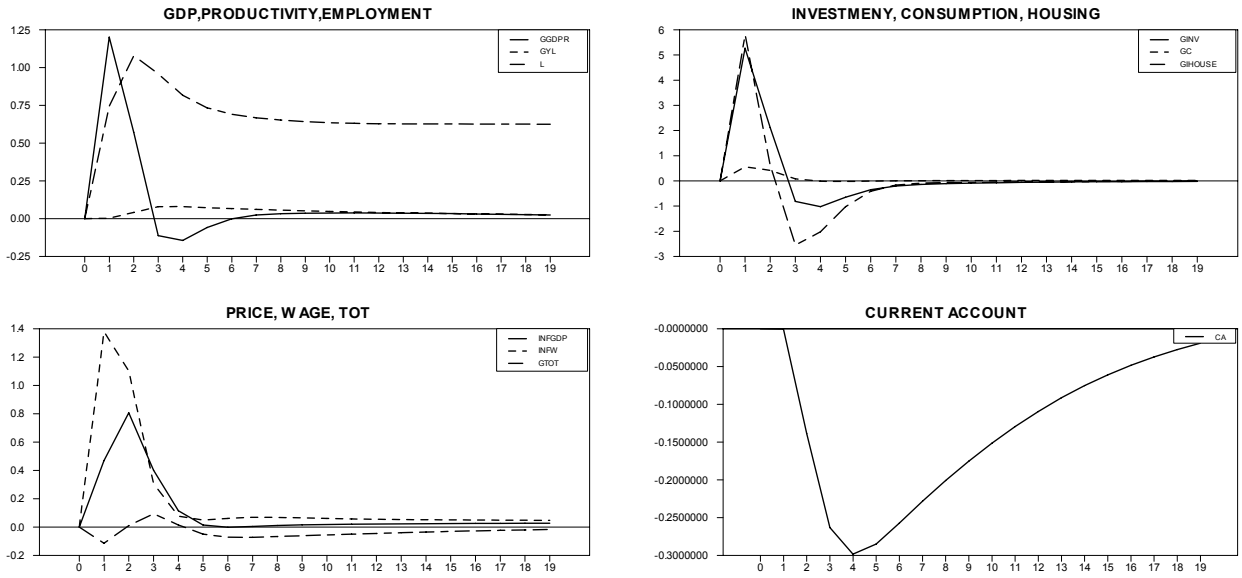
A shift in the preference for housing (e. g. due to a change in the age composition of the population (or foreign purchases of houses) has a strong effect on housing investment and initially hardly any crowding-out effect on other types of investment. Because the demand shift generates inflation for houses and other non tradeables, the real interest rates decline and the housing boom are sustained for another two years. Interestingly, the demand shift for housing is associated with a positive labour supply response, because households want to sustain a certain consumption level. Housing booms accompanied by wage moderation and an increase in employment has been experienced by Ireland, the Netherlands and Spain, while Germany has experienced a decline in housing and little employment creation.

Graph S6: Population shock (10 years, anticipated, +1 per cent)



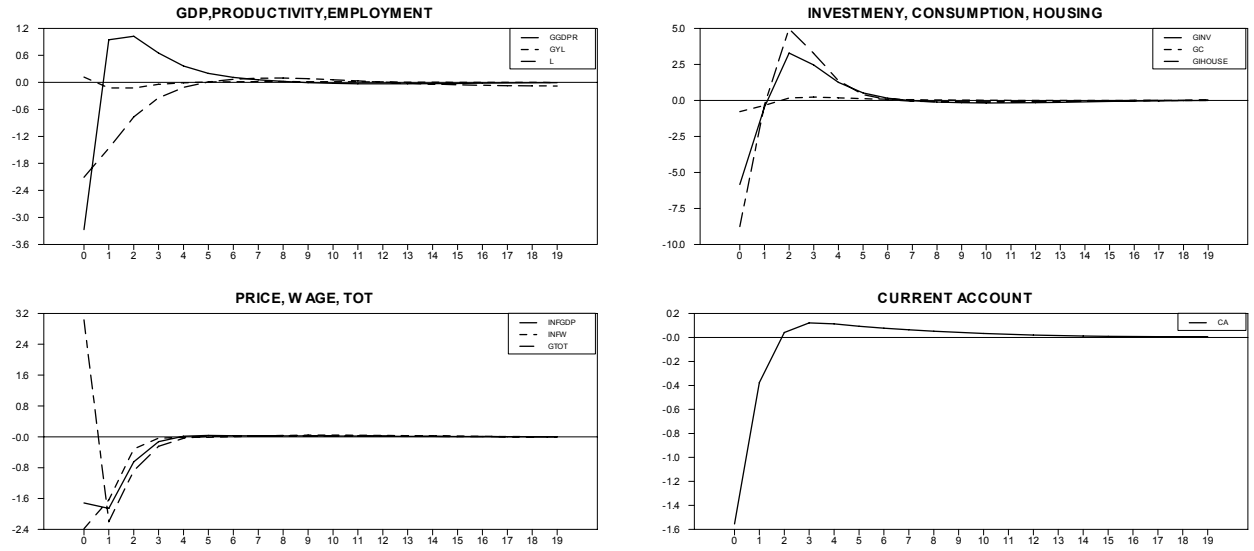
A population/immigration shock – especially if anticipated – has a powerful effect on investment demand, in particular non-tradeableinvestment (housing). It also increases house price inflation. The increase in housing demand takes place at the expense of private consumption. Immigration also raises the employment rate and, therefore, increases the growth of GDP per capita. Immigration is also associated with an increase in the current account deficit. A positive population shock has been experienced by Spain and Ireland.

Graph S7: Reduction in mark-up due to openness



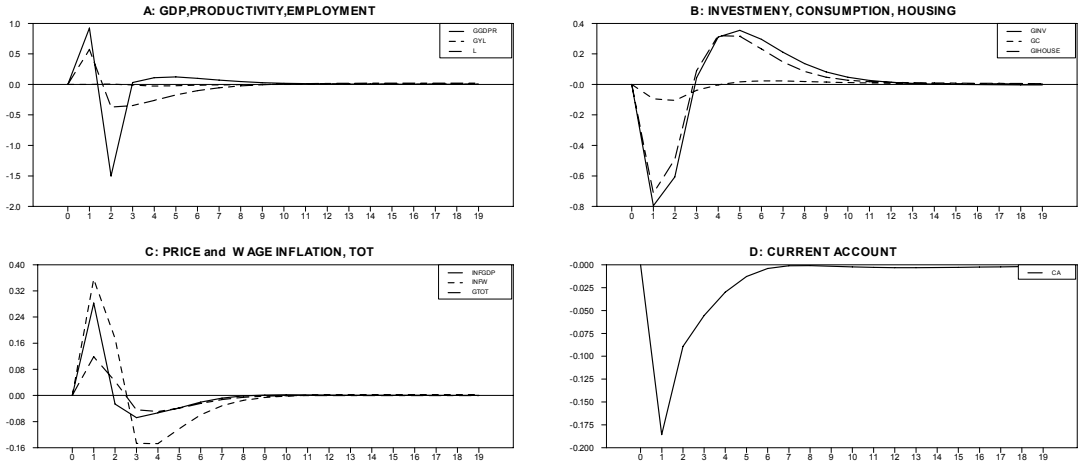
In the trade literature it is argued that monetary unions increases trade within participant countries. This in turn enhances competition, which leads to higher productivity growth and employment. The channel through which these effects are generated is via reductions in the mark up in the tradeablesector. Recent empirical work by Kee and Hoeckman (2003), Chen, Imbs and Scott (2004), and Badinger and Breuss (2005) suggests that an increase in the import share of 1 percentage point could lower mark ups in the tradeablesector in the order of magnitude of 0.1% to 0.2%. Increased competition in the tradeablesector raises labour demand and investment, which drives up wage inflation in the tradeablesector. This causes wage increases in the non-tradeablesector and generates inflation in the non-tradeablesector. Inflation in non tradeables dominates the inflation-reducing effect in the non tradeablesector. This effect helps to explain the performance of the Spanish manufacturing sector in recent years.

Graph S8: Entering EMU with an overvalued exchange rate (5%)



In the model an overvaluation of 5% leads to output loss of -3.3% in the first year. Prices in the tradeablesector decline by 2.1% in the first year, by 1.6 in the second and by .4 in the third year. After three years prices have adjusted sufficiently and the competitiveness loss from the overvaluation is eliminated. In the non tradeablesector the price decline is slightly more sluggish. It is interesting to notice that the overvaluation shock has a strong negative effect on non tradeableinvestment, because of the real interest rate effect, while the effect on tradeableinvestment is less strong.

Graph S9: Increase of Government demand (1% of GDP for one year)



This experiment shows how the economy responds to a temporary increase in government expenditure in a single country within EMU. The fiscal multiplier is positive in the first year and slightly below one. The increase in government demand also has a positive short run employment effect. In the short run the model shows a typical Keynesian response to a (temporary) demand shock[8]. The positive effect is mainly due to the sluggish adjustment of prices and the desire of consumers to smooth consumption. However, the increase in government expenditure reduces private demand, in particular investment. This suggests that there is a possibility for countercyclical fiscal interventions, however there are clear intertemporal trade offs associated fiscal policy, a positive effect in the first

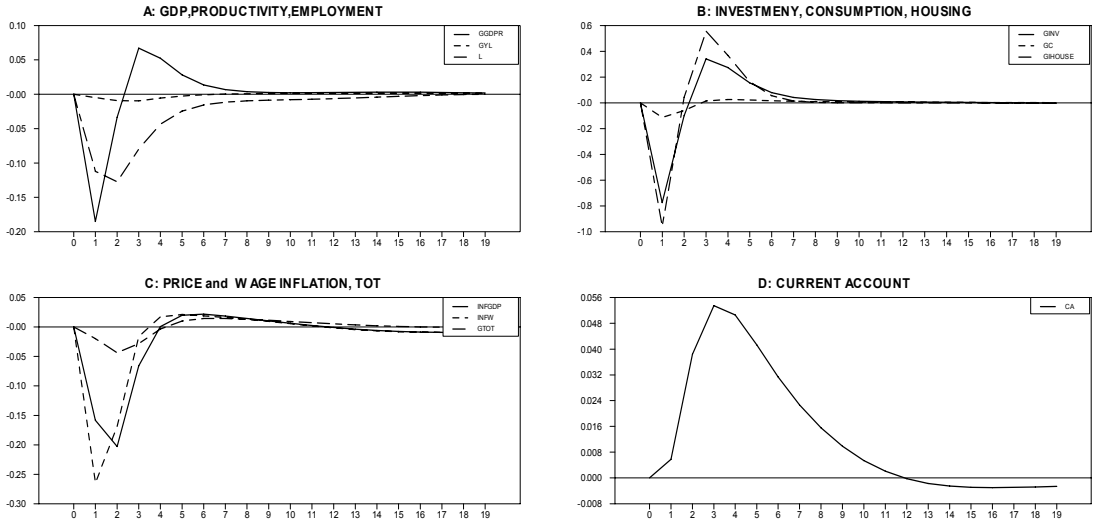
8 For permanent fiscal shocks, the fiscal multiplier becomes smaller and can even turn negative.

year is followed by a negative effect in the second year. This suggests that fiscal instruments should be used with caution, i.e. only in cases where a temporary demand short fall has clearly been identified.

International spillover of shocks within a monetary union

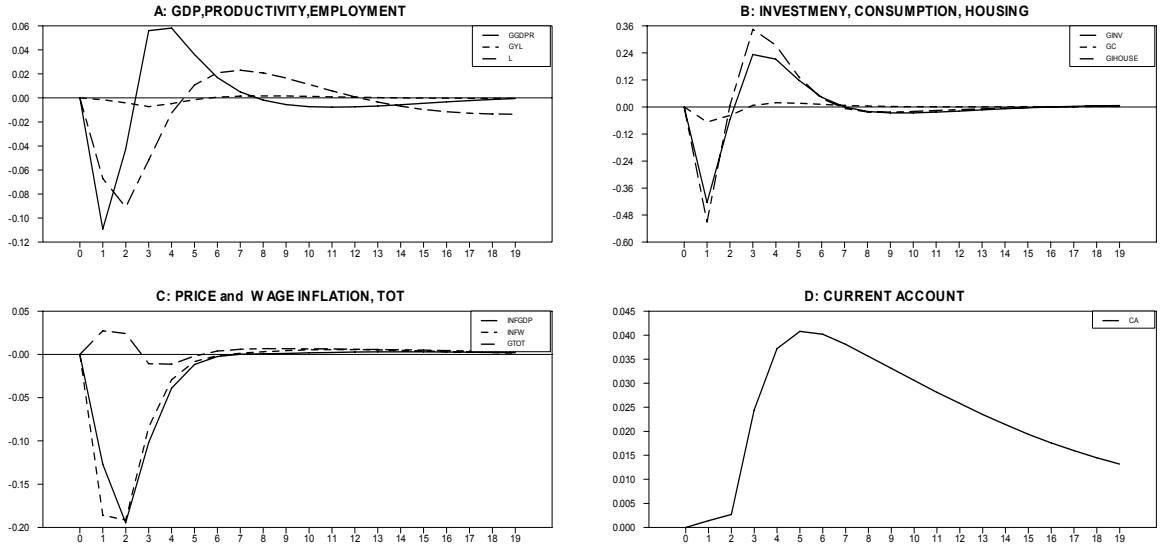
One important issue within a monetary union is the transmission of shocks across Member States. There are various channels of shock transmission, namely an income channel, a competitiveness channel and an interest rate channel. In this section we will analyse how (asymmetric) inflationary shocks in the rest of the euro area affect a particular Member State (the home country). The shocks we consider are: a negative TFP shock to the non-tradeable sector, a positive TFP shock to tradeables, and an increase in housing demand. These three types of shocks have occurred in euro-area Member States since 1999. We assume that the home country has a 10% share in euro-area GDP.

Graph S10: Reduction of non-tradeable TFP by 1.0% in the first year



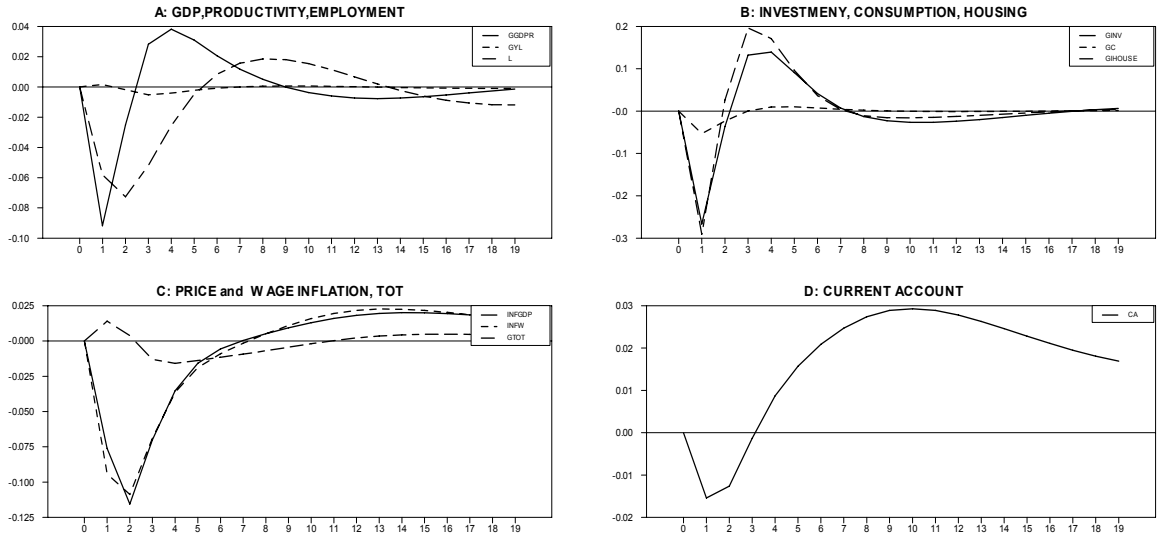
The spillover effect of slower TFP growth in the RoEA on the home country GDP is sizeable (-0.23 of a percentage point lower growth in the home country vs. -0.33 of a percentage point lower growth in the RoEA), especially in the short run (i.e. the first two years). The main transmission channel is a monetary policy response. The central bank responds to the inflationary shock with an increase in interest rates. There is however a difference in the dynamic adjustment pattern to the shock between the home country and the RoEA. While the negative TFP shock leads to a persistent output loss in the RoEA, GDP in the home country starts to recover slowly, starting in the third year after the shock has occurred.

Graph S11: Increase of tradeable TFP by 1.0% in the first year



The spillover effect of higher productivity growth in the tradeable sector is negative but small. While the effect on GDP growth in the RoEA in the first year is 0.18 of a percentage point of additional growth, the spillover effect is negative (-0.03 of a percentage point). The smaller size of the spillover effect is explained by two factors. First, the tradeable sector is smaller (only 50% of the size of the non-tradeable sector) and, second, the contractionary effect of a monetary response to higher inflation in is accompanied by a positive income effect from an increase in demand in the faster growing RoEA.

Graph S12: Increase of housing demand (plus 10 percentage points permanent)



An increase in housing demand in the RoEA is negatively transmitted to the home country. A shock to housing demand increases GDP growth in the RoEA by 0.45 of a percentage point in the first year (and by 0.65 of a percentage point in the second year) but leads to reduced growth in the home country by 0.1 of a percentage point in the first year (and by 0.03 of a percentage point in the second year). The relatively strong spillover comes from the fact that demand in the RoEA is shifting away from tradeables to non tradeables i.e. the home country not only suffers from a contractionary monetary policy response but also from a loss in demand for tradeables.

3. Country dynamics

In this section we apply the model to Germany, Ireland, Italy, the Netherlands, Portugal and Spain which have shown the largest deviation from the Euro area in terms of growth, inflation and the current account. The goal of this exercise is to see whether this model can approximately match orders of magnitude of deviations of important macro aggregates from the Euro area average as well as account for the duration of these deviations. We don't have the intention of fitting the variables exactly. An exact fit is not possible since we base our analysis only on a very small set of exogenous shocks.

The table below shows the country specific development ('shocks') on which we focus. First, on the supply side these are differences in TFP trends in the tradeable and non tradeable sector. Second, related to the creation of EMU, changes in the exchange risk premia could be an important factor explaining some of the country specific developments in the early years of EMU. Third on the demand side some financial market liberalisation has occurred. Banks have introduced new lending instruments which have effectively increased credit ceilings for housing investment of private households. Apart from these shocks we also take into account fiscal developments and some other country specific shocks which will be explained in more detail in the respective country sections.

Table 3.1: Exogenous Driving Forces (1999-2003)

	Productivity Tradeables*	Productivity Non tradeables**	Risk premium vs Germany (basis points)***	Household debt****
Germany	3.4	1.7	0	-2.0
Ireland	15.8	3.2	60	21.1
Italy	0.7	0.0	90	6.8
Netherlands	2.8	1.5	0	22.5
Portugal	2.0	0.5	140	24.8
Spain	1.8	0.1	90	23.8
Euro area	2.8	0.9		

Source: GGDC sectoral data base, AMECO
*Primary production and manufacturing (average productivity p.a. growth 1999-2003 in %).
**Private services (average productivity growth p.a. 1999-2003 in %).
***Assumed values calculated over the period 1995-1998. Ex post estimates from open arbitrage conditions give larger absolute values. However these estimates are dominated by outliers and therefore likely to be biased upwards.
****Difference between 2005 and 1999 as a % of GDP.

3.1 Germany

Stylised facts (see table DE-1)

Germany has shown a poor growth performance (in per capita terms) in the first few years after the creation of the euro area. However, after a particularly weak performance in 1999, the growth rate gradually caught up with the euro-area average. In the last two years, Germany has slightly exceeded per capita growth in the euro area. The slow growth performance in the first years of the euro area is somewhat surprising given the above average TFP growth, especially in the non-tradeable sector. Most observers of the German economy attribute the sluggish growth to weak domestic demand, especially investment and construction. Consistent with the hypothesis of weak demand, inflation has been persistently below the euro-area average by about 1 percentage point p.a. Rising current surpluses (reaching close to 4% of GDP in 2005) further support the view that Germany is facing a demand problem.

Shocks

In this section we explore how in the context of the model, specific demand and supply shocks hitting the German economy could have contributed to these growth and inflation trends. On the demand side there are various explanatory factors. Germany entered EMU at a slightly overvalued exchange rate[9] and lost a negative risk premium vis-à-vis euro area competitors associated with the reputation of the DM. Though these developments may also partly explain weak demand, most likely other more structural factors play a role as well. Probably weak demand for housing is also due to a correction of overinvestment during the unification induced construction boom in the mid 90s. However, housing investment is not sufficient to explain the slowdown in investment; business investment has

[9] Real effective equilibrium exchange rate estimates suggest that most of the real appreciation had disappeared at the the end of the 90s. For example the estimates provided by Hansen and Roeger (2000) give an overvaluation in effective terms of 2%.

been particularly weak as well. A possible explanation advanced by Broadbent et al. (2004) is structural changes in the German banking system which could have increased capital costs for firms by 200BP[10]. This estimate appears high. The DSGE model replicates the low investment rate with a 30BP increase of capital costs. Low consumption growth is possibly due to precautionary savings in a context of uncertainty surrounding pension and labour market reforms and anticipation of future taxation to adjust public finance imbalances in the light of the ageing population. The observed high productivity growth in non tradeables could be a supply side explanation for low inflation.

Simulation results (see Graph DE-1)
The loss of the risk premium bonus and the overvaluation can indeed explain some of the demand shortfall in the first two years. Eliminating the risk premium reduces housing investment growth by about 1.5 percentage points in the first year and close to 1% in the second year. Also the initial overvaluation had a temporary negative demand effect. However, it does not explain the sustained weakness of consumption and even more striking the low investment growth. Though housing is the investment category most affected by the elimination of the risk premium, a more permanent shock to housing is required in order to replicate the low growth of investment.[11] The negative housing shock does indeed explain a significant part of low growth in Germany (without a negative housing demand shock GDP growth in Germany would have been about .25 percentage points higher). But it only explains about 10% of the inflation differential to the euro area. Low housing investment is also insufficient to completely explain low total investment. According to the model corporate investment should be boosted because of positive TFP trends. In order to account for a decline in corporate investment a shock to the required rate of return in the tradeable sector is given (in the order of magnitude of 50 basis points). This has a powerful effect; it not only reduces investment but also helps to explain some of the weakness of consumption and adds another .25 percentage point reduction to the inflation rate. An additional demand shock is generated by rising transfers, financed by distortionary labour taxes[12]. The net effect on consumption growth is negative and adds another quarter of a percentage point to reducing the inflation rate in Germany in the period 2002 to 2005. Finally, high productivity growth in non tradeables, explains a negative inflation differential of about .33 percentage point.

Summing up
1) Shocks related to the creation of the euro area explain GDP and its components as well as inflation in the first 2 to 3 years. The rise in the risk premium also explains a lower permanent consumption level and a more permanent current account surplus (of about .6 percent of GDP)

2) In order to match the model simulations with the data in recent years (since 2002) specific demand shocks must be given (especially shocks to housing investment and corporate investment in the tradeable sector plus a fiscal shock to explain weak consumption growth). These demand shocks partially explain low inflation plus an increase in the current account surplus.

3) On the supply side, TFP growth of non tradeables is important for two features of the German data, namely first a gradual recovery of German growth and second low inflation.

4) Notice, no particular shock is given to the labour market. The demand shocks, especially housing and corporate investment are sufficient to generate a decline of the employment rate in the order of magnitude as observed in the data.

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[10] This point is also made in the German country study. Broadbent et al argue that German Banks have operated with relatively low margins in the past. However financial market harmonisation since EMU has made it easier to compare bank performance across countries in the EA and Basel II is forcing German banks to reassess the risk of outstanding loans.

[11] About 2/3 of the deviation results from a decline in the investment rate in Germany, while 1/3 is explained by an increase in the investment rate in the rest of the euro area. The investment shock decreases the value of housing relative to the value of consumption expenditure (excluding housing services) by about 5%.

[12] While most euro area member states have lowered the share of transfers in GDP, this share has risen by about 2 percentage points in Germany since the mid 90s. In the simulation an increase of 1 percentage point over the period 1999 to 2005 is assumed but a further increase by 2% over the next decade is projected. This is less than the observed rate of increase in the last two decades and conservative given the demographic pressure in Germany.

Graph DE-1: DSGE Results for Germany (deviation from Euro area average)

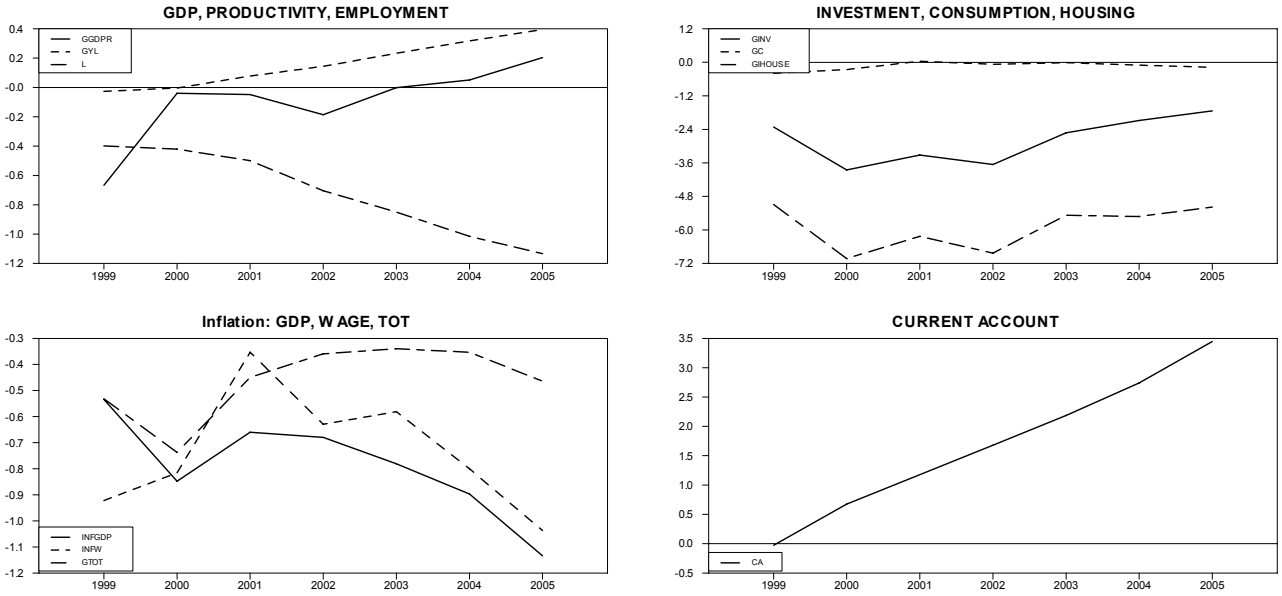

Table DE-1: Economic Development – Germany (relative to euro area)

Variables	1999	2000	2001	2002	2003	2004	2005
Growth rate of real GDP	-0.69	-0.23	-0.20	-0.37	-0.17	0.51	0.04
Growth rate of private consumption	-0.13	-0.36	0.40	-0.94	-0.21	-0.06	-0.84
Growth rate of investment	-1.42	-1.99	-4.15	-4.61	-1.63	-2.48	-2.43
Labour productivity growth	-0.31	-0.10	0.44	0.34	0.40	-0.21	0.44
Employment rate	-0.15	-0.13	-0.51	-0.99	-1.40	-0.90	-1.17
Inflation (GDP)	-0.51	-2.10	-1.18	-1.10	-0.98	-1.13	-1.29
Wage inflation	-1.45	-0.56	-1.04	-1.21	-0.79	-1.81	-1.71
Growth of terms of trade	0.55	-4.83	-0.13	2.11	1.02	-0.24	-1.52
Current account	-0.47	-0.91	0.69	2.95	2.82	4.44	4.66

Source: Commission services

Note: 1. The growth rates of GDP and its components is per capita.
2. The employment rate and the current account is expressed as deviation from 1998 levels.

3.2 Ireland

Stylised facts (See table IR-1)

Like no other country in the euro area, Ireland benefited from the ICT boom of the 1990s, which generated high rates of technical progress in the production of computers, semiconductors and telecom equipment. With a high ICT production share the Irish economy has exhibited very high growth rates of labour productivity. Productivity growth in the tradeable sector of the Irish economy exceeded that of the rest of the euro area by about 13 percentage points p a. on average over the period 1999-2003 . In recent years there have been some signs that the rate of technical progress is slowing down. However, other sectors of the economy have also scored above average in terms of productivity growth. In the non-tradeable sector productivity growth has been 2 percentage points higher than the euro-area average over the same period. High productivity growth biased towards the tradeable sector could at least partly explain the above-average Irish inflation rates (Balassa-Samuelson effect). The labour market may have been another factor adding to the persistence of inflation. The Irish employment rate increased throughout the 1990s. As the unemployment rate approached 4%, some wage pressure emerged eventually and the unemployment rate finally stabilised at a low level. On the demand side two characteristic features may be observed. First, there is strong housing demand with growth rates deviating from the euro-area average by about 10 percentage points p a. and

second government consumption (as a share of GDP) has increased at an above average speed between 2000 and 2005. Despite high domestic growth and inflation above the euro-area average, the external balance has remained remarkably stable, with the current account surplus deteriorating by about 2 percentage points since the late 1990s.

In the last two years of our sample (2004 and 2005), the high growth of labour productivity came to an end in Ireland but employment growth has picked up once again. Also inflation has diminished very quickly in recent years, although wage inflation remains high. It is therefore somewhat puzzling that the employment rate and investment growth (both construction and equipment) has started to increase again.

Shocks

In the model the productivity trends in Ireland are implemented as supply shocks to tradeables and non tradeables TFP such that the model replicates the productivity growth differential between Ireland and the rest of EMU as well as the productivity growth differential between the tradeable and non tradeable sector in the Irish economy. After the year 2000 a negative wage shock is removed in order to replicate the end of wage moderation in Ireland. Some idiosyncratic demand shocks can also be identified. From 2000 to 2005 the share of government consumption in GDP has increased by 2 percentage points, (compared to an increase below 1 percentage point in the Euro area). There is also empirical evidence of liberalised mortgage markets allowing rising household debt. Like in the case of Spain the housing boom is to some extent an autonomous demand shock fuelled by demographics and catching up processes. Some attention is devoted to the last two years, where we can observe a decline in the growth rate of GDP and a fall of productivity growth below the euro area average. Within the context of the model a possible explanation for a simultaneous drop in productivity and inflation could be a decline in TFP growth in the tradeable sector. In order to make these two developments consistent with no fall in wage inflation, rising employment shares and continued investment growth (both construction and equipment), increased competition in the non tradeable sector must be assumed[13].

Simulations (see Graph IR-1)

According to the model simulations, the TFP shocks are the most important factors for explaining the productivity trend in Ireland and other stylised facts. Tradeable sector TFP growth explains a productivity differential of about 2.5% from 1999 to 2003. Productivity growth in the tradeable sector leads to (GDP) inflation with a certain lag (see standard simulation) via second round effects through wages and prices in the non tradeable sector. Eventually the inflation differential exceeds the productivity differential by about 30%. Productivity growth in the non tradeable sector contributes to reducing GDP inflation. The stylised fact of falling inflation in recent years is generated by continued productivity gains in the non tradeable sector but falling productivity growth in tradeables. According to the simulation results, the effect of increased housing demand on inflation has been relatively small[14] (not exceeding .4% on average in terms of explaining the inflation differential). The relatively minor impact of house prices on inflation is not inconsistent with the fact that despite buoyant housing demand there has been a deceleration of inflation in recent years. Expansionary fiscal policy in Ireland helps to explain both the decline in the growth rate of investment and subdued growth in private consumption after 2000.

Summing up

1) The model accounts reasonably well for the decline in the growth rate of GDP (per capita) from around 5% in 1999 to about 1% in the last two years and a similar decline for productivity. The model also captures the evolution of employment.

2) Concerning prices and wages, the model explains the initially high inflation differential and its convergence to the euro area average rate in recent years. The model is less successful in matching the terms of trade development, especially in recent years[15].

3) Despite persistently high housing investment, the growth rate of Irish total investment has been declining from high levels in the late 1990s. This is roughly matched by the model. The model also generates a downward trend in consumption per capita, though it undershoots private consumption in the last two years.

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[13] The recent development of manufacturing and service prices supports this view. Manufacturing inflation has increased sharply since the beginning of 2004 while service sector inflation has declined from about 7% over the period 2000 to 2003 to about 3.5% over the period 2004/05. (see, Irish CB Quaterly Bulletin, April 2006). The Irish CB attributes the decline in service prices at least in part to increased competition in home and transport insurance and the communications sector.

[14] In the model, increased housing demand mainly leads to an increase in land prices and has less of an impact on construction because of wage equalisation across sectors. There are also two offsetting effects. First, an increase in housing demand is partly compensated by lower demand for consumer goods. Second a shift in the preference for houses increases labour supply and therefore has a dampening effect on wages. Finally imputed rents are not considered.

[15] The increase in the terms of trade as generated by the model results from an assumed reduction in TFP growth in the tradeable sector.

4) The model also replicates the overall decline in the current account; however it fails to match the speed of its deterioration in the first years of the euro area.

Graph IR-1: DSGE Results for Ireland (deviation from Euro area average)

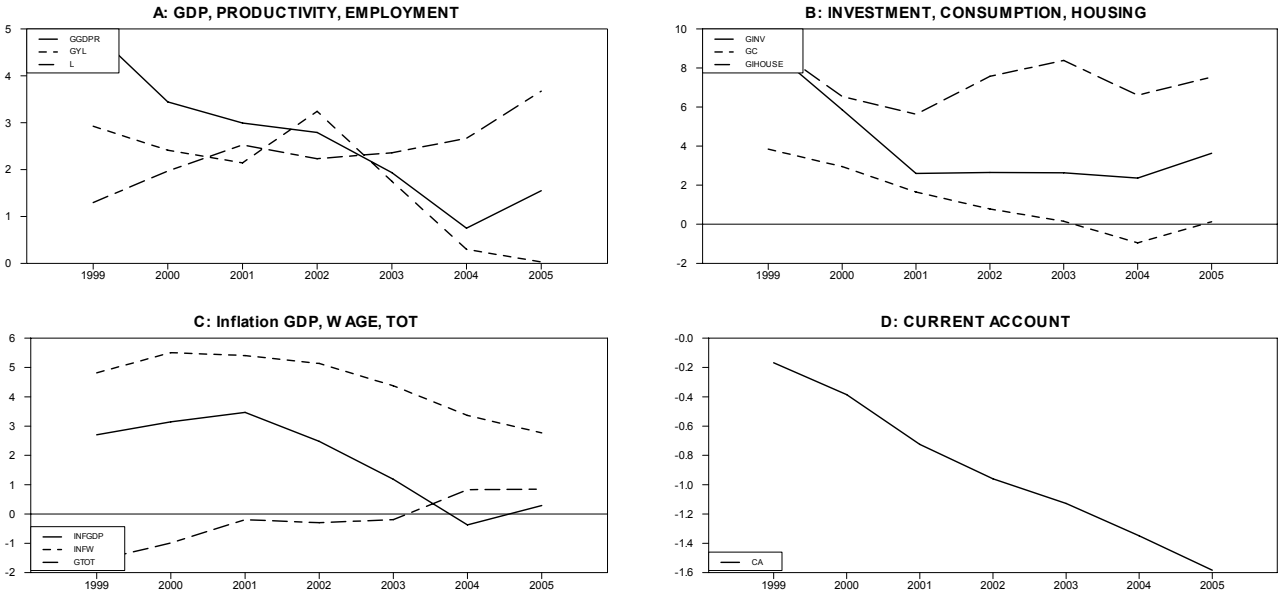

Table IR-1: Economic Development – Ireland (relative to euro area)

Variables	1999	2000	2001	2002	2003	2004	2005
Growth rate of real GDP	5.97	3.49	2.30	3.33	2.31	0.84	1.27
Growth rate of private consumption	3.21	3.58	1.54	0.67	0.93	0.95	2.21
Growth rate of investment	8.67	2.54	-0.73	5.12	4.85	5.64	10.82
Labour productivity growth	3.25	2.95	2.72	3.98	2.03	-0.12	-0.75
Employment rate	1.59	1.91	1.64	1.22	1.40	2.04	3.40
Inflation (GDP)	3.16	4.05	3.29	2.47	0.02	0.33	1.38
Wage inflation	1.99	5.57	4.83	2.47	3.32	3.42	3.21
Growth of terms of trade	-0.26	-1.11	0.38	0.96	-1.07	-0.33	0.37
Current account	0.35	-0.36	-0.57	-0.99	0.00	-0.79	-1.04

Source: Commission services

Note: 1. The growth rates of GDP and its components is per capita.
2. The employment rate and the current account is expressed as deviation from 1998 levels.

3.3 Italy

Stylised Facts (see table IT-1)

Persistently low growth of GDP per capita and moderate wage developments did not induce low inflation and improving competitiveness in Italy. On the contrary, unit labour costs and prices continued to increase faster in Italy than in competitor euro-area countries, resulting in a loss of competitiveness and export market shares. The current account gradually deteriorated over the whole period 1997-2005, in spite of weak domestic demand.[16]

[16] Note that we considered in the case of Italy also the year 1997 and 1998 in the simulation, as these were characterised by strong fiscal consolidation which affected economic developments after the start of the euro area.

Since 1999, consumption growth has been lacklustre and broadly in line with slow GDP growth. Investment growth has been supported somewhat by construction demand in view of accelerating housing prices. In recent years, investment growth turned negative again, mainly driven by falling equipment investment. After a sharp improvement in the run-up to 1999, the government budget balance has worsened considerably.

On the supply side, slow or even negative total factor productivity growth in both the tradeable and non-tradeable sectors largely explains the slow growth. In particular, in the more recent years under review, labour productivity growth was particularly low since employment growth remained robust in spite of the negative cyclical conditions and TFP growth literally collapsed.

Shocks

As did other Member States with a history of devaluations and high and volatile inflation, Italy benefited from a reduction in the exchange risk premium when entering EMU. A conservative estimate based on deviations from interest parity between the lire and the Euro before 1999 suggests a risk premium of about 50BP was eliminated in the running up phase to EMU. This provided a stimulus to domestic demand. However, other factors played in the opposite direction and contributed to the lacklustre growth performance. Fiscal retrenchment to qualify for the Maastricht criteria implied a drag on growth in 1997 and 1998. The most important shocks we consider in the case of Italy concerns the continuous and accelerating reduction in TFP growth, both in the tradeable and non-tradeable sectors. A widespread view is that insufficient competition, especially in the service sector, low human capital accumulation, weak innovation and insufficient R&D expenditure are amongst the determinants of the marked slowdown[17] in TFP. In particular, productivity in manufacturing industry has stagnated since the mid-1990s, resulting in a significant and persistent differential in terms of unit labour costs with respect to euro area, and a concomitant deterioration of the Italian competitive position. Furthermore, low productivity growth in manufacturing reflects a productive specialisation in low-demand, low-technology sectors[18], where the Italian industry is faced with strong competition from emerging producers. As a consequence, Italy has experienced a loss of market share amounting to more than 40% in cumulative real terms since 1995. In addition, since 1992, the working age population has been in decline in Italy.

Simulation (see Graph IT-1)

The reduction in the risk premium has a strong positive effect on domestic demand in 1997 and 1998. The risk premium reduction does however not feed into higher GDP in this last phase of the run-up to EMU as its effects are outweighed by the strongly contractionary effect of fiscal policy in that period such that GDP growth remains low. The contribution of fiscal policy to GDP growth turns positive in 1999-2001 as the fiscal stance turns strongly expansionary. It remains slightly positive until 2003. Despite continued deterioration of the cyclically adjusted primary balances, the net effect of fiscal policy turns negative again from 2004, as the degree of crowding out of domestic demand generated in the model simulation exceeds the direct positive effect of net government demand.

From 2000 onwards, the increase in the employment rate through labour market reform and as a result of the negative TFP growth largely counter the effects of negative population growth on the GDP growth rate. A shift in demand towards housing together with loosening of lending constraints allowed increasing housing prices despite the unfavourable economic developments and underpinned construction investment.

The shocks to total factor productivity explain most of the low GDP growth and high inflation over the whole period considered. Especially from 2003 onwards, the cumulated effect of the TFP shocks weighs heavily on consumption and investment and reduces GDP growth by more than 1 percentage point per year. A shift in demand towards housing together with loosening of lending constraints helped (construction) investment.

The deterioration in the current account is largely explained by the reduction in the risk premium and the competitiveness effects of the negative TFP shocks.

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17 See for instance Banca d'Italia (2006).

18 See Larch (2005) and Monti (2005).

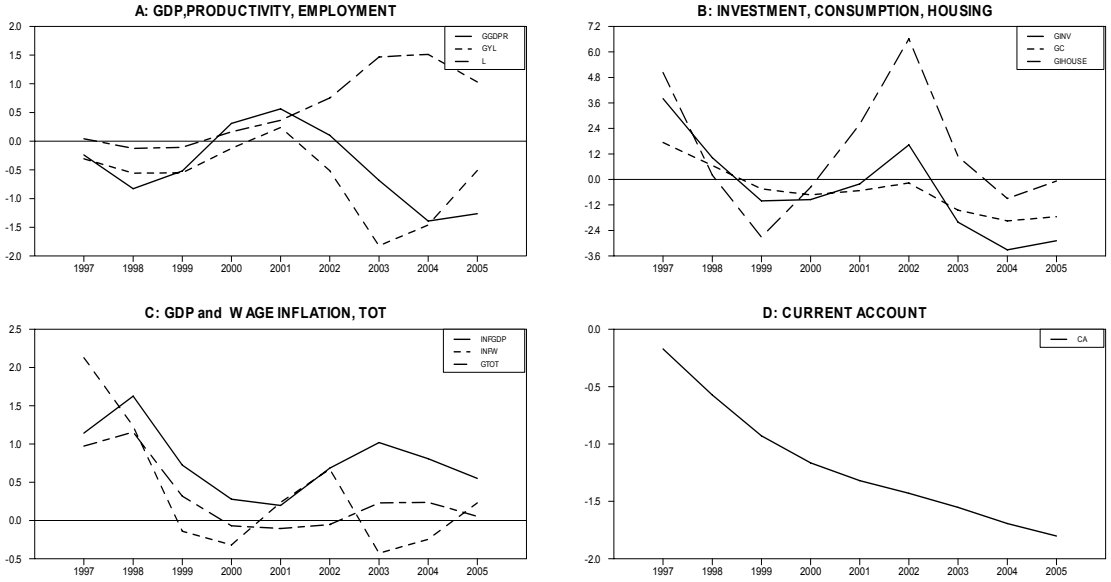

Table IT-1: Economic Development – Italy (relative to euro area)

Variables	1997	1998	1999	2000	2001	2002	2003	2004	2005
Growth rate of real GDP	-0.20	-0.97	-0.52	0.30	0.54	-0.08	-0.61	-1.22	-1.15
Growth rate of private consumption	1.95	0.83	-0.28	-0.22	-0.61	-0.22	-0.01	-1.20	-1.02
Growth rate of investment	-1.06	-1.52	-2.61	1.36	2.00	5.46	-2.54	-0.15	-2.86
Labour productivity growth	-0.06	-0.45	-0.13	0.20	-0.58	-1.63	-1.82	-0.74	-0.91
Employment rate	-0.11	-0.48	-0.78	-0.84	-0.23	0.72	1.48	1.18	1.02
Inflation	1.19	1.06	0.47	0.60	0.61	0.82	1.04	1.02	0.34
Wage inflation	4.34	-2.43	-0.56	-0.20	0.31	-0.36	0.19	0.98	0.63
Growth of terms of trade	1.04	3.42	2.73	2.55	3.71	3.36	2.34	3.36	3.81
Current account	-0.19	-1.12	-2.03	-3.20	-2.77	-3.39	-3.96	-3.58	-4.13

Source: Commission services

Note: 1. The growth rates of GDP and its components is per capita.
2. The employment rate and the current account are expressed as deviations from 1996 levels.
3. The terms of trade are defined as export prices of the MS relative to export prices of the rest of EMU.

Summing up

1) Shocks related to the creation of EMU do not explain GDP and its components nor inflation developments in Italy. The risk premium reduction did lead – as expected – to a deterioration of the current account; the anticipated higher growth rate did however not materialise.

2) By adding negative shocks to TFP, the development of the main variables can be matched. Structural challenges, feeding into negative total factor productivity shocks thus seem the major factor behind persistently low growth and above average inflation.

3) In addition, the fluctuations in GDP growth and its components seem to reflect to some extent fiscal policy behaviour: an initial sharp contraction, followed by strongly expansionary fiscal policy. From 2004 onwards, the crowding-out effect outweighs the direct expansionary effects of net government demand on GDP growth in the model simulations.

3.4 The Netherlands[19]

Stylised Facts (see table NL-1)

In the second half of the 1990s, the Dutch economy consistently grew faster than most other euro-area countries. Annual real GDP growth outpaced the euro-area average by 1 percentage point in the period 1996-2000. High growth rates were fed by strong consumption and investment growth, in particular construction. The strong growth period coincided with booming housing prices and a massive increase in mortgage debt. These developments, also fuelled by the falling nominal interest rates at the end of the 1990s, resulted in significant re-mortgaging and equity withdrawal that fed into private consumption expenditure. The *Nederlandsche Bank* estimates the annual spill-over effect of mortgage equity withdrawal on GDP growth via consumption expenditure at 0.5 to 1 percentage point in 1998–2000, turning to a negative contribution of around 0.5 of a percentage point in the period 2001-2003 as equity withdrawal lessened[20]. As a result, household financial liabilities (as a percentage of GDP) in the Netherlands almost doubled since 1990. On the supply side, employment and the labour share grew rapidly. Amidst symptoms of overheating, inflation peaked in 2000 and 2001 at more than 2 percentage points above the euro-area average. In 2001, a period of below average growth set in the Netherlands and inflation came down to below the euro-area average in the later years of the period under review.

Shocks

In the second half of the 1990s, the Dutch economy had an advantageous initial competitive position, reflected in an undervalued real exchange rate which exacerbated and prolonged the period of strong economic growth in the second half of the 1990s. The effects of the undervalued exchange rate were reinforced by a sharp increase in household debt as debt ceilings were increased and mortgage repayment requirements loosened.[21] Household debt increased by about 30% of GDP since the mid 1990s. The housing boom is to some extent an autonomous demand shock as dual income households became more prevalent in the 1990s as female participation rates increased rapidly, increasing the mortgage borrowing capacity of households. A shock to debt financing and a housing demand shock is modelled to cover the increase in housing prices and indebtedness. Some fiscal shocks are given to reflect that a substantial part of windfall revenues was used to finance structural expenditure in the later phases of the upturn in the mistaken belief that these windfalls reflected sustainable revenue growth. In addition, data suggest that the Netherlands suffered from negative total factor productivity shocks at the end of the economic boom, which were reversed in the period 2003 to 2005. As the Dutch guilder had been credibly linked to the D-mark for over a decade, the Netherlands did not benefit from the disappearance of an exchange risk premium with the entry into EMU. As the risk premium declined in most other euro-area Member States, this implies that we need to give a negative shock to the risk premium in the Netherlands (as compared to the euro-area average)

Simulation (see Graph NL-1)

The real exchange rate undervaluation at the entry into EMU can explain a large part of the high consumption and investment growth in 1997 and 1998. As the shock is given in the simulation in a single year - rather than built-up gradually through wage moderation - it distorted the terms of trade development in 1997. The undervaluation led to increasing external and domestic demand which resulted in price pressures. It explains up to 2.5 percentage point of higher GDP level in the late 1990s[22]. Its effect was somewhat dampened by the loss of the negative risk premium compared to other euro-area Member States, which was associated with the credibility of the link to the DM. Since the late 1990s, prices and wages have grown faster in the Netherlands than in the rest of the euro area. Expansionary fiscal policy in the last phases of the long-lasting economic boom and strong consumption demand induced by the sharp increase in housing prices and wealth induced some overshooting dynamics.

A preference shift towards housing demand and raising of the debt ceiling together with pro-cyclical fiscal policy can partially explain high inflation and growth in the latter phases of the upturn, leading to overshooting of equilibrium price and wage levels, some over-investment and strong employment growth which put the unemployment rate below its equilibrium level. The booming housing market in particular stimulated consumer demand and further fuelled the build-up of imbalances until 2001-2002. As the effect of these shocks on the faded out, consumption and investment dropped back to their baseline levels and the rate of inflation dropped below the euro-area average. The

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19 Note that we considered in the case of the Netherlands we include the years 1997 and 1998 in the simulation, as demand pressures built up during this period which had repercussions in later years after the start of the euro area.

20 See Els,van , P.J.A , End, van den ,W.A and. Rooij, van, M.C.J (2005).

21 The housing boom in the late 1990s was accompanied by a massive increase in mortgage debt, fuelled by a fiscal regime which permits virtually full tax deductibility of mortgage interest payments at the marginal tax rate. In combination with the liberalisation of the mortgage market and increased competition between mortgage providers, this led to the introduction of new mortgage products that postpone loan redemption until maturity (concerns around 90% of mortgages extended since 1995). Additionally, dual income households became more prevalent in the 1990s, increasing the borrowing capacity of households.

22 Note that while the shock to the real exchange rate is given in single year (1997), its building up (and unwinding) has been a gradual process.

ending to the fiscal impulses and the subsequent fiscal tightening exacerbated the downturn. Together, the risk premium shock and the undervaluation of the real exchange rate explain the 2% improvement in the current account balance over the period considered.

Summing up
1) The simulation of a shock to the real exchange rate in the run-up to EMU explains part of high GDP growth and inflation in the first 2 to 3 years of the period considered.

2) The undervalued real exchange rate at entry into the euro area cannot explain the differences in the growth rate of housing investment and the extent of the consumption growth. This effect can be captured by assuming specific housing demand and debt financing shocks.

Graph NL-1: DSGE Results for the Netherlands (deviation from euro-area average)

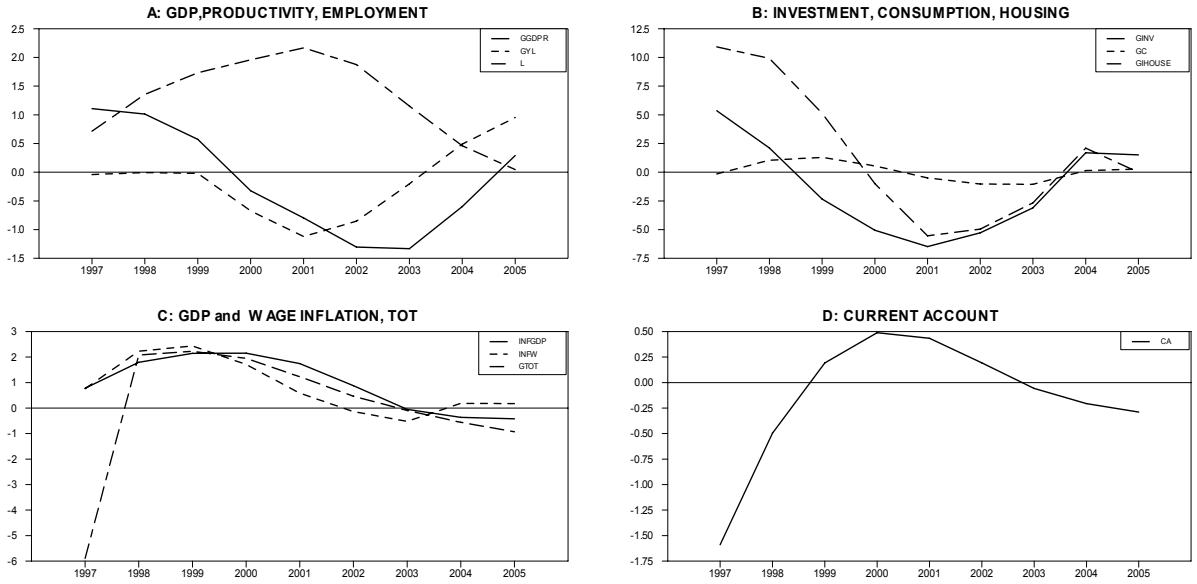

Table NL-1: Economic Development – Netherlands (relative to euro area)

Variables	1997	1998	1999	2000	2001	2002	2003	2004	2005
Growth rate of real GDP	1.10	1.20	0.71	-0.74	-0.82	-1.03	-0.72	-0.06	0.13
Growth rate of private consumption	1.13	1.47	1.05	0.03	-0.93	-0.16	-1.62	-1.23	-0.65
Growth rate of investment	3.95	-1.57	1.62	-3.62	-0.27	-3.07	-4.41	0.60	0.01
Labour productivity growth	1.04	0.77	0.37	-0.22	-0.97	-0.70	0.09	1.71	0.79
Employment rate	1.53	1.99	2.41	2.25	2.51	2.29	1.66	0.37	-0.10
Inflation	0.66	0.19	0.70	2.52	2.84	1.27	0.51	-1.04	-0.17
Wage inflation	2.03	3.09	0.56	1.86	2.22	1.76	1.50	1.04	0.13
Growth of terms of trade	0.79	-1.39	-0.48	3.71	0.28	-1.82	0.22	-1.06	0.49
Current account	0.72	-2.33	-1.39	-0.54	-0.01	0.85	0.68	0.93	2.38

Source: Commission services

Note: 1. The growth rates of GDP and its components is per capita.
2. The employment rate and the current account are expressed as deviations from 1996 levels.
3. The terms of trade are defined as export prices of the MS relative to export prices of the rest of EMU.

3.5 Portugal

Stylised facts: (see Table PT-1)
The Portuguese economy went through a boom in the running up phase to EMU which started soon after the mid 90s. GDP per capita growth was exceeding that of the euro area until 1999. However since 2000 growth dropped

below euro average levels. High growth was accompanied by rising external imbalances. Somewhat surprisingly the current account deficit remains high despite the recent decline of GDP growth. The boom in the late 90s was driven by extraordinary investment growth. Because of rising demand pressures, wage and price inflation exceeded the euro average by more than 5, respectively 2% p. a. in the 90s. In the meantime inflation differentials came down but so far they have not disappeared completely.

Shocks

We model the Portuguese development since 1997 by imposing specific demand and supply shocks. On the demand side there was an EMU related shock, namely the abolition of the exchange risk premium at entry into EMU (100 BP). Portugal also experienced financial market liberalisation in the form of a reduction of credit constraints for housing investment. Finally one can observe a shift of demand from manufacturing to services. On the supply side a marked reduction in TFP growth in the non tradeable sector since the end of the 90s can be identified. NAIRU estimates also suggest that there has been an increase of structural unemployment from about 5% in the year 2000 to about 7% in 2005[23].

Simulation

According to the model the reduction of the risk premium was instrumental for the investment boom and the level shift of private consumption (consistent with the permanent income hypothesis) and caused the current account to decline by about 5 percentage points from 1997 to 2000. Consistent with the data, investment grows strongly in 1997 and 1998. There is however some overshooting of investment. After three years of strong investment, investment growth falls below Euro area average from 2000 onwards. From 2000 to 2002 investment growth is about 2% below Euro area average. The fall in the risk premium does not explain inflation persistence beyond the year 2000. In order to explain above average inflation after 2000 four shocks seem relevant. First the decline in non tradeable TFP growth, second a rising debt ceiling, third an adverse wage shock and fourth a shift of demand to non tradeables. Apart from being inflationary, the demand shocks also explain some other developments. The wage shock is important for capturing the trend reduction in the employment rate (relative to the euro area), which is however cushioned by the demand shift to non tradeables. Low TFP growth is the most important factor for low investment growth and also has a negative effect on employment. The reduction of the risk premium is the most important factor for explaining the persistent current account deficit. A non negligible effect comes from a loosening of credit constraints. According to the model, increasing the debt ceiling for households has contributed about .5% of GDP to the current account deficit in the most recent years and is the second most important factor for explaining the current account deficit.

Summing up

As can be seen from graph PT-1, with these supply and demand shocks imposed, the model is capable of replicating some characteristic features of the Portuguese economic development since 1997, namely high growth of GDP and its components in the late 90s, followed by a sustained negative growth differential since 2000; persistently positive (but declining) inflation differentials relative to the euro area; initially rising and then falling terms of trade growth; a rising current account deficit in the late 90s which stabilised at high levels around 2000 and below average productivity growth starting around the year 2000.

[23] In order to capture the strong decline of GDP growth in 2003 we impose two additional shocks, namely negative TFP shock in the tradeable (primary) sector and a cut in government expenditures.

Graph PT-1: DSGE Results for Portugal (deviation from Euro area average)

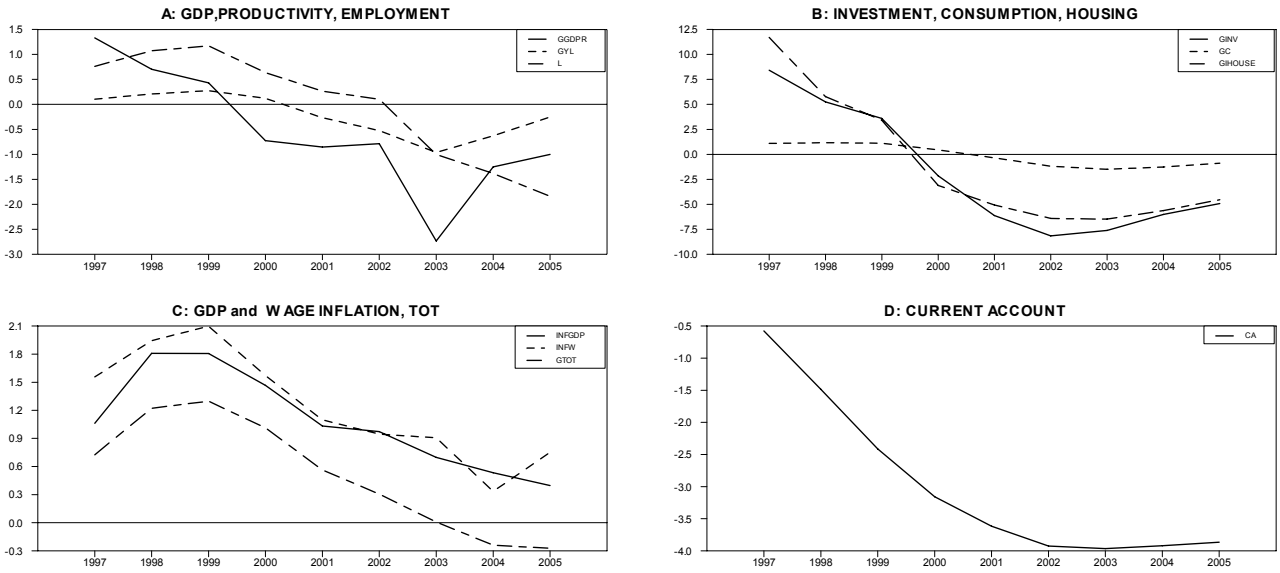

Table PT-1: Economic Development – Portugal (relative to euro area)

Variables	1997	1998	1999	2000	2001	2002	2003	2004	2005
Growth rate of real GDP	1.35	1.58	0.67	-0.21	-0.12	-0.39	-1.92	-0.94	-1.06
Growth rate of private consumption	1.61	1.86	1.52	0.29	-0.84	0.19	-1.03	0.88	0.65
Growth rate of investment	11.61	5.93	-0.01	-1.52	0.48	-2.01	-10.85	-1.44	-5.17
Labour productivity growth	0.94	1.12	1.06	0.73	-0.10	0.09	-1.12	-0.48	-0.37
Employment rate	0.30	0.71	0.56	0.05	0.11	-0.22	-0.81	-1.12	-1.60
Inflation (GDP)	2.46	2.22	2.40	1.61	1.29	1.39	0.67	0.86	1.00
Wage inflation	5.94	4.62	2.84	4.25	2.74	1.80	0.82	0.35	0.99
Growth of terms of trade	1.56	1.95	0.68	0.37	-0.47	0.20	-0.74	-0.11	-0.30
Current account	-2.19	-3.24	-4.77	-6.61	-6.10	-4.06	-2.29	-3.65	-5.29

Source: Commission services

Note: 1. The growth rates of GDP and its components is per capita.
2. The employment rate and the current account is expressed as deviation from 1996 levels.
3. The terms of trade are defined as export prices of the MS relative to export prices of the rest of EMU.

3.6 Spain

Stylised Facts (see table ES-1)

In the running up phase to EMU the currency risk premium of Spain declined and disappeared at the beginning of 1999. Starting in the 90s the productivity performance in the non tradeable sector worsened relative to the Euro area. These two developments are similar to those which occurred in Portugal. However Spain differs from Portugal in a number of dimensions. The employment rate is still rising at an impressive pace. Since the beginning of the 90s the participation rate has increased by 10 percentage points and the structural unemployment rate which peaked at nearly 17% in the mid 90s came down to 14% in 1999 and has now reached a level of about 9%. The increase in the employment rate is accompanied by a strong increase in the working age population, mainly due to immigration. Second unlike in Portugal the housing boom in Spain is continuing, possibly fuelled by high population growth, the age structure of the population and a boom in tourism (in particular an increasing number of holiday homes of foreigners). Because of high employment growth, GDP per capita has persistently been above the Euro area average, despite weak productivity growth. Investment growth has outpaced the Euro area average by roughly 4% each year since the end of the 90s. This is mostly due to housing investment (growth rate exceeds Euro area average by about 9%). However corporate investment in equipment has also shown strong growth in recent years. Inflation has permanently been high in Spain (about 2% above Euro area average). Wage inflation is however much more

moderate with a differential below 1% to the euro area. High demand is also reflected in the current account balance. The current account deficit has reached a level above 6% in 2005.

Shocks
An important country specific shock in the case of Spain is the reduction of the exchange risk premium when entering EMU. A conservative estimate based on deviations from interest parity between the peseta and the Euro before 1999 suggests a risk premium of about 50BP was eliminated in the running up phase to EMU. This provides a big stimulus to investment and consumption. Housing investment has also benefited from financial market liberalisation as shown for example by higher household debt (increase from 42.8% (as a share of GDP) in 1999 to 64.5% in 2005). However, other factors related to demographics, immigration and tourism also play a major role. In the simulation exercise all three types of housing shocks have been taken into account[24]. Spain differs from the rest of the Euro area w. r. t. labour market trends. First we allow for different population (of working age) trends and second we calculate negative shocks to the wage setting rule such that the model replicates the increase in the employment rate. Another interesting structural development in the case of Spain is increased openness to foreign trade. While in the 80s Spain was the country with the lowest import penetration (import share of 16.8 in 1980 vs. 23.1 for France (second lowest) and EUR 29.0) it has now overtaken France (30.6 for Spain vs. 27.5 for France, EUR: 36.3). Following the empirical trade literature, increased openness is likely to increase competition in the tradeable sector. In the simulations reported below this is captured by a reduction in mark ups in the tradeable sector. Finally we consider deviations in productivity growth in the non tradeable sector.

Simulation (see Graph ES-1 and Table ES-2)
The reduction in the risk premium has a powerful short run effect on investment and consumption. Consumption is increased by about 3% in the first three years of EMU and has stayed at a higher level. Housing investment has responded vigorously to the reduction in the risk premium. Within the first two years it has risen by about 8%, however afterwards housing investment gradually returns to baseline levels.[25] The risk premium can account for higher inflation between .5 and 1% in the first 4 years of EMU, however after 4 years the contribution of a lower risk premium to inflation is insignificant. Due to the level shift in demand, the risk premium shock has a rather long lasting effect on the current account. It is the largest individual factor in explaining the current account deficit (and explains a deficit of 2.5% in 2005). Other structural factors (including the lifting of credit ceilings) have a more long lasting effect on housing demand and on inflation (+.4% p. a. in recent years). Other significant contributions to inflation derive from supply side factors, namely low productivity growth in non tradeables and increased competition in tradeables[26] (the joint inflation effect is about .8% per year over the last three years).

Summing up:
1) Shocks related to the creation of EMU explain GDP and its components as well as inflation in the first 2 to 3 years. The fall in the risk premium also explains a lower permanent consumption level and a more permanent current account deficit (of about 2.5% of GDP)

2) The risk premium cannot explain sustained differences in the growth rate of housing investment. This can only be captured by assuming specific housing demand shocks. Increased housing demand can partially explain high inflation and a rising current account deficit in recent years.

3) On the supply side, low TFP growth of non tradeables and increased competition in tradeables are important explanatory factors for inflation and the external balance in the Spanish economy.

4) The increase in the employment rate is only to a limited extent explained by the shocks considered. Both the population increase and increased competition contribute positively to employment. However the bulk of the increase of the employment rate is generated by a shift in the wage setting rule consistent with the observed decline in structural unemployment. Increased employment in Spain contributes significantly to housing demand, investment and private consumption.

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[24] The last shock has been constructed as a residual shock to the model in order to replicate the divergent housing trend in Spain.

[25] The effect of a reduction in the risk premium is an increase in the desired housing capital stock of private households. This is realised by initially rising investment, followed by a period of higher investment levels and a gradual return to the baseline level of investment.

[26] An inflationary effect from increased competition in tradeables sounds counterintuitive. Indeed increased competition does not increase prices in the tradeable sector but it increases wages which in turn leads to higher inflation in the non tradeable sector.

Graph ES-1: DSGE Results for Spain (deviation from Euro area average)

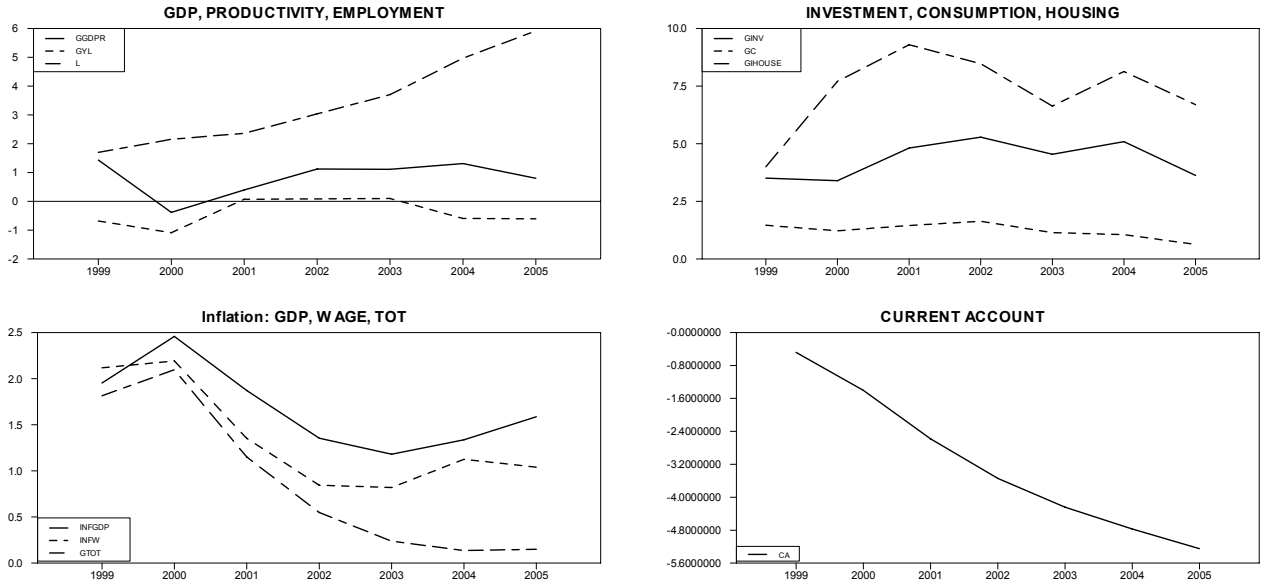

Table ES-1: Economic Development – Spain (relative to euro area)

Variables	1999	2000	2001	2002	2003	2004	2005
Growth rate of real	1.41	0.49	0.71	0.58	1.01	-0.22	0.96
Growth rate of private consumption	1.55	1.11	0.34	0.79	0.24	1.56	1.92
Growth rate of investment	4.27	1.62	4.04	4.82	4.67	2.55	4.93
Labour productivity growth	-0.81	-1.46	-0.07	0.02	0.03	-0.98	-0.79
Employment rate	1.10	2.09	2.49	2.82	3.42	3.88	4.97
Inflation (GDP)	1.77	2.03	1.79	1.88	1.93	2.16	2.69
Wage inflation	-0.45	0.35	0.96	0.74	1.06	1.18	0.25
Growth of terms of trade	-0.30	-2.95	2.15	3.13	1.29	0.19	0.79
Current account	-1.50	-2.85	-3.08	-2.50	-2.93	-4.68	-6.23

Source: Commission services

Note: 1. The growth rates of GDP and its components is per capita.
2. The employment rate and the current account is expressed as deviation from 1998 levels.

4. Assessment of adjustment in EMU

The model simulations described above provide a rather good match of actual divergences in growth and inflation of the euro-area economies. To a large extent, the diverging growth and inflation developments and current account shifts can be attributed to one-off adjustment to EMU (initial parities and exchange risk premium convergence) which broadly seems to have run its course. The absence of an exchange risk premium in EMU allows an increase in capital mobility resulting in a lower correlation between savings and investment. The model simulations show a persistent effect on the current account, which largely operates through the wealth effect. Differences in investment growth are the main driver of growth differences after the establishment of EMU. Due to its non-tradeable character, housing investment is the most responsive component of the investment growth to the changes in the interest rate (risk premium).

In a number of countries some structural divergences are observed, in particular related to total factor productivity and labour market developments. The link between inflation and competitiveness is not always strong. It depends on the sector in which the inflation in generated. For instance, high total factor productivity growth in the tradeable sector in Ireland allows high inflation without deteriorating competitiveness.

While the model matches the more short-lived (up to 3 years) divergences from the euro-area average rather easily with the standard entry-related shocks, some difficulties are observed in matching longer-term divergences. The

rather smooth adjustment and difficulty to model more persistent divergence and building of imbalances can be considered as giving a rather benign picture of adjustment in EMU. The adjustment seems more or less efficient, with little risk of overheating unless fiscal policy is pro-cyclical. After the one-off adjustment after the creation of the monetary union, economic developments apparently can be expected to be more symmetrical, mainly adjusting to a possible continuation of the series of consecutive supply shocks.

However, some caution is warranted. The model requires continuous shocks to allow matching the persistent and substantial increase in housing prices in some Member States (e.g. Spain) which may be a crucial element inducing consistently increasing consumption demand through the wealth effect. However, the real interest rate effect as well as the convergence of lending practices and availability of longer-term mortgages could feed through in particularly high increases in the housing prices, and especially land prices, through endogenous dynamics. If housing plays a larger role leading to endogenous building-up of excess demand, especially through the wealth effect, a somewhat less benign picture is possible.

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Appendix: A Two-Country-Three-Sector DSGE Model

We consider two countries within a monetary union. There is a high degree oft capital mobility within the monetary union. Production is distinguished in tradeables and non tradeables. The non tradeable sector is further disaggregated into construction and services. Labour is mobile between sectors but not between countries. The tradeable sector in each country produces a commodity which is an imperfect substitute for goods produced in the other country. Tradeables and non tradeables are themselves imperfect substitutes. In each sector there is a continuum of monopolistically competitive firms that set prices subject to convex adjustment costs. The household sector consists of a continuum of households $h \in [0,1]$. A share $(1-slc)$ of these households are not liquidity constrained and indexed by $i \in [0,1-slc)$. They have full access to financial markets, they buy and sell domestic and foreign assets. The remaining share *slc* of households is credit constrained and indexed by $k \in [1-slc,1]$. These households only engage in credit markets to finance housing investment. They are constrained in the sense that financial intermediaries charge a risk premium which depends on the value of the collateral. Both types of households sell labour and act as wage setters in monopolistically competitive labour markets. Nominal rigidity in wage setting is introduced by assuming that the household faces adjustment costs for changing wages. These adjustment costs are borne by the household. The government sector in each region makes spending decisions and collects taxes on labour, capital and consumption. Finally there is a central bank which sets nominal interest rates for the whole area via a Taylor rule.

1. Firms:

There are n^T firms producing tradeables indexed by *j* and n^N firms producing non tradeables indexed by *l*. Each firm produces a variety of the corresponding (domestic) good which is an imperfect substitute for varieties produced by other firms. Because of imperfect substitutability, firms are monopolistically competitive in the goods market and face a demand function for goods. Domestic firms sell to private domestic households, to other firms the government and to exporting firms. All demand sectors have identical preferences across varieties. The demand function for firm j depends on its relative price to other tradeables and the total demand for tradeables which is composed of the demand of households, the government and firms for tradeables plus exports[27]

$$\text{(1a)} \qquad Y_t^{T,j} = \frac{1}{n^T}\left(\frac{P_t^{T,j}}{P_t^T}\right)^{-\frac{1}{\tau_t}}\left[\left(C_t^{TD} + G_t^D + I_t^{TD} + X_t\right)\right].$$

The demand function for non tradeables is given by

$$\text{(1b)} \qquad Y_t^{N,l} = \frac{1}{n^N}\left(\frac{P_t^{N,l}}{P_t^N}\right)^{-\frac{1}{\tau_t}}\left[\left(C_t^N + G_t^N + I_t^{TN} + I_t^N + I_t^H\right)\right]$$

Demand for an individual firm in the non tradeable sector depends on the relative price of the variety offered by the firm, aggregate household and government demand for non tradeables and investment demand of the tradeable the non tradeable sector and the construction sector.
In what follows it is assumed that firms influence the demand for varieties for tradeables and non tradeables with their pricing decision, however, they are small with respect to the total market and therefore take as given P_t^T , P_t^N.
Output in both sectors is produced with a Cobb Douglas production function

$$\text{(2)} \qquad Y_t^s = (K_t^s U_t^s)^{1-\alpha}(N_t^s TFP_t^s)^{\alpha}, \text{ where } s = \{Tj, Nl\}$$

[27] Here we assume only firms operating in the tradeable sector invest in tradeables. Firms in the non tradeable sector invest entirely in non tradeables.

Firms rent capital and hire labour from the household sector. Labour input N_t^s is itself a CES aggregate of labour supplied by individual households *i*, $N_t^s = \left[\int_0^1 L_t^{i,s\frac{\theta-1}{\theta}} di\right]^{\frac{\theta}{\theta-1}}$ where the parameter $\theta > 1$ determines the degree of substitutability. The level of technology is given by TFP^s. The objective of the firm is to maximise profits

(3) $$G_t^s = \frac{P_t^s}{P_t} Y_t^s - \frac{W_t}{P_t} N_t^s - i_t^T \frac{P_t^{CT}}{P_t} K_{t-1}^s - adj(P_t^s) - adj(N_t^s) - adj(U_t^s).$$

For adjustment costs we choose the following convex functional forms

(4)

$$adj^L(N_t^s) = \frac{\gamma_N}{2} \Delta N_t^{s\,2}$$

$$adj^P(P_t^s) = \frac{\gamma_P}{2} \Delta \pi_t^{s\,2} \quad , with \quad \pi_t^s = P_t^s / P_{t-1}^s - 1$$

$$adj^{CAP}(U_t^s) = K_t^s (a_1 (ucap_t^s - ucap^*) + a_2 (ucap_t^s - ucap^*)^2) \text{ , with } ucap^*=1.$$

The firm determines labour input, the capital stock and prices optimally in each period given the technological and administrative constraints as well as demand conditions. The first order conditions are given by:

(5a) $$\frac{\partial G_0^s}{\partial N_t^s} => \left(\alpha \frac{Y_t^s}{N_t^s} \eta_t^s + \frac{\gamma_L}{R_t} ({}_t N_{t+1}^s - N_t^s) - \gamma_N (N_t^s - N_{t-1}^s) \right) = \frac{W_t}{P_t^s}$$

(5b) $$\frac{\partial G_0^s}{\partial K_t^s} => \left((1-\alpha) \frac{Y_t^s}{K_t^s} \eta_t^s \right) = i_t^s \frac{P_t^{I,s}}{P_t^s}$$

(5c) $$\frac{\partial V_0^s}{\partial Y_t^j} => \eta_t^s = 1 - \tau^0 + \gamma_P \left[\beta_t \pi_{t+1}^s - \pi_t^s \right]$$

Firms equate the marginal product of labour, net of adjustment costs, to wage costs. As can be seen from the left hand side of equation (5a), the convex part of the adjustment cost function penalises in cost terms accelerations and decelerations of changes in employment. Equation (5b) determines the optimal capital stock by equating the marginal value product of capital to the rental price. Equation (12c) defines the mark up factor as a function of the elasticity of substitution and changes in inflation. We follow Smets and Wouters and allow for additional backward looking elements by assuming that a fraction (*1-sfp*) of firms keep prices fixed at the t-1 level. This leads to the following specification:

(5c') $$\eta_t^s = 1 - \tau^0 + \gamma_P \left[\beta (sfp_t \pi_{t+1}^s + (1 - sfp) \pi_{t-1}^s) - \pi_t^s \right] \quad 0 \le sfp \le 1$$

There are n^H firms n^H (indexed by *h*) in the construction sector. The construction sector simply transforms non tradeable inputs (I_t^{HI}) into buildings (I_t^{HO}) using a decreasing returns to scale technology

(6) $$I_t^{HO,h} = I_t^{HI,h^\theta} U_t^H \quad \text{with } \theta \le 1.$$

Firms in the construction sector also operate under monopolistic competition and adjust prices sluggishly.

2. Households:

2.1 Non Liquidity constrained households

Non liquidity constrained households decide about five types of assets, domestic and foreign nominal bonds (B, B^F), stocks of domestic companies operating in the tradeable and non tradeable sector (K^T, K^N), housing (*H*) and cash balances (*M*). Each household owns land (*L*) which is inelasticaly supplied and traded among households. The household receives income from labour, nominal bonds and rental income from lending capital to the tradeable and non tradeable sector.

The utility function is additively separable in consumption, leisure and the stock of housing. And the stock of housing is composed of buildings and land. For the model economy to attain a steady state we assume log utility for total consumption (C_t^i) and housing and CES for leisure. In addition we allow for habit persistence

(7a) $$U(C_t^i) = \log((1+habc)C_t^i - habcC_{t-1}) .$$

Consumption is an aggregate over varieties of tradeables and non tradeables. The tradeables are nested into domestic and foreign varieties. C_t^i is a composite of tradeable $C_t^{T,i}$ and non tradeable consumption $C_t^{N,i}$

(7b) $$C_t^i = \left[s_T^{\frac{1}{\rho}} C_t^{T,i(\frac{\rho-1}{\rho})} + (1-s_T)^{\frac{1}{\rho}} C_t^{N,i(\frac{\rho-1}{\rho})} \right]^{(\frac{\rho}{\rho-1})}$$

where ρ denotes the elasticity of substitution between tradeables and non tradeables. For tradeables households have a choice between domestic and foreign varieties, with an elasticity of substitution given by ς .[28]

(7c) $$C_t^{T,i} = \left[s_{TD}^{\frac{1}{\varsigma}} C_t^{TD,i(\frac{\varsigma-1}{\varsigma})} + (1-s_{TD})^{\frac{1}{\varsigma}} C_t^{TF,i(\frac{\varsigma-1}{\varsigma})} \right]^{(\frac{\varsigma}{\varsigma-1})}$$

Normalising the total time endowment of the household with one, then the utility from leisure is given by

(8) $$V(1-N_t^i) = \frac{\omega + e_t^L}{1-\kappa}((1+habl)(1-N_t^i) - habl(1-N_{t-1}^i))^{1-\kappa} \quad \text{with } \kappa > 0,$$

Where N_t^i is labour supplied by household *i*. Finally the household enjoys utility from the stock of housing (*HL*), The parameter φ determines how the household distributes expenditure over consumption and housing . Due to demographic and other changes this parameter is subject to exogenous shocks denoted by e_t^H

(9a) $$Z(HL_t^i) = (\varphi + e_t^H)\log((1+habh)(HL_t^i) - habh(1-HL_{t-1})) \quad \text{with } \kappa > 0,$$

Housing is itself an aggregate of buildings (H) and land (L). The utility the household receives from both components is given by a CES utility function

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[28] It is assumed that households and the government have identical preferences over domestic and foreign varieties in order to facilitate aggregation.

(9b) $$HL_t^i = \left[s_H^{\frac{1}{\sigma}} H_t^{i(\frac{\sigma-1}{\sigma})} + s_L^{\frac{1}{\sigma}} L_t^{i(\frac{\sigma-1}{\sigma})} \right]^{(\frac{\sigma}{\sigma-1})}$$

The investment decisions w. r. t. real capital are subject to convex adjustment costs, therefore we make a distinction between real investment expenditure (*I*) and physical investment (*J*). Investment expenditure of households including adjustment costs is given by

(10) $$I_t^{j,i} = J_t^{j,i}\left(1+\frac{\phi}{2}\left(\frac{J_t^{j,i}}{K_t^{j,i}}\right)\right) \text{ where } j = \{T, N, H\}$$

The Lagrangian of this maximisation problem is given by

(11)

$$Max \quad U_0^i = E_0 \sum_{t=0}^{\infty} \beta^t \left(U(C_t^i) + V(1-N_t^i) + Z(HL_t^i) \right)$$

$$-\sum_{t=0}^{\infty} \lambda_t \beta^t \left(\begin{array}{l} \frac{(1+t_t^c)P_t^C}{P_t} C_t^i + \frac{B_t^i}{P_t} + \frac{E_t B_t^{iF}}{P_t} + \frac{P_t^{CT} I_t^{T,i}}{P_t} + \frac{P_t^N I_t^{N,i}}{P_t} + \frac{\mathrm{P_t^H} I_t^{H,i}}{\mathrm{P_t}} + \frac{\mathrm{P_t^L} L_t^i}{\mathrm{P_t}} \\ -\frac{(1+i_{t-1})B_{t-1}^i}{P_t} - \frac{(1+i_{t-1}^F)(1-r(.))E_t B_{t-1}^{iF}}{P_t} - \frac{i_t^T P_t^{CT} KT_{t-1}^i}{P_t} - \frac{i_t^N P_t^N KN_{t-1}^i}{P_t} - \frac{\mathrm{P_t^L} L_{t-1}^i}{\mathrm{P_t}} - \frac{(1-t_t^w)W_t^i}{P_t} N_t^i \\ + \frac{\gamma_w N_t^i}{2}\left(\frac{\Delta w_t^i}{w_t}\right)^2 + TAX_t^i \end{array} \right)$$

$$-\sum_{t=0}^{\infty} \xi_t \beta^t \left(K_t^{T,i} - J_t^{T,i} - (1-\delta) K_{t-1}^{T,i} \right)$$

$$-\sum_{t=0}^{\infty} \vartheta_t \beta^t \left(K_t^{N,i} - J_t^{N,i} - (1-\delta) KN_{t-1}^{N,i} \right)$$

$$-\sum_{t=0}^{\infty} \chi_t \beta^t \left(H_t - J_t^{H,i} - (1-\delta) H_{t-1} \right)$$

The budget constraint is written in real terms, all prices are expressed relative to the GDP deflator (*P*). Investment in the tradeable sector is a composite of domestic and foreign tradeables (manufacturing), while we regard investment for non tradeables as largely non tradeable (construction). The first order conditions of the household (FOCs) with respect to consumption and financial wealth are given by the following equations:

(12a) $$\frac{\partial U_0}{\partial C_t^i} => U_{C,t}^i - \lambda_t \frac{(1+t_t^c)P_t^C}{P_t} = 0$$

(12b) $$\frac{\partial U_0}{\partial B_t^i} => -\lambda_t + {}_t\lambda_{t+1}\beta(1+i_t)\frac{P_t}{{}_tP_{t+1}} = 0$$

(12c) $$\frac{\partial U_0}{\partial B_t^{iF}} => -\lambda_t + {}_t\lambda_{t+1}\beta(1+i_t^F)(1+risk(\frac{BW_t}{GDP_t}))\frac{P_t}{{}_tP_{t+1}}\frac{{}_tE_{t+1}}{E_t} = 0$$

(12d) $$\frac{\partial U_0}{\partial K_t^{T,i}} => -\xi_t + {}_t\xi_{t+1}\beta(1-\delta) + {}_t\lambda_{t+1}\beta i_t^T \frac{P_{t+1}^{CT}}{P_{t+1}} = 0$$

(12e) $$\frac{\partial U_0}{\partial J_t^{T,i}} => -\lambda_t \frac{P_t^{CT}}{P_t}(1+\phi\left(\frac{I_t^{T,i}}{K_{t-1}^{T,i}}\right)) + \xi_t = 0$$

(12f) $$\frac{\partial U_0}{\partial K_t^{N,i}} => -\vartheta_t + {}_t\vartheta_{t+1}\beta(1-\delta) + {}_t\lambda_{t+1}\beta i_t^N \frac{P_{t+1}^{N}}{P_{t+1}} = 0$$

(12g) $$\frac{\partial U_0}{\partial J_t^{N,i}} => -\lambda_t \frac{P_t^{N}}{P_t}(1+\phi\left(\frac{I_t^{N,i}}{K_{t-1}^{N,i}}\right)) + \vartheta_t = 0$$

(12h) $$\frac{\partial U_0}{\partial H_t^{i}} => \varphi \frac{1}{HL_t^i} s_H{}^{\frac{1}{\sigma}} \left(\frac{HL_t^i}{H_t^i}\right)^{\frac{1}{\sigma}} - \xi_t + \xi_{t+1}\beta(1-\delta) = 0$$

(12i) $$\frac{\partial U_0}{\partial J_t^{H,i}} => \phi_t \frac{P_t^H}{P_t}\left(1+\theta\frac{J_t^{H,i}}{H_t^i}\right) = \xi_t$$

(12j) $$\frac{\partial U_0}{\partial L_t^{i}} => \varphi \frac{1}{HL_t^i} s_L{}^{\frac{1}{\sigma}} \left(\frac{HL_t^i}{L_t^i}\right)^{\frac{1}{\sigma}} - \phi_t \frac{P_t^L}{P_t} + \phi_{t+1}\frac{P_{t+1}^L}{P_{t+1}}\beta(1-\delta) = 0$$

All arbitrage conditions are standard, except for a trading friction on foreign bonds, which is modelled as a function of the ratio of net foreign assets (*BW*) to GDP.

Using the arbitrage conditions, investment in the tradeable and non tradeable sector is given by

(13a) $$\left(\frac{I_t^{T,i}}{K_{t-1}^{T,i}}\right) = \frac{1}{\theta}\left(q_t^T - 1\right) \text{ with } q_t^T = \frac{\xi_t}{\lambda_t}\frac{P_t}{P_t^{CT}}$$

Where q_t^T is the present discounted value of the rental rate of return from investing in the tradeable sector

(13b) $$q_t^T = q_{t+1}^T \frac{1}{(1+\delta+i_t-\pi_{t+1}^{CT})} + i_t^T$$

Notice, the relevant discount factor for the investor in the tradeable sector is the nominal interest rate minus expected inflation of tradeables. This is because investment in the tradeable sector is assumed to be a composite of domestic and foreign tradeables and an increase in tradeable inflation constitutes a capital gain for then investor and lowers capital costs.

Similarly, for the non tradeable sector, investment is given by

(14a) $$\left(\frac{I_t^{N,i}}{K_{t-1}^{N,i}}\right)=\frac{1}{\theta}\left(q_t^N-1\right) \text{ with } q_t^N=\frac{\vartheta_t}{\lambda_t}\frac{P_t}{P_t^N}$$

Where q_t^N is the present discounted value of the rental rate of return from investing in the tradeable sector

(14b) $$q_t^N=q_{t+1}^N\frac{1}{(1+\delta+i_t-\pi_{t+1}^N)}+i_t^N$$

In the case of non tradeables, the relevant discount factor for the investor is the nominal interest rate minus expected inflation of non tradeables because investment in the non tradeable sector is assumed to be a composite of domestic non tradeables only.

Housing investment (buildings) is given by

(15a) $$\left(\frac{I_t^{H,i}}{K_{t-1}^{H,i}}\right)=\frac{1}{\theta}\left(q_t^H-1\right) \text{ with } q_t^H=\frac{\xi_t}{\lambda_t}\frac{P_t}{P_t^H}$$

Where q_t^H is the present discounted value of the shadow price of housing

(15b) $$q_t^H=q_{t+1}^H\frac{1}{(1+\delta+i_t-\pi_{t+1}^H)}+(\rho+\varepsilon_t^H)s_H^{\frac{1}{\sigma}}\frac{C_t^iP_t^C}{H_t^iP_t^H}HL_t^{\frac{1}{\sigma}-1}.$$

This expression shows that households aim at stabilising expenditure shares for consumption and housing (if σ is close to one) which is implied by the log specification of the utility function. Investment is large if the stock of housing (relative to its equilibrium level) is low and vice versa. The present discounted value of the ratio of the marginal utility of housing to the marginal utility of consumption is discounted with the nominal interest rate minus the expected inflation rate for buildings. The discount rate again reflects the impact of capital gains on housing investment decisions.

Finally, households make decisions about the acquisition of land. Demand for land crucially depends on expected changes of land prices. Since at the aggregate level, land is fixed, the arbitrage equation determines the relative price of land

(15c) $$\frac{P_t^L}{P_t}=\frac{P_{t+1}^L}{P_{t+1}}\frac{1}{(1+\delta+i_t-\pi_{t+1})}+(\rho+\varepsilon_t^H)s_L^{\frac{1}{\sigma}}\frac{C_t^iP_t^C}{L_t^iP_t}HL_t^{\frac{1}{\sigma}-1}$$

The land price behaves like an asset price. Under the assumption that land is inelasticaaly supplied it jumps upwards if there is a positive expectation about future consumption and a positive expectation about *HL*, the house-land aggregate in the standard case where land and buildings are complements ($\sigma<1$). In the model it is especially the price of land which drives housing price inflation.

2.2 Credit constrained households (k)

Credit constrained households have identical preferences as unconstrained households, however they do not participate in asset markets except for mortgage market. Household *k* spends his income either on consumption goods or invests in housing. Housing investment is subject to a credit constraint. Though the household can borrow, however the borrowing cost depend on the ratio of outstanding debt (*D*) to the value of the housing stock ($V(K^H)$)

(16)

$$Max \quad U_0^i = E_0 \sum_{t=0}^{\infty} \beta^t \left(U(C_t^k) + V(1 - N_t^k) + Z(HL_t^k) \right)$$

$$- \sum \phi_t \beta^t \left(\frac{P_t^L}{P_t} L_t^k + \frac{D_t^k}{P_t} - (1 + r_{t-1} + \kappa(\frac{D_{t-1}^k}{V(K_{t-1}^{H,i})})) \frac{D_{t-1}^k}{P_{t-1}} - \frac{P_t^L}{P_t} L_{t-1}^k - \frac{P_t^C}{P_t} C_t^k - \frac{P_t^H I_t^{H,k}}{P_t} (1 + \frac{\phi}{2} \left(\frac{I_t^{H,k}}{H_{t-1}} \right)) + \frac{W_t}{P_t} \mathrm{N_t^k} \right)$$

$$- \sum \xi_t \beta^t \left(K_t^{H,k} - I_t^{H,k} - (1 - \delta) H_{t-1}^{H,k} \right)$$

where . $(1 + r_{t-1}) = (1 + i_{t-1}) / (1 + \pi_t)$

The first order conditions of credit constrained households for consumption, buildings and land are similar to those of unconstrained households, except for a risk premium on household debt.

2.3 Wage setting

Workers from each household have market power in the labour market, because they offer services, which are imperfect substitutes to services offered by other workers. There is a continuum of monopolistically competitive unions indexed over the same range as households $h \in [0,1]$ which act as wage setters for the differentiated labour services. In a monopolistic labour market the elasticity of substitution between different types of labour determines the mark-up of wages over the equilibrium wage. This elasticity is defined by

(17a) $$\frac{\partial L_t^i}{\partial W_t^i} = -\theta \left(\frac{W_t^i}{W_t} \right)^{-\theta} L_t^i \frac{1}{W_t^i} = -\theta \frac{L_t^i}{W_t^i}.$$

Now the wage setting rule can be derived taking derivatives of the Lagrangian w.r.t. wages. Using symmetry: $W_t^i = W_t$ and neglecting second order terms allows us to write

(17b) $$\pi_t^w - \bar{\pi}^W = \frac{(\theta - 1)(1 + t_t^C) PC_t}{\gamma_w W_t} \left[\frac{-V_{L,t}}{U_{C,t}} (1 + mup^w) - \frac{(1 - t_t^w) W_t}{PC_t (1 + t_t^C)} \right] + \beta_{t\,t} (sfw \pi_{t+1}^w + (1 - sfw) \pi_{t-1}^w - \bar{\pi}^W)$$

with a wage mark up term $mup^w = \frac{1}{\theta}$ which goes to zero as the substitutability between different types of labour goes to infinity Households are setting the real net consumption wage as a mark up over the value of leisure which is defined as the marginal utility of leisure divided by the marginal utility of consumption. That means the real (consumption) wage increase with an increase in the marginal utility of leisure, i. e. an increase in the supply of labour or a decrease in the marginal utility of consumption, i. e. an increase in consumption or permanent income of households. This formulation generalises the neoclassical labour supply model along two dimensions. First, because of imperfect substitutability between different types of labour, households can set a consumption wage which is above the reservation wage as determined by the value of leisure. The magnitude of the wage mark up depends on the degree of substitutability between varieties of labour. Second, by introducing convex wage adjustment costs ($\gamma_w > 0$), workers want to smooth wage adjustments, taking into account current and future expected labour market conditions.

2.4 Aggregation

The aggregate of any household specific variable X_t^h is given by $X_t = \int_0^1 X_t^h dh = (1-slc)X_t^i + slcX_t^k$ since household within each group are identical. Hence aggregate consumption is given by

(18) $$C_t = (1-slc)C_t^i + slcC_t^k$$

aggregate employment is given by

(19) $$N_t = (1-slc)N_t^i + slcN_t^k$$

Liquidity constrained households do not own financial assets.

3 Policy

3.1 Fiscal Policy

Local governments dispose of the following fiscal instruments: On the revenue side, capital, labour and consumption taxes and on the expenditure side, government consumption and government transfers. The government has to obey an intertemporal budget constraint. The intertemporal budget constraint is guaranteed to be satisfied via a debt rule. I. e. the government adjusts labour taxes according to the following rule

(20) $$\Delta t_t^w = b1(\frac{B_t}{GDP_t} - b^*) + b2(\Delta\frac{B_t}{GDP_t})$$

3.2 Central bank policy rule (interest rate rule):

Monetary policy in the Euro area is modelled via a Taylor rule which targets an EMU aggregate output gap and inflation rate. It also allows for some smoothness of the interest rate response to the inflation and output gap

(21) $$i_t = ilag * i_{t-1} + (1-ilag) * (Ex.R + \pi^T + t^\pi(\pi_{t-1}^{EMU} - \pi^T) + t_M^Y(Y_t - YPOT_t^{EMU})) + e_t^M$$

4. Calibration:

The parameter values for the model are taken from the estimated Euro area model (Ratto et al (2006). We follow the trade literature in setting the trade elasticities. Accordingly we set the elasticity of substitution between tradeables and nontradeables to .4 and the elasticity between domestic and foreign tradeables to 5. This is at the higher end given existing estimates. However we think this is justified given the fact that we are looking at trade among countries in the euro area.

Table A-1: Parameter Values

β	Discount factor	.99
habc	Consumption habit	.8
slc	Share of credit constrained households	.5
risk	Credit constraint	.01
ρ	Elast. of subst. between *T* and *N*	.4
ς	Elast. of subst. between *TD* and *TF*	5.
κ	Inverse of labour supply elasticity	.23
θ	Capital adjustment costs	42.
α	Output elasticity of labour	.6

γ_p	Adjustment costs (prices)	24.
γ_w	Adjustment costs (wages)	17.
sfp	Share of fwd looking price setters	.75
$sfpw$	Share of fwd looking wage setters	.83
t^{π}	Monetary policy response to inflation	1.5
t^{y}	Monetary policy response to YGAP	0.1

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