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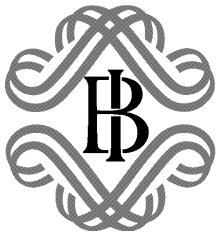

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MONETARY POLICY TRANSMISSION IN THE EURO AREA: WHAT DO AGGREGATE AND NATIONAL STRUCTURAL MODELS TELL US?

by Peter van Els[*], Alberto Locarno[**], Julian Morgan[***] and Jean-Pierre Villetelle[****]

Abstract

This paper analyses the monetary transmission mechanism in the euro area through the use of large scale macroeconomic models at the disposal of the European Central Bank and the National Central Banks of the Eurosystem. The results reported are based on a carefully designed common simulation experiment involving a 100 basis point rise in the policy interest rate for two years accompanied by common assumptions regarding the path of long-term interest rates and the exchange rate. Aggregating the country level results, the fall in output is found to reach a maximum of 0.4 per cent after 2 years. The maximum aggregate fall in prices is also 0.4 per cent, but it occurs 2 years later. The dominant channel of transmission in the first two years is the exchange rate channel, but in terms of the impact on output, the user cost of capital channel becomes dominant from the third year of the simulation onwards.

JEL classification: C50, E17, E5

Keywords: monetary policy transmission mechanism, macroeconomic models.

Contents

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1. Introduction[1]

The purpose of this paper is to analyse the monetary transmission mechanism in the euro area through the use of large scale macroeconomic models at the disposal of the European Central Bank (ECB) and the National Central Banks (NCBs) of the Eurosystem. A wide range of tools are used for economic analysis in both the ECB and NCBs which play an important role in forecasting and providing policy advice. In view of the adoption of monetary union, it is timely to re-examine the properties of these models in a systematic way and this exercise is a first step in this direction. The results reported in this paper are the fruit of co-operation within the Working Group on Econometric Modelling (WGEM) and are based on a carefully designed common simulation experiment.

Analysing whether the countries of the euro area behave similarly in the face of a monetary policy action is not purely a theoretical curiosity, but has become, with the launch of the euro, a crucial issue for appraising the challenges of running a single monetary policy. As stressed in Guiso *et al.* (1999), there are a few conditions which must be met for a single policy to succeed without causing frictions among the members of the coalition: first, there must be a general agreement on the ultimate goals the monetary authority has to achieve; second, member countries' business cycles should be as aligned as possible; finally, the transmission mechanism should operate in a similar fashion within the currency area. Differences in the response to a policy stimulus, whether caused by asymmetries in the business cycle or in the transmission mechanism, will imply that the burden of adjustment is not equally shared across countries and may create political tension which, in the extreme, may even jeopardise the mutual sharing of the goals underlying the creation of the monetary union.

The last major study of comparative properties of central bank models in terms of monetary transmission was carried out by the BIS in 1994 (BIS, 1995). The present study

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[1] The views expressed are those of the authors and do not necessarily reflect those of the institutions to which they are affiliated. The authors are grateful to the members of the Working Group of Econometric Modelling for the use of their results in this paper and for their helpful comments, whilst retaining responsibility for all errors.

has important similarities with, and differences from, this earlier study. The BIS (1995) study looked for cross-country differences in the transmission mechanism of monetary policy and examined the extent to which these could be linked to differences in financial structure. An important element of this study was a comparison of a monetary experiment undertaken using large-scale macroeconomic models developed by national central banks and the Multi-Country Macroeconomic (MCM) model of the Board of Governors of the Federal Reserve. The experiment involved a one percentage point increase in the policy interest rate for 2 years and the results were summarised by Smets (1995).

There are a number of important reasons why it is timely to re-examine the transmission mechanism on the basis of properties of central bank models rather than relying on BIS results. First, there is evidence that the monetary transmission mechanism may change considerably even in a short period of time. Taylor (1995) provides some evidence that in the US, Japan and Germany the impact of a monetary policy action has changed with respect to the 1970s.[2] Galì et al. (2000) compare the pre-Volcker and the Volcker-Greenspan period and detect significant differences in the response of the economy as well as the US Federal Reserve to technology shocks. In a recent paper, Boivin and Giannoni (2001) have tried to assess on quantitative grounds whether the way in which monetary policy impulses are transmitted has changed in the last two decades. Their main finding is that monetary policy, by becoming more aggressive, has contributed to reduced output and inflation variability, while changes in the transmission mechanism, in other words the structure of the economy, have generated a more rapid response of the endogenous variables to monetary policy shocks. Evidence for the euro area is more thin on the ground, but it is clearly likely that the regime switch which has occurred with the creation of the ECB means that past studies of the monetary policy transmission – based on differing interest and exchange rate assumptions for individual euro area countries - are now of only limited relevance.

Second, the previous results are now a little dated as the models have evolved since the exercise, reflecting new approaches, the availability of new data, and possibly changes in

[2] Taylor (1995) finds that "a comparison of […] two sets of estimates [one from the early 1970s trough the mid-1980s and the other through the mid-1990s] gives a sense of the magnitude of change in the monetary transmission mechanism over time. In the United States, the interest rate elasticity of investment has declined, but the interest rate elasticity of consumption has increased. ".

financial structures and institutions. Moreover, new models have become available and it has become possible to undertake this experiment for all 12 members of the euro area rather than the 8 EU countries included in the BIS exercise. Another new model which can now be used in such an exercise is the ECB's Area Wide Model (AWM) which is a model of the aggregate euro area economy (as detailed in Fagan et al. (2001)).

Third, although the aim was to undertake a comparable simulation across countries in the BIS exercise, there were nonetheless important differences in the nature of the simulations undertaken by the respective central banks. Since the research was conducted when macroeconomic convergence among the member states of the euro area was still to be achieved, interest rates differed between countries. In the presence of non-linearities, imposing the same 100 basis point shock to all the models translated into an impulse of different magnitude hitting each of the (future) euro area economies, depending on the level of the interest rates in the baseline simulation.[3] Another important difference was that some central banks undertook the simulations with fixed intra-European exchange rates whilst others allowed these exchange rates to vary as a result of the change in monetary policy. Even for those countries which did adopt fixed exchange rates (with ERM countries) there was not a consistent movement in the exchange rates with third party currencies. These points are perhaps not surprising as the composition of the euro area was not yet known in 1995. However, it significantly affects the comparability of the results for the euro area countries and limits their usefulness in the current environment of monetary union. More fundamentally, it is inappropriate for euro area as there is a need to have a fully consistent treatment of the exchange rate. A similar argument applies with respect to the treatment of long-term interest rates since, in the BIS exercise, the response pattern of long-term interest rates reflected the NCB's model equation explaining the representative long-term rate.

[3] This applies especially as regards the impact on income and also depends on whether the agents are net creditors or net debtors – and by what amount – when the shock occurs. In addition, a number of countries have adopted various measures of financial deregulation, at various times. Hence, country by country, depending on when the shock is simulated, the outcome may be different and not necessarily representative of the situation prevailing today. To avoid these drawbacks and in order to simulate the shock over a long enough period of time, it has been decided to simulate it out of sample under a set of common assumptions. The exact definition of the baseline is revisited in detail below.

This point leads to one of the key aspects of this study – namely the consistency of the experiment undertaken on the models. Considerable attention was paid to undertaking a genuinely comparable monetary policy experiment on all models that reflects the realities of monetary union in the euro area. The details of the exercise were agreed at various meetings of the WGEM, held in the latter half of 2000 and the first half of 2001. In essence, the aim was to take the BIS experiment as a starting point, but to go beyond this and agree details on questions such as the use of monetary and fiscal policy rules and the path of the exchange rate and long-term interest rates.

Another important issue which is addressed in this paper is that of intra-euro area spillover effects from the exercise. Unlike the BIS (1995) study, the exercise on national models is conducted on the basis that the change in monetary policy has taken place simultaneously in all euro area countries. In the BIS (1995) study the exercise was conducted in isolation in each of the NCB's models (although such spillover effects were clearly captured in the MCM).

This paper is structured as follows. In the next section a general discussion of the views on the monetary policy transmission process in the literature provides a frame of reference to the present exercise. Next, details are provided on the way in which monetary policy enters the models used in the exercise. Following this there is a discussion of the design of the monetary policy experiment and the motivation for the simulation that was chosen. Next there is a discussion of the method chosen for decomposing the monetary transmission process into channels. Finally there is a discussion of the results including the decomposition into channels and some comparison with the 1994/1995 BIS results.

2. Channels of transmission

There is a long list of comprehensive surveys of the monetary transmission process available in the literature. A few notable contributions in this area are by Cecchetti (1995), Mishkin (1996), and Christiano et al. (1997), although this is by no means an exhaustive list. Whilst a general consensus on the monetary transmission mechanism has not emerged from this work, there are a few elements that are common to all the theories which try to explain how monetary impulses affect the economy. The first concerns the ability of the central bank

to control the supply of an asset, "outside money", that is demanded by financial institutions and for which no perfect substitute exists. By engaging in open market operations, the monetary authority affects the liquidity of the banking system and the interest rate on reserves and in so doing changes the prices on a variety of domestic and foreign assets. The second common element relates to the existence of nominal rigidities - either in the labour and goods markets or in the financial sector – which prevent the price level from fully adjusting in the short-run. A few sources of nominal rigidities have been proposed in the literature: sticky prices, sticky wages and imperfections which limit the ability of households to participate in financial markets. Theories relying on such stickiness exploit the idea that nominal rigidities arise because of the existence of fixed costs in changing prices and wages, which makes it sub-optimal for firms and workers to continuously respond to changes in the economic environment. In the financial sector, limited participation models, instead, assume that, while prices are perfectly flexible, households are unable to immediately adjust their nominal saving in response to financial shocks and for this reason monetary contractions disproportionately affect the reserves of banks and hence the supply of loanable funds. The result is a rise in interest rates which induces firms who need working capital to cut back on their scale of operations.

Though all theories of the monetary transmission mechanism share the view that central banks can control money market real interest rates, there is less agreement on the process through which a change in the monetary policy stance affects households' and firms' behaviour.

The traditional view [4] suggests that monetary policymakers use their leverage over short-term interest rates to influence a host of asset prices, in particular longer term interest rates and the exchange rate. The ensuing change in interest rates is then transmitted to the real cost of capital, so altering the optimal capital-output ratio and investment. A similar mechanism, although somewhat simplified, operates for investment in housing and structures and for the accumulation of inventories. In addition, changes in interest rates affect the rental cost of durable goods and the relative price of present as opposed to future

[4] Cecchetti (1999) labels this theory as *money view*.

consumption, thereby affecting consumer spending. Since in the short-run production is demand driven, the response of "interest-sensitive" components of aggregate demand changes the output and unemployment gaps and induces adjustments in wages and prices, which feed back to the spending decisions of firms and households until a new equilibrium is reached. The exchange rate provides additional leverage to the policy maker. A monetary tightening appreciates the exchange rate, affecting prices directly via the import deflator and indirectly via a fall in net exports caused by the loss in competitiveness.

As stressed in Cecchetti (1999), a noteworthy implication of the traditional view, which attributes a pivotal role to the response of investment demand, is that a more restrictive monetary policy stance hits only those projects which are the least productive (i.e. those with the lowest rate of return). Given that a decline in the capital stock and output is required in order to curb inflationary pressures, the allocation of the decline across sectors is at least socially efficient. Externalities and financial market imperfections play no role in the transmission mechanism and this marks the starkest difference with the basic insight of the credit channel theory.[5]

Two stylised facts appear to be at variance with the traditional view of the monetary transmission mechanism, namely the low elasticity of the cost-of-capital in estimated spending equations[6] and the high degree of amplification, i.e. the empirical evidence that though central bank's actions induce relatively small and transitory movements in open market interest rates, nevertheless they have large and persistent effects on the purchase of long-lived assets, such as housing or production equipment. According to the lending view, theory and evidence can be reconciled by focusing on those frictions - such as imperfect information or costly enforcement of contracts - which interfere with the smooth functioning of financial markets and which drive a wedge between the expected return received by lenders and the costs faced by potential borrowers, the so-called external finance premium. Advocates of the credit channel claim that monetary policy affects not only the general level of interest rates, but also the size of the external finance premium. It is this additional

[5] Cecchetti (1999) labels this theory as *lending view*.

[6] Taylor (1995) rejects this criticism and claims that, on the contrary, econometric evidence is supportive of the existence of a sizeable response of domestic demand components to interest rate movements.

element which helps explain the strength, timing and composition of a monetary impulse. The link between monetary policy and the external finance premium passes through borrowers' net worth and the supply of bank loans. By reducing expected future sales and by increasing the cost of rolling over outstanding debt, a policy tightening causes a deterioration in the firm's net worth. As the latter declines, the deadweight costs associated with the principal-agent problem rise,[7] an outcome that will lead potential lenders to increase the risk premium they require. The initial monetary impulse is further magnified by the contraction in bank reserves, which must be matched by a reduction in the level of both deposits and loans. If there are firms (or households) without an alternative source of financing, spending must be curtailed.

A third view of the monetary transmission mechanism, which has only recently received some attention and which is described in Christiano *et al.* (1997) and Barth and Ramey (2001), stresses the relevance of supply factors. Since firms must pay their factors of production before they receive revenues from sales, they must raise the required funds by borrowing. An increase in interest rates is therefore associated with a downward shift in the labour demand schedule, similar to a negative productivity shock, and leads to higher production costs and to a decline in output which is driven by supply-side factors.[8] According to its advocates, this approach can potentially explain a few empirical puzzles which do not square well with the traditional view. The first is the aforementioned degree of amplification. If monetary policy shocks exert both demand-side and supply-side effects, then the additional leverage provided by the latter may help explaining the amplification mechanism. The second one is the well known "price puzzle" when a short-run increase in the price level is observed following a monetary contraction. If a more restrictive stance affects only aggregate demand, no reasonable explanation for such a phenomenon exists; if instead it also generates a rise in production costs, then an initial apparently perverse reaction of inflation may appear, to the extent that the increase in production cost is not

[7] The usual explanation goes as follows: the higher the net worth, the higher the stake of the firm's projects which is self-financed and/or the higher the share of debt which is collateralized. Both outcomes favour a reduction in the external finance premium.

[8] The assumption in these models is that prices are not sticky but adjust immediately to changes in marginal costs. The source of nominal rigidities is found in capital market imperfections, which limit the participation of households.

offset by a procyclical reduction in the mark-up. While the former induces a fall in productivity and real wages, consistently with a worsening of production possibilities that leads to a downward shift in labour demand, the latter engender a rise in both variables, consistently with a stable production function. The third and final one is the differing responses of key macroeconomic variables after a rise in interest rates compared with other shifts to aggregate demand

Notwithstanding the distinguishing features of the three approaches, they are in fact not inconsistent with each other. As stressed by Bernanke and Gertler (1995), the credit channel is not to be thought as a distinct, free-standing alternative to the traditional monetary transmission process, but rather an enhancement mechanism, which contributes to amplifying and propagating conventional interest rate effects. The same consideration applies to the cost channel, where supply-side factors are to be seen as powerful collaborators in the transmission of the real, short-run effects of monetary policy changes.

The traditional view, being based exclusively on macro relationships, is better suited for econometric modelling. The lending view, which stresses the role of asymmetric information in determining the size of the external finance premium, treats large and small firms differently, and, within the financial sector, distinguishes between healthy and unhealthy banks. The cost channel, instead, requires that firms adjust their prices immediately after a monetary policy action, which contrasts with the observed stickiness in the pricing behaviour of the corporate sector.[9] The models used in the WGEM Monetary Transmission Exercise are no exception and tend to model the monetary transmission mechanism by focusing on the response of interest-sensitive components of aggregate spending and on the amplification process generated by the multiplier and the accelerator principles.[10]

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[9] For monetary policy to have real effects, some nominal rigidities must exist. The cost channel usually relies on frictions limiting households' participation to capital markets. In principle, price stickiness would do as well, but it is unlikely that the cost channel may explain a significant part of the effects of a monetary policy shock if prices are not free to fluctuate.

[10] In a few cases attempts have been made to adopt a more eclectic view and to combine the features of three different approaches. For instance, the models of the National Banks of Belgium and Holland relate the main price variable not only to unit labour costs but also to the cost of capital, so allowing for a direct effect of monetary policy on inflation, as suggested by the cost channel theory; furthermore, the Nederlandsche Bank's

The transmission of monetary policy impulses may be described as developing in three phases. First, a change in the policy instrument is transmitted to the whole set of interest rates and exchange rates. Second, the movements in financial prices interact with the spending behaviour of households and firms. Third, the ensuing change in the output and unemployment gaps induces wages and prices to adjust to restore a new equilibrium. The changes in prices and quantities feed back into the financial system, inducing modifications in the composition of balance sheets which may exert second round effects on interest rates, thus setting the stage for the interaction between the real and the financial side of the model. The process through which interest rates affect the aggregate demand – the second phase – can be, somewhat arbitrarily, grouped into transmission channels, which tend to single out one at a time the components of aggregate spending which are affected by the policy action and the processes which drive these shifts. In the WGEM Monetary Transmission Exercise five channels have been identified, which are present in most of the participating models:[11]

- *The exchange rate channel* – in most models of exchange rate determination, a monetary policy tightening appreciates the currency. A stronger exchange rate exerts a widespread influence on both the real and the financial side of the economy. It causes a fall in exports, partially compensated by the parallel contraction in import volumes via the multiplier effect, and an increase in consumer spending, induced by the positive income effect which follows an appreciation. It also yields a fall in the price level, directly since it reduces the cost of imported goods and the size of the mark-up and indirectly since it worsens the competitive position of domestic firms and hence net exports.

- *The substitution-effect-in-consumption channel* – the real interest rate represents the relative cost of present versus future consumption. Following a policy tightening, it

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model includes among the determinants of capital accumulation a measure of profitability, which can be viewed as a proxy for firms' net worth, capturing, in accordance with the lending view, the influence of capital market frictions on the monetary transmission mechanism. A previous version of the quarterly model of the Bank of Italy allowed credit conditions to influence the monetary mechanism by making the spread between the loan rate and rates on Treasury securities a function of the degree of liquidity of banks' balance sheets. This variable is however disappeared, since with the most recent vintages of data it turned out statistically insignificant.

[11] In some models, additional channels are singled out: a price-monetary channel is included in the one of the Bundesbank; an expectation channel is present in the Italian model.

becomes more rewarding to delay consumption and increase saving, which exerts a negative impulse on the current level of economic activity.

- *The cost-of-capital channel* – the rise in the real interest rate is reflected in the real cost of capital. The optimal capital-output ratio falls and the pace of capital accumulation slows down accordingly. A similar mechanism operates for investment in housing and structures and for inventories accumulation. The rental cost of durable goods moves in parallel with the cost of capital and also causes a contraction in consumer spending.[12]

- *The income and cash-flow channel* – a rise in financial yields increases the disposable income of net lenders and worsens the cash flows of net borrowers. The effects are stronger the higher the portfolio share of short-term and floating rate securities. The relevance of the cash-flow channel is strictly linked to the financial structure of the economy and depends also on the relative propensity to spend of borrowers and lenders.

- *The wealth channel* – a deterioration in borrowing conditions reduces the discounted value of future expected payoffs of physical and financial assets. The market value of households' net wealth adjusts to incorporate capital losses, constraining the opportunity set of consumers, and household spending falls accordingly.

3. The structures and main features of the models used

This section gives a brief overview of how changes in monetary policy affect the models used in the exercise. The aim here is to give an overview rather than discuss the transmission mechanism in the models in detail. Where important features of the models can help explain differences in the results observed in the monetary policy experiment, these are highlighted in the results section of the paper.

[12] Since most econometric models used in the experiment do not distinguish between consumption of durables and non-durables, to allow comparisons the response to the monetary policy shock of durables spending has been allocated not to the cost-of-capital channel but to the substitution-effect channel.

Table 3.1 Conventional channels of monetary transmission in ESCB models

	Exchange rate	Substitution	Cost of capital	Income	Wealth
Belgium	P	S	P	S	P
Germany	P	P	P	P	N
Greece	P	P	P	N	N
Spain	P	P	S	P	N
France	P	P	S	P	N
Ireland	P	P	S	N	P
Italy	P	P	P	P	P
Luxembourg	P	P	P	N	P
Netherlands	P	P	P	S	S
Austria	P	P	S	P	S
Portugal	P	P	P	P	N
Finland	P	P	P	P	S
AWM	P	P	P	P	P

P: Channel present; S: Channel present but has special feature; N: Channel not present

Table 3.1 provides an overview on which of the channels of monetary policy transmission discussed in the previous section are present in each of the models. The exchange rate channel exists in all models. It directly feeds into the euro-price of oil and other commodities (involving the euro-dollar exchange rate) and the foreign prices of other goods and services (involving the effective exchange rates). The change in import and competitors' prices in euros initiates a change in domestic prices, which will spread through the price and wage system. Therefore competitiveness and real wages are affected at least in the short and medium term. There is some heterogeneity in the treatment of the exchange rate across models, so in order to ensure an identical exchange rate path across the euro area it was necessary to agree a common path for the exchange rate as discussed in the next section.

The substitution-effect-in-consumption channel (henceforth: substitution channel) also exists in all models, but the distinction between this channel and the income channel cannot be made very precisely in the case of Belgium. Table 3.2 gives more details on the interest rate effects on consumers' expenditure. In the Irish case and in the AWM, real short-term rates affect short-run consumption and there are also direct interest rate effects on consumption in Portugal and Greece. In the German model and in the Netherlands' model, the long-term interest rate influences real consumption per capita. In Italy, Austria and

Finland bank lending rates affect consumer spending. Moreover, in the Italian case a distinction between durables and non-durables is made.

The cost-of-capital channel is present in all models. However, there are differences between the various models in the way this channel is incorporated. As Table 3.2 reveals, interest rates – generally long term – can affect investment in all the models, although there are differences in the mechanism. In many cases the link between interest rates and business investment is via the capital stock. A change in interest rates affects the user costs of capital, which affects the desired capital stock and thereby investment. Because of adjustment costs, investment can only gradually bring the actual capital stock to its desired level.

The user cost of capital variable is designed to reflect long-term borrowing costs. For example, in the Irish model, long-term interest rates and corporate borrowing costs are used to construct a measure of the cost of capital which determines the optimal capital stock. In the Portuguese model, the user cost of capital is the average of the long term interest rate and the credit interest rate. In the Finnish model, interest rates affect investment through the rental price of capital – this is disaggregated into four categories of investment. In this case long-term interest rates do not play any role as the expected short-term interest rate is implicitly taken into account in the structure of the equations. In the German model there is a direct link between long-term interest rates and real machinery and equipment investment and an indirect link through the impact of the user cost of capital on the present value of depreciation allowances. In the Netherlands model, non-residential investment depends on a weighted average of short- and long-term interest rates and on the profitability of investment expressed as the after-tax yield on capital.

Table 3.2: Direct Interest Rate Effects in Private Investment and Consumption

	Private Investment	Private Consumption
AWM	Effect via cost of capital term which is the short-term real interest rate.	Real short-term interest rates affect short-run consumption.
Germany	Direct effect of long-term interest rates and indirect influence through long-term rate's effect on the present value of depreciation allowances and on the user costs of machinery and equipment, which affects the investment deflator.	Long rate affects real consumption per capita.
Greece	Effect via a user cost of capital term	Direct interest rate effect.
Spain	Real user cost of capital (long rate)	Real long-term interest rate
France	Both the short and the long term interest rate play a role but through the cash-flow effect only.	Direct real short term interest rate effect
Ireland	Effect via cost of capital term which is the long-term interest rate and corporate borrowing costs.	Real short-term interest rates effect short-run consumption.
Italy	Equipment investment depends on the cost of capital, which is defined in terms of a convex combination of the yield of Treasury bonds (long-term rate) and the average loan rate (averaged over short and long maturities). Investment in structures depends on the average loan rate. Residential investment is a function of the short-term loan rate.	Durables consumption depends on the interest rate on short-term loans, while non-durables consumption is affected by a longer-term interest rate (Treasury bond yield).
Luxembourg	Cost of capital term combining short and long term interest rate	Real long-term interest rate
Netherlands	Weighted average of short and long-rates.	Long-term interest rate
Austria	Direct effect of bank lending rate	Direct effect of the bank lending rate
Portugal	Effect via cost of capital term which is the average of a short and long term interest rate.	Direct effect of real short-term interest rate.
Finland	Effect via cost the rental price of capital which is affected by the short-term interest rate.	Direct effect of the bank lending rate.

Residential investment in the Netherlands depends on long-term interest rates, as households tend to favour long-term mortgages for financing the cost of building new houses or renovating existing houses. The combined cash flow/income channel exists in all models except those for Greece and Ireland. As noted before, the impact of this channel will depend on the financial position of households and firms at the time of the policy action. In the case of the Netherlands the income channel includes the effects of portfolio reallocation by households and firms.[13]

The wealth channel is not present in the models for Germany, Greece, Spain, France, and Portugal. Changes in wealth are caused by (cumulated) changes in asset holdings (M3, bonds, shares, and net foreign assets) as well as by valuation effects. As to the latter, asset prices are endogenous in the models for Austria (shares), Finland (house prices) and Netherlands (house, share and bond prices). In the models for Finland and Netherlands wealth not only affects consumption directly but also residential investment through changes in house prices.

Finally, there are a number of country-specific channels that are not shown in the table. In the German model there is separate monetary channel which transmits interest rate impulses to inflation via the price gap, i.e. the deviation of the actual price level from the equilibrium price level P-star. This channel, which is absent in other country models, accounts for the empirical observation that inflation in the long run is a monetary phenomenon. A rise in interest rates leads to a reduction in the monetary aggregate M3 and P-star, thereby leading to a fall in prices. More details of the operation of this channel are provided in the box. In the case of Italy two additional channels are operating: (1) the expectations channel capturing the direct impact of changes in policy controlled interest rates on inflation expectations, and (2) the portfolio channel which includes the effects of portfolio reallocation by households and firms. The latter channel is also present in the Netherlands' model but there it is included in the joint income/cash flow channel. An inflation channel also plays a role in explaining the dynamics of consumption in the case of France (Pigou-effect), but has not been isolated as a separate channel in the present exercise.

[13] The change in interest payments sums up to zero, when taking into account the rest of the world.

BOX on the monetary channel in the Bundesbank model

In the Bundesbank model there is a separate monetary channel which transmits interest rate impulses via the price gap to inflation. This channel, which is absent in other country models, accounts for the empirical observation that inflation in the long run is a monetary phenomenon. The price gap derives from the long run money demand equation,

(1) $$m = p + \beta \tilde{y} - \gamma i + u$$

where m denotes the stock of money holdings, p is the price level, $\tilde{y}$ is output (all in logs), i is the interest rate and u is the deviation between money holdings and long run money demand, i.e. the monetary overhang. Moreover, ß is the long run income elasticity and γ is the interest rate elasticity of money demand. Using (1), the equilibrium price level (p*) is defined as the price level which is consistent with the actual stock of money holdings if output, the interest rate and money demand are in equilibrium (i.e. $\tilde{y} = \tilde{y}^*$, i = i*, u = 0):

(2) $$p^* = m - \beta \tilde{y}^* + \gamma i^*$$

Defining the output gap as $y = \tilde{y} - \tilde{y}^*$ and the deviation of the interest rate from its equilibrium as R = i – i* , the price gap is

(3) $$p^* - p = y + [(\beta - 1)y - \gamma R + u] = \beta y - \gamma R + u$$

The term in brackets is the liquidity gap (v* - v), i.e. the deviation between trend velocity and actual velocity of money. Hence, the price gap can be viewed as a measure for inflationary pressures which combines information from the aggregate goods market (the output gap) as well as from the money market (the liquidity gap). There is a positive liquidity gap, i.e. velocity is below its trend level, if the output gap is positive,[14] if the interest rate is below its equilibrium level or if there is a positive monetary overhang. Empirically, the P-Star model relies on two conditions: (1) There is a stable long run money demand function and (2) Inflation is a function of the price gap. Both conditions have found empirical support for Germany and may hold at the Euro area level as well.

4. The monetary policy experiment

This section summarises the agreed design of the standard simulation experiment that was followed for the WGEM Monetary Transmission Exercise. Before spelling out the details of the simulation it is worthwhile discussing the possible approaches available for conducting comparative simulation exercises. There is a large literature on undertaking model comparisons and a number of different approaches can be seen. One approach is to '*let models be models*'[15] and – on the basis of a broad outline - give individual modellers considerable freedom in the design of the simulation exercises that they are undertaking. For example this approach was taken in the projects sponsored by the Brookings Institution (Bryant et al (1988) and (1993)) and the European Commission (Barrell and Whitley (1992)). The argument for doing this is that individual modellers are in the best position to know how to use their models in such simulation exercises. Early attempts by 'outsiders' to undertake identical simulations on different models were heavily criticised:

"Third-party scholars have frequently attempted to evaluate and compare large-scale econometric models by trying to interpret the model builders' data, work-sheets, and procedures. In many cases the outsiders have failed to employ acceptable procedures, have done violence to the models in respecification or reestimation and , in general, used data inefficiently" (Fromm and Klein (1973), p. 385).

Nevertheless, there will always be the question of comparability of the results when individual modellers are given considerable freedom in the design of simulations. As Mitchell et al (1998) point out when discussing the comparability of global models:

"Thus, when important differences are observed in the model's predictions of the global economic response to policy interventions of various kinds, as they invariably are, it may be that these are due at least in part to differences in side conditions or other adjustments that individual model proprietors have made, but the extent to which this is true remains unknown." (Mitchell et al (1998), p.2)

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[14] This is a spillover effect from the goods market which appears if the income elasticity of money demand is larger than unity.

[15] To use a phrase coined by Adams and Klein (1991).

One approach to undertaking genuinely comparable exercises is for one body which had a good understanding of the models to undertake the simulation exercise. This was the approach taken by the Macro Modelling Bureau at the University of Warwick which – prior to its closure in 1999 - undertook regular comparative exercises on models of both the UK and the global economy that were deposited with it. Such an approach would not have been viable with this exercise given the use of 13 separate models from the banks comprising the Eurosystem. Rather it was decided to agree the details of a common simulation exercise to be undertaken on all models. This way it was hoped that it might be possible to generate genuinely comparable results without doing too much 'violence to the models'.

These details were agreed at meetings of the WGEM in late 2000 and early 2001 and relate to the treatment of monetary and fiscal policy, long rates, exchange rates, international spillovers and wage policies. If given complete freedom it is fair to say that many of the individual modellers would probably not have chosen to undertake exactly the agreed experiment. In all likelihood they would have preferred to undertake the exercise in a somewhat different way to best utilise the features of their models. Nevertheless, for an exercise of this type it was particularly important that members of the working group agreed all the details of the simulation design in order to ensure that the simulation results were genuinely comparable. For example, it would not have been meaningful to compare results across simulations that were based on different assumptions about fiscal policy or the exchange rate following a monetary policy shock. The aim was to minimise differences due to simulation design so that by comparing results it would be possible to gauge the effects of differences in the models. The differences in the models would reflect in part, differences in the underlying economies and also in part differences in the philosophy of the model builders.

Nevertheless, in recognition of the fact that this exercise could have been performed in a number of different ways some scope was allowed for individual members who wished to undertake additional variant simulations to illustrate the importance of some assumptions or features of their models. For example, the model of the Bundesbank has been used with and without a P-star effect incorporated to offer an insight into the effect of such an approach. More generally, the issues surrounding the design of monetary policy experiments are explored in the paper by McAdam and Morgan (2001).

The first detail to be agreed by the WGEM members related to the construction of a baseline. This was necessary as there was the possibility that differences in the baseline may have some impact on the simulation results.[16] Although it was not appropriate to fix an identical baseline (e.g. the same GDP growth rates etc in each country) it did make sense to ensure that they were based on the same external assumptions and that they related to the same time period. It was agreed that the exercise would cover a 10-year horizon and from 2001Q1-2010Q4 and would therefore require a baseline extending at least to 2010Q4. This was the minimum length of the baseline, however, since those models with many forward-looking elements would benefit from having a significantly longer baseline than this. The baseline short-term interest rate was projected at a constant value and the exchange rate was projected at its last assumed value over the horizon. External assumptions were also made common across the baselines.

The agreed details of the monetary policy experiment were as follows. Following BIS (1995), the monetary policy shock was a two-year increase of the short-term policy interest rates by 1 percentage point from 2001Q1-2002Q4. From and including 2003Q1 a return to baseline values was assumed.[17] This meant that no monetary policy rules were implemented. Whether this choice is appropriate or not is arguable. According to Taylor (1995), the links of the monetary transmission form a circle, with the circle being closed by linking the movements in real GDP and inflation back to the short-term interest rate through a policy rule. A story of the monetary transmission mechanism which does not include a description of the central bank's reaction function is therefore incomplete. In addition, a policy rule may be helpful for achieving model stability. Whilst recognising these objections, no simple solution was available: if a common policy framework is to be imposed, the policy rule must respond not to domestic but to area-wide variables, whose path represents the output of the

[16] The baseline is only an issue in the presence of non-linearities. For some models variant simulations were undertaken with differing baselines and the effects were not found to be particularly large. Nevertheless, the construction of a baseline using a common set of assumptions was thought to be a prudent starting point for the exercise.

[17] This meant that the experiment was a temporary one, as a permanent change in the nominal interest rate would force most models onto an explosive path. An alternative approach would have been a permanent shock such as a permanent shift in a policy rule. For example, Church et al (2000) examine monetary policy through a permanent change in the inflation target. Unfortunately such an approach would not have been possible in this

experiment and is therefore not known when the national models are simulated. It could be possible to iterate so as to reach some kind of convergence, but the value of such an approach is far from certain. Although not the most faithful representation of the working of a central bank, it is likely that the experiment, so as it is designed, provides a reasonable approximation to the response of the euro-area economy to a monetary policy tightening.

Under the assumption that the policy action was perfectly anticipated by financial markets, asset prices were assumed to move according to arbitrage conditions. The term structure was modelled using the expectations hypothesis, while exchange rates were determined by an uncovered interest parity condition. In both cases, risk premia were held constant at baseline values and there were no changes in inflation expectations.[18] The bilateral exchange rate between third country currencies (e.g. USD versus JPY) was assumed to remain unchanged. Clearly there was also no change in the bilateral exchange rates for the residual currencies of the euro area. As a result, the nominal effective exchange rate of each country changes as a function of the weight of the non-euro countries (Table 6.1).

Models were initially operated in 'isolated' mode without international spillovers (e.g. changes in foreign demand). Therefore, at the outset no assumptions were made about any change in foreign variables due to the simulation that might feed back into the domestic results. However, such effects were taken into account in a second round through an exchange of results between modellers whereby the results of the first run of all models in isolated mode were incorporated in each model.[19]

No fiscal policy rules (e.g. targeting a specific government budget or debt stock target) were used in the simulations. Once again, it may have been useful in terms of stabilising some of the models to ensure that such rules were in operation. Nevertheless, incorporating

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exercise as a common change in a policy rule would have induced differing interest rate reactions in each country – which would not have been compatible with monetary union.

[18] Whilst there are small differences in long-term interest rates in euro area countries it was not thought appropriate to allow different long-rate reactions across countries. In other words, it was assumed that the differential between long-term interest rates were unaffected by the monetary policy experiment.

[19] This process could be repeated a number of times until the spillover effects appear to have settled down. The results presented in this paper are those obtained after one round of iteration as after close inspection it was concluded by the Working Group that more rounds of iteration were not required as no further meaningful changes in the results were anticipated.

differing fiscal reactions would have seriously undermined the comparability of the results. However, in line with their usual practices, modellers were free to choose whether to keep nominal or real government consumption constant. In some countries government expenditure is typically fixed in nominal terms for a few years ahead so that a shock which alters the deflator for government expenditure may affect real magnitudes. In other cases it may be more realistic to envisage nominal government expenditure adjusting somewhat to ensure that real magnitudes are unchanged.

Despite the need for a wide-ranging agreement on the details of these simulations, many differences remained in model design. For example, some models incorporated – to a greater or lesser extent - forward-looking behaviour in financial markets and the real economy. As regards some financial variables, such as asset prices, it was also agreed to let each team decide on whether to endogenise such factors and thus the way and extent to which the shock would impact on such variables.

5. Method of identifying the channels

The channel decomposition has been implemented according to the so-called 'flag approach', which is described in Altissimo *et al.* (2001). The method is designed to provide a decomposition which minimises the unexplained residual and which does not alter the relative magnitude of the various channels. In particular, Altissimo *et al.* claim that this approach guarantees an exact decomposition when applied to linear models, without regard to the expectations formation mechanism. The implementation of the method requires that a number of simulations equal to the number of channels are run. It may be briefly described as follows:

1. identify all the J channels whose empirical relevance is to be quantified;
2. for each channel, introduce a dummy variable taking the values 0 or 1 ("flag" variable). There will then be as many flag variables as the number of channels. The flag variable associated with the *j-th* channel will be set equal to 1 only in the simulation aiming at isolating the effects that transit through the *j-th* channel; it will be set equal to 0 in all other simulations;

3. replace the policy variable, wherever it appears in the model, with an expression given by the sum of two components: (i) the shocked policy variable times the flag variable corresponding to that channel; (ii) the baseline policy variable times the difference between 1 and the flag variable;

4. run *J* simulations; in each of them, only one flag variable is set equal to 1, whereas all others are set to zero. Hence, in each simulation, the endogenous variables are left free to react (because simultaneity is fully taken into account), but can directly respond to the policy shock only through the channel corresponding to the active flag variable.

A possible alternative decomposition suggested in Mauskopf (1990) takes a different route. Mauskopf selected a set of sub-blocks of the Federal Reserve's MPS model, that were then successively simulated in isolation. The sub-blocks were designed in such a way so that each of them included just one direct transmission mechanism of monetary policy, and a number of indirect mechanisms, chosen so as not to interfere with the mechanisms activated by other channels. While allowing for possible within-block simultaneity, such an approach clearly neglects, by design, any simultaneous interactions among sub-blocks. As a result of not fully taking the simultaneous nature of the model into account, this approach generates an unexplained residual, being the difference between the overall effect and the sum of the effects associated with all individual transmission channels.

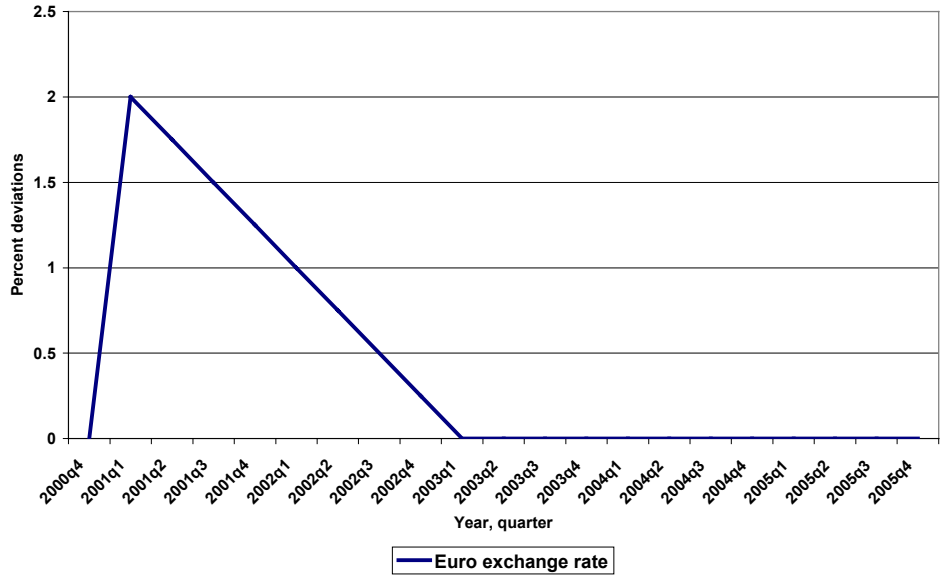
The fact that the sum of individual effects does not match the overall effect of a monetary policy shock on the economy may not be such a serious drawback. If the approach described above turned out not to bias the ranking of the various channels and the relative size of the associated effects on output and prices, then that approach would still be largely reliable for all practical purposes. However, the approach proposed in Mauskopf (1990) can be shown to result, in general, in an incorrect ranking of the channels of transmission of monetary policy. For this reason there was a preference to use the ‘flag’ method.

6. The results

6.1 Introduction

This section presents the results of the simulation exercise. The outcomes relate to full model simulations based on the common design of the experiment, and using the 'flag' method of channel decomposition discussed in the previous section.

Figure 6.1: Exchange rate and interest rates profiles



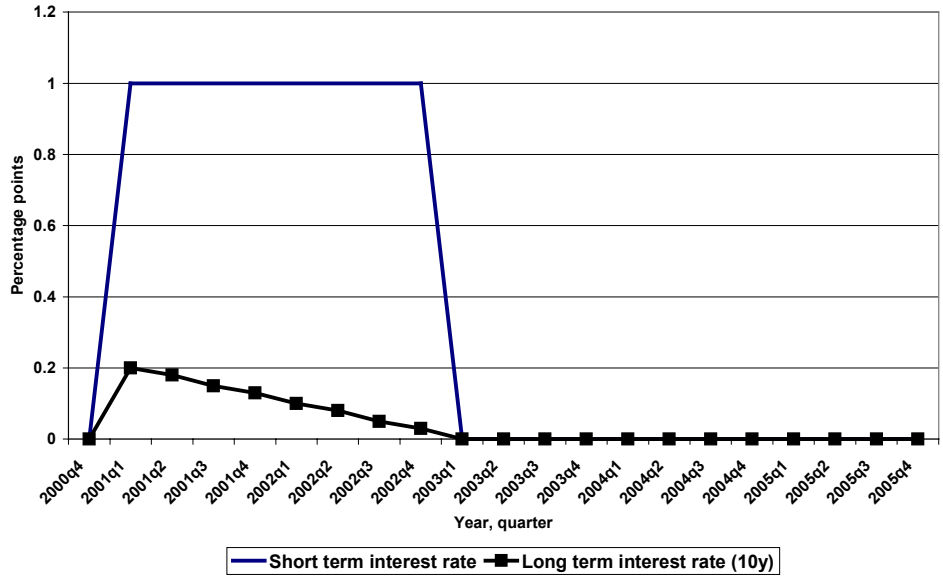


Figure 6.1 summarises the common assumptions underlying the response pattern of the euro exchange rate vis-à-vis non-euro countries and the long-term interest rate (10 year bond). These assumptions entail that the interest rate shock is accompanied by an appreciation of the euro with respect to non-euro currencies of 1.6per cent on average in the first year and 0.6per cent in the second. However, the size of this change in terms of the national effective exchange rates depends on the weights of the non-euro countries in the international trade of the respective economies. Table 6.1 reports on these weights.

Table 6.1: Weights of the non-euro countries in the nominal effective exchange rates

	Average Weights
Belgium	35%
Germany	57%
Greece	30%
Spain	40%
France	32%
Ireland	70%
Italy	40%
Luxembourg	55%
Netherlands	45%
Austria	40%
Portugal	27%
Finland	60%

The results across countries share some general features coming from the characteristics of macro-econometric models. A widely shared property of these models is that the effect of a change in prices, to the extent that it affects the system of relative prices, has in general a more immediate effect on volumes (real activity) than the reverse. Aside from the impact of the price of imported goods and services and competitors' prices, domestic prices are basically a function of unit labour costs. Due to the productivity cycle, a change in activity is slow to fully materialise into a change in employment and therefore to impact on wages through a change in the unemployment rate (Phillips effect). But different treatments of expectations may alter this scheme. In the Italian case, for instance, the expectation channel speeds up the working of the Phillips curve and contributes to shorten

the average length of output fluctuations. In the Bundesbank model domestic prices are also determined by a weighted average of forward-looking and backward-looking inflationary expectations, and by changes in the euro area equilibrium price level P-Star as well as by deviations of P-Star from the German price deflator of domestic demand. Nonetheless, on the basis of this general property, a distinction can be made between the exchange rate channel, that will have a direct impact on prices, and the other conventional channels that will have a direct impact on components of domestic demand and hence indirectly on prices. Section 6.2 gives a more detailed discussion of price effects, while section 6.3 focuses on real activity. Various graphs illustrate the main trust of the results whilst more detailed background tables are presented in the Annex.

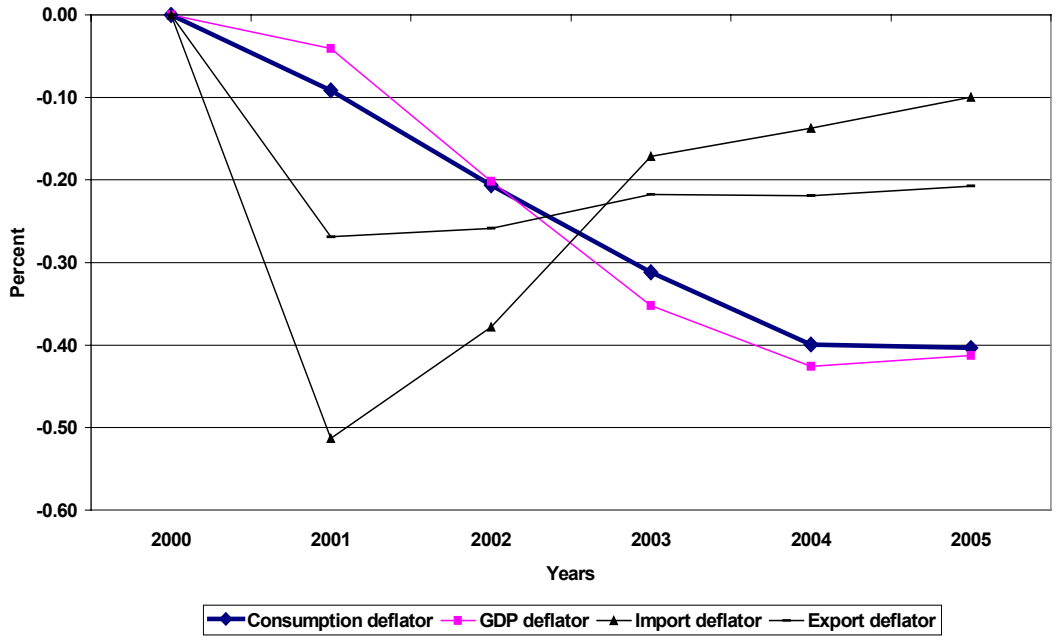
6.2 Impact on prices

In macro-econometric models the wage-price system forms a highly interdependent system of equations. In many models - but not all - the consumption and investment deflators are modelled using quasi-definitional relationships, making them a weighted average of the output price and the import price, the weights being respectively the shares of domestically produced and imported goods and services. The import price is basically a weighted average of a competitors' price index and the domestic output deflator. The former gives the average price at which the foreign suppliers sell their goods and services. The latter reflects the domestic market conditions. This set-up gives a key role to the output deflator, since it impacts both on the other domestic deflators and to some extent on the import deflator. This output deflator is usually modelled as a mark-up over unit labour costs. Finally, to close the system, the nominal wage is itself a function of a price variable – either the output price itself or the consumption price or a combination of the two – labour productivity, and the unemployment rate.

Figure 6.2 provides an overview of the aggregate effects for the euro area on four price variables: the deflators of private consumption, real GDP, exports and imports. Figures 6.3 and 6.4 show the effects of the monetary policy shock on the private consumption deflator according to the national models, the aggregate euro area response (see line "aggregate"), as well as the response according to the AWM.

In the *first* year the impact of the shock is smaller on the GDP deflator than on the trade deflators. The internal developments driving the response of the GDP deflator have not yet had a noticeable effect, whereas the exchange rate shock has a direct and immediate impact on the trade deflators. Everything being equal, the higher the degree of openness, the bigger the impact on import prices. The difference in the magnitude of the change in domestic prices compared to trade prices leads to a loss of competitiveness. [20] The biggest impact on the GDP deflator (see Table A.1 in the Annex) appears in Finland (-0.44%). This is actually the country in which the labour market reacts most rapidly to the exchange rate. To some extent, a similar pattern can also be seen in Greece (-0.15%). In Italy, there is also a reduction in the GDP deflator (-0.16%), but in this case it is linked to a fall in the mark-up in order to reduce the losses in competitiveness created by the exchange rate response. As expected, the trade deflators are modified more markedly in the countries that are more open to trade with non-euro area countries (Ireland and Finland).

Figure 6.2 Effect on aggregate euro area prices according to NCB models[21]



[20] Because of the delayed response of employment to the change in activity, the reduction in activity can lead to a temporary fall in productivity compared to baseline, leading to a rise in unit labour costs and hence, in some cases, in the output price.

Figure 6.3 Effects on consumption deflator in various countries: moderate effects

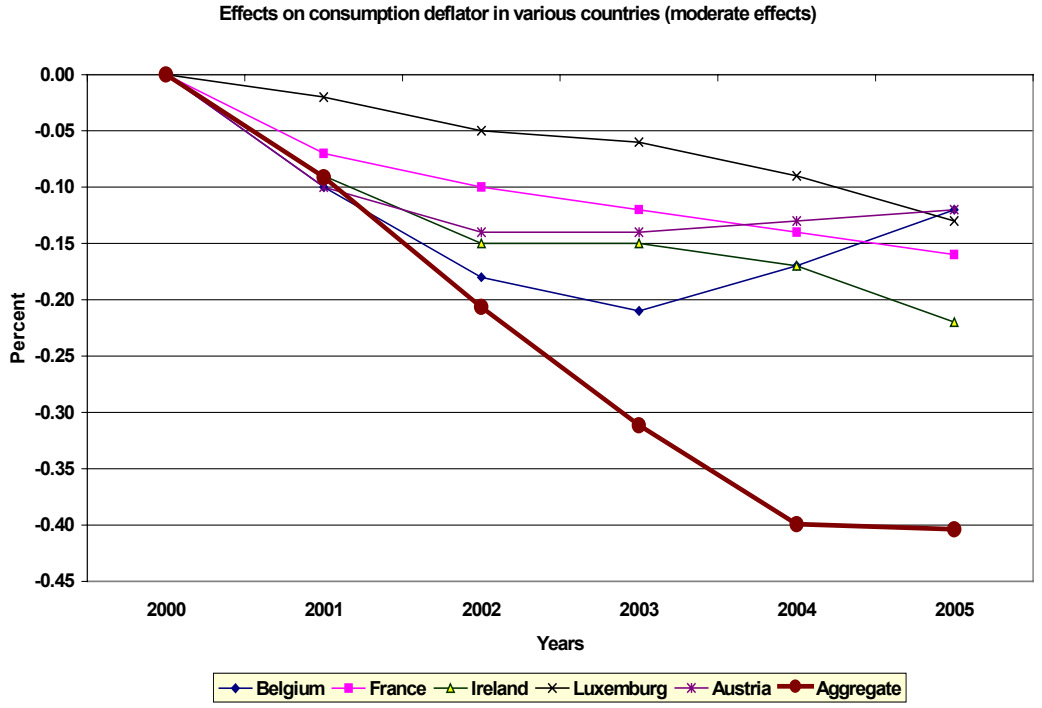
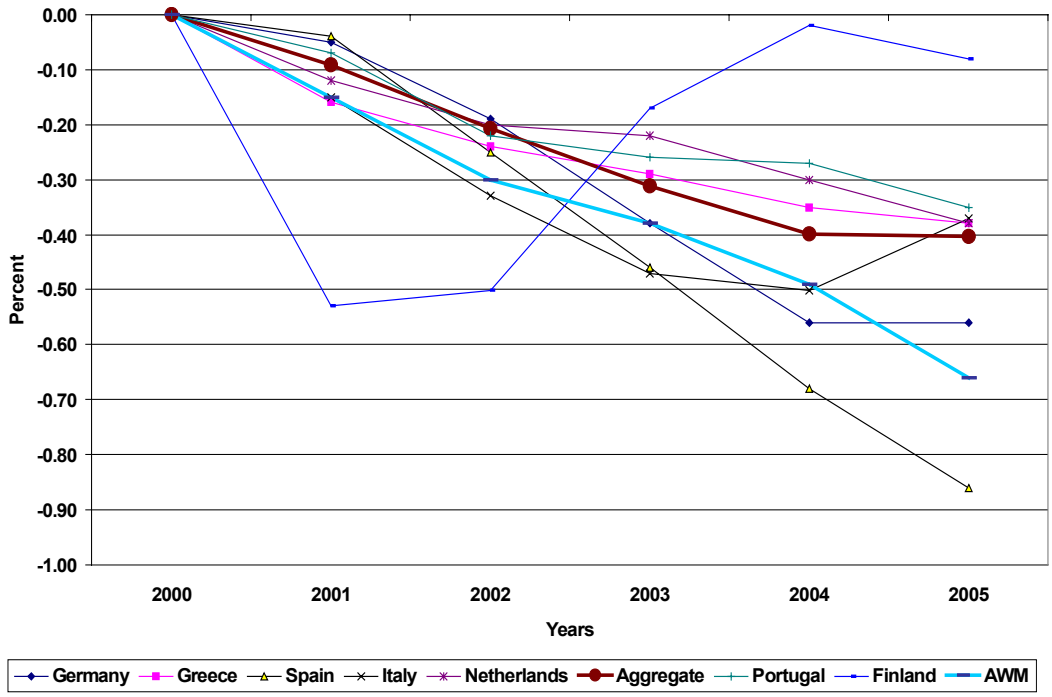


Figure 6.4 Effects on consumption deflator in various countries: larger effects



[21] Aggregate effects for the euro area are GDP-weighted averages of national effects.

The change in the consumption deflator in the first year is almost exclusively due to the exchange rate response and its impact on the import deflator. This is confirmed by the decomposition which shows that other channels of transmission make at most a negligible contribution to the change in the consumption deflator. Figure 6.5 reports on the decomposition of the aggregate effects on the private consumption deflator according to the NCB models. TOT is the total effect, EXR the contribution of the exchange rate channel, SUB the substitution channel, UCC the user cost of capital channel, INC the combined income and cash-flow channel, WEA the wealth channel, OTHER the combined contribution of the monetary channel (Germany) and the expectations channel (Italy), and SPILL the contribution of the international spilllovers. In Finland, Greece and Italy, where there is a more substantial impact on the GDP deflator in the first year, the response of the consumption deflator is also bigger than in the other countries (Table A.1).

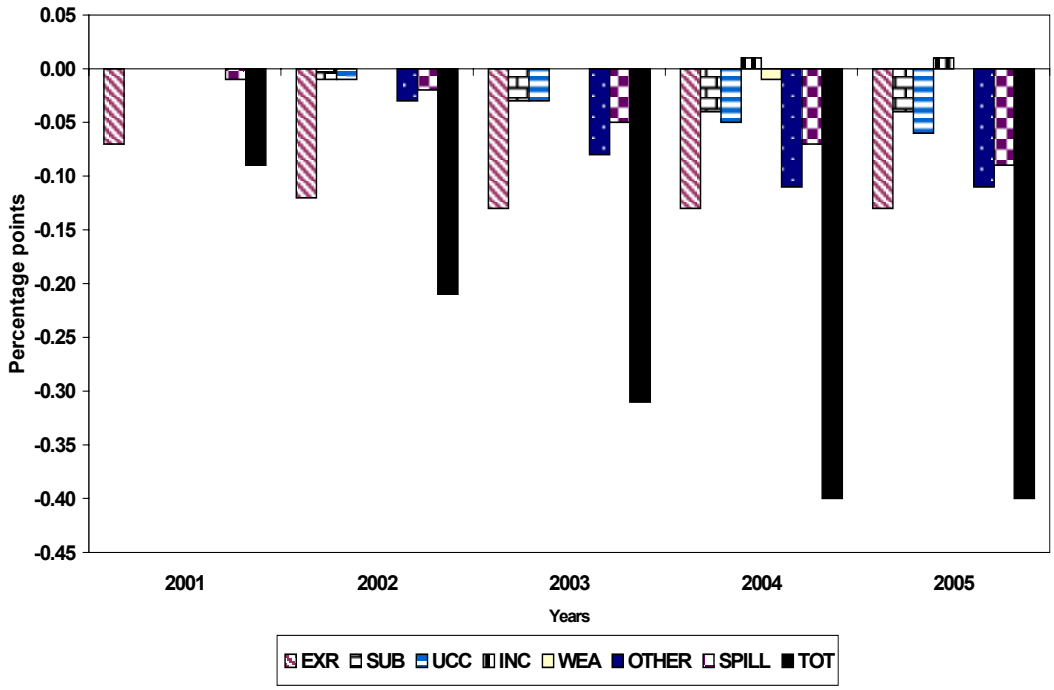
As of the *second year*, the GDP deflator deviates more markedly from baseline in all countries except Finland (Table A.1). These changes in turn influence both the trade deflators and the domestic deflators. Nevertheless the channel decomposition still shows that, for the most part, the exchange rate channel remains the main driving force of the consumption deflator in the second year. In Germany and Italy where country-specific channels have been taken into account, these channels actually start to a play a role in the second year. Most notably, in Germany the monetary channel accounts for one third of the fall in consumer prices (Table A.3 in the Annex). International spillover effects, although slowly gaining weight, are not very important at this stage.

The interest rates and the exchange rate are back to baseline at the beginning of the *third year*. This represents a "counter shock" but, strictly speaking, only for the short term rate since, both the long term rates and the exchange rate already moved gradually back to baseline over the first two years (Figure 6.1). The dynamics are then influenced by the evolution of these variables and the lagged effects triggered in the preceding years. The GDP deflator and the import deflator exhibit different behaviour (Figure 6.2). In most countries, the GDP deflator continues to fall below baseline whereas the import deflator tends to move back towards the baseline. In around half of the countries, the consumption deflator continues to decline relative to the baseline as in these cases it is mainly driven by the GDP deflator at this stage of the propagation mechanism. However, in some other countries, the

influence of the import deflator allows a stabilisation of the consumption deflator (most notably Austria, Luxembourg, France, Ireland, the Netherlands). In Finland, the rapid dynamics at work when the shock occurred in the first year are also at work when the exogenous variables are back at baseline: the GDP deflator rapidly returns to the baseline as from the third year and also drives the consumption deflator in this direction.

In addition, the channel decomposition shows that in some countries, even if the exchange rate channel is still important, the other channels have started to take over (Figure 6.5 and Table A.3). As already indicated, this is clearly evident in Germany, where the monetary channel accounts for the main part of the price effects, and in Italy, where the expectations channel is an important transmission mechanism for prices. But it is also true for Spain (cost of capital channel), France and Portugal (substitution channel). In Finland, the contribution of the exchange rate channel is partly offset by the contributions of other channels that exert inflationary pressures, essentially the cost-of-capital and substitution channels. International spillovers are becoming more and more important with an aggregate contribution similar in size to that of the combined substitution and cost-of-capital channel.

Figure 6.5 Decomposition of the effects on the consumption deflator (NCB models)



There is no general consensus about what drives prices from *the fourth year onwards*. In most countries, the exchange rate channel still plays an important role. In fact on average it remains the largest single contributor over the simulation horizon (Figure 6.5). International spillovers are gaining further weight, as is the monetary channel in the German case. The substitution channel makes a significant contribution, notably in Greece, Ireland, France and Portugal, and the cost-of-capital channel in Spain and Italy. In general, the income/cash flow and the wealth effects do not play any significant role in the determination of prices, except in the case of Italy where the former explains part of the drift in the price level. To some extent this will be due to the offsetting effects of changes in interest rates on the income of lenders and the cash flow of borrowers as discussed in section 2.

To sum up:

- There are a number of countries for which price effects are relatively moderate (Figure 6.3), with consumer prices falling 0.25per cent below base at the maximum. This group includes Belgium, France, Ireland, Luxembourg and Austria. There is another group showing price effects close to or exceeding the aggregate response (Figure 6.4). This group includes the other countries and the AWM also belongs to this category.

- The impact on the consumption deflator is on average around -0.1per cent in the first year. Finland is the only country where a particularly marked short term impact arises (-0.5%). The aggregate maximum response of consumer prices is 0.4per cent below base, an effect that is reached in the fourth year. Note that this aggregate timing profile masks differences between countries. In the models for Greece, Spain, France, Ireland, Netherlands, Portugal and the AWM prices still seem to be decreasing in the fifth year, although in many cases the price falls are becoming less marked. In Belgium price levels reach their maximum reduction in year 3, in Luxembourg in year 2, and in Finland in year 1. In the long run price responses are relatively large for AWM (-0.7%) and Spain (-0.9%).

- Overall the exchange rate channel is the most important channel throughout the simulation period, very much so in the short run. In the medium term other channels become marked as well: the monetary channel in the German case; the expectations

channel in the Italian case; the cost of capital channel in Spain and Italy; and the substitution channel in Greece, Ireland, France and Portugal. Moreover, international spillovers provide a significant propagation mechanism in all countries.

6.3 Impact on real activity

Figures 6.6 and 6.7 summarise the main findings in terms of real GDP. In the *first year* real GDP falls on average by 0.2 per cent relative to baseline (see line "aggregate"). The maximum average reduction in real GDP of 0.4per cent is obtained in year 2 of the simulation. Thereafter, with nominal short-term interest rates returning immediately to base, real GDP also starts its return to baseline, which is reached by year 5 (2005). These "aggregate" results contrast with those obtained by the AWM. The latter show a stronger impact of the monetary policy action, both in the short and in the medium term. The AWM requires a monetary policy rule to be in place in order to speed the adjustment towards a stable equilibrium. Without such a rule kicked in after year 2, the experiment initiates a quite persistent deflationary spiral in the AWM. In this respect, the AWM differs from most of the national models.

Figure 6.6 Effects on real GDP in various countries: moderate effects

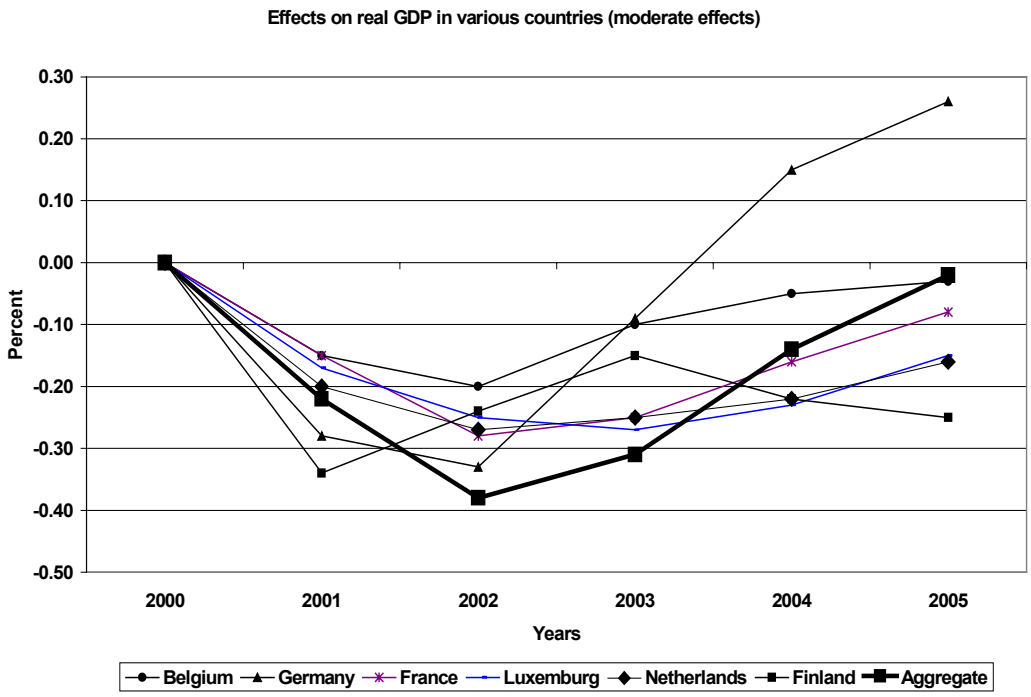
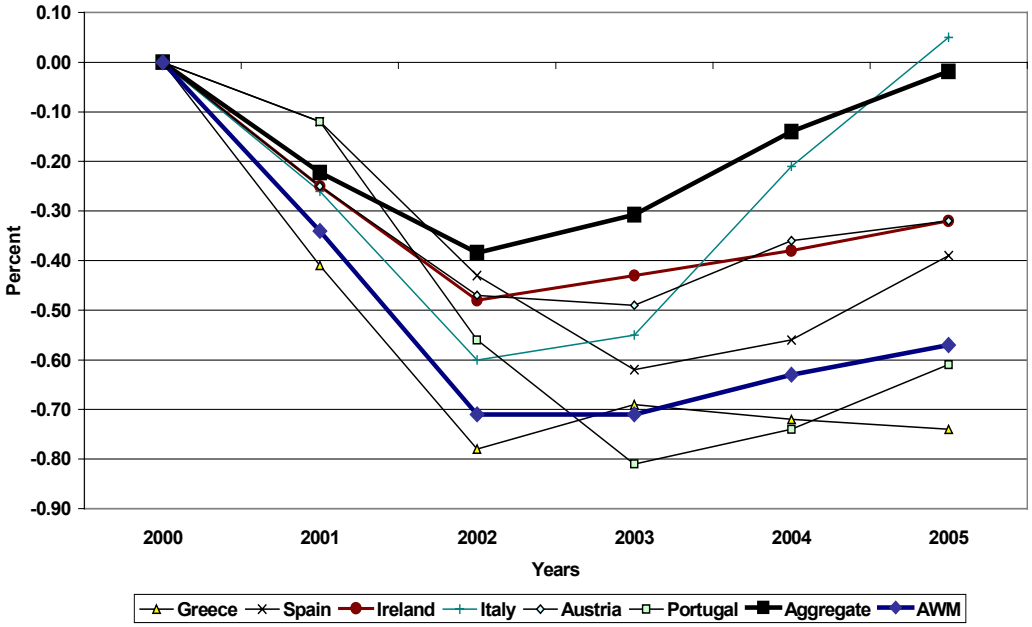


Figure 6.7 Effects on real GDP in various countries: larger effects



Across countries differences may be noted. Effects on real GDP are modest for Belgium, Germany, France, Luxembourg, Netherlands and Finland, with maximum effects in absolute terms under 0.35per cent (see Figure 6.6 and Table A.2). A second group of countries with maximum effects on real GDP in the range between -0.35 per cent and -0.6 per cent consists of Spain, Ireland, Italy and Austria. Finally, in Greece and Portugal the fall in real GDP is largest: close to 0.8 per cent below base (Figure 6.7). Differences also occur in terms of timing and cycling. In 7 out of 12 euro-countries the negative impact on real GDP is strongest in year 2. In Finland the impact on output is faster, whereas in Portugal, Austria, Luxembourg and Spain it takes about three years to reach the maximum response. Cycles, in the sense that the initial reduction in real GDP bottoms out and output starts moving to above baseline levels within five years, occur in Germany and Italy.

Further insights into the underlying similarities and differences across countries may be obtained by looking more closely at the importance of the various transmission channels. Figure 6.8 does so for the aggregate GDP effects, whereas Table A.4 in the Annex presents

the results for individual country models and the AWM.[22] This gives rise to the following observations:

- The exchange rate channel plays its main role in the short run. In the first year it is the main contributor to the fall in real GDP in Germany, Luxembourg, Netherlands, Austria, Finland, and Belgium. It is second important and still quite substantial in Greece, Spain and Italy. In Ireland the exchange rate channel, while not very prominent in the first year, gains strength in the medium term.

- The direct substitution channel is particularly strong in Greece, France, Ireland and Portugal, dominating the results in the short and medium term. As of year 2002 it is also very substantial in Austria, surpassing in size the other channels from 2003 onwards.

- In the short run, the cost-of-capital channel is the most important channel in Italy, Spain (together with the exchange rate channel) and the AWM. In the longer term it is the main factor driving the results in Italy, Netherlands, Ireland, and Finland. In the AWM it dwarfs the other channels in the medium and long run.

- The income/cash flow channel tends to be rather weak in the short run and mitigates the reduction in real GDP in most countries up to and including year 3. In comparison with other countries it is fairly strong in Italy.

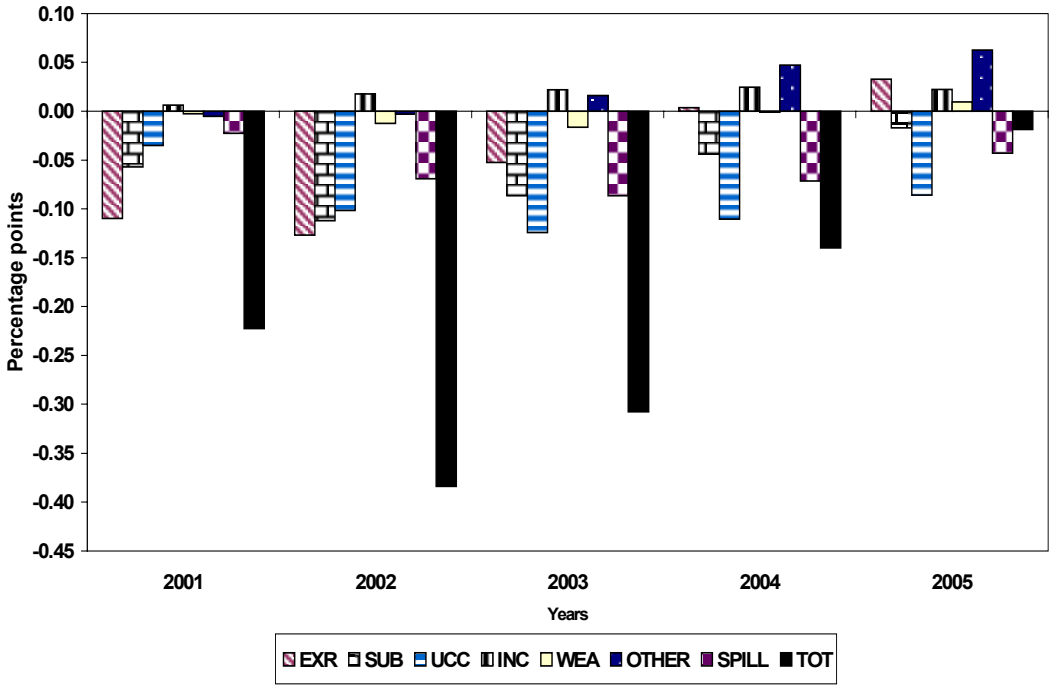
- The wealth channel is also rather weak, with the exception of Austria (and to some extent also Italy) where it contributes substantially to the fall in GDP. In Germany, Greece, Spain, France and Portugal the wealth channel is absent.

- The monetary channel in the German model triggers a relatively fast return of real GDP to baseline due to a fall in prices in connection with lower holdings of M3. In the Italian model, the expectations channel, implying that monetary policy actions directly affect inflation expectations, plays a modest role but nonetheless helps to bring real activity levels back to base fairly quickly.

[22] The residual channel is relatively large in the AWM as it includes interest rate effects on inventories.

- International spillovers enhance the size of the output effects significantly as from 2002. In 2003 they account for one third of the total aggregate effect on real GDP in the euro area.

Figure 6.8 Decomposition aggregate effects on real GDP according to NCB models



The aggregate effect on euro-area output (and prices) suggests that on average the exchange rate channel is crucial in the process of monetary policy transmission in the short-run. This is confirmed by the AWM simulations (Table A.4 in the Annex). In the medium and long term, the cost-of-capital channel and the direct substitution channel account for most of the downward pressure on real GDP. Another perhaps remarkable result, given the increased importance of stocks and bonds in portfolios of households and firms, is the fairly modest role of the wealth channel. In the case of France, the issue is controversial and the evidence supporting the existence of a wealth channel is not very robust (see Artus et. al. (1989) and Bonnet and Dubois (1995)). The absence of wealth as a separate transmission channel in Germany and the fact that in France wealth does not seem to be very important at least in the short run finds support in a recent IMF-study by Edison and Sloek (2001). Another reason why wealth and valuation effects would be moderate anyway, even if

accounted for in the models, relates to the fact that, by assumption, the interest rate shock is a temporary one so that forward looking long-term interest rates respond only partially, mitigating the impact on asset prices.

The same mechanism weakens the strength of the substitution and cost-of-capital channels in Germany and Netherlands, where long rates rather than short rates affect investment and private consumption. This is in line with the fact that firms and households in these countries prefer long-term over short-term debt as a means of financing spending (see Table 6.2). A further argument for Germany is the existence of 'relationship banking' entailing close ties between corporations and banks, such that changes in the cost of capital have a relatively small impact. Further evidence on this is documented in Ehrmann and Worms (2001).

Table 6.2 Fraction of short-term financing 1999/2000

	BE	DE	GR	ES	FR	IR	IT	LX	NE	AT	PT	FI
Households	7	8	29	35	7	n.a.	20	n.a.	6	n.a.	9(*)	n.a.
Fims	30	22	70	7	28	n.a.	57	n.a.	34	n.a.	20(*)	73

(*)< 1 year.

Table 6.3 Net interest received 1999/2000 (% of disposable income)

	BE	DE	GR	ES	FR	IR	IT	LX	NE	AT	PT	FI
Households	8	-3	4(*)	1	1	n.a.	5	n.a.	-7	n.a.	0	-3
Fims	-131	n.a.		-28	-42	n.a.	-30	n.a.	-27	n.a.	-4(#)	-26

(*) households plus firms; (#) % of GDP.

Qualitatively, the contribution of the income/cash flow channel of transmission depends on the financial position of households and firms (Table 6.3). In Italy, the positive contribution of the income channel reflects the fact that households are net creditors, and raise consumption in response to the increase in interest payments received on holdings of government debt. In Finland and Netherlands, households are net debtors. Hence, the income channel tends to reinforce the drop in output in these countries.

Effects on private consumption are notably strong in countries where the substitution channel plays an important role (Table A.2 in the Annex). This holds for Greece and

Portugal, but also for Austria and Ireland and to some extent France. In Belgium consumption is slightly but persistently above base, which is due to the net creditorship of households feeding into the substitution channel (note that the income and substitution channels are difficult to disentangle in the case of Belgium).[23] In Finland the exchange rate and substitution channels push private consumption above base in year 2 and 3, respectively. In Italy higher net interest payments to households are the main factor driving private consumption above base as of 2004. In Germany the monetary channel makes prices fall faster than wages in the medium term, thereby fostering consumer spending. All in all, effects on private consumption tend to be relatively weak in Belgium, Netherlands, Germany and Finland. This is due in part to the moderate change in long-term interest rates.

Capital formation (including inventories) falls in the short run relative to the baseline, as a result of both higher cost-of-capital and lower economic activity, the latter initiated by the reduction in exports and private consumption. In nearly all cases, the cash-flow channel appears negligible. Exceptions are Belgium where the cash flow effect on investment is quite important (Table A.4). This is in line with the net debtorship of Belgian firms (see Table 6.3). In the longer term lower cash flows also explain a substantial part of the negative investment response in the Netherlands (2005), where firms too are net debtors. The distribution of the national responses of investment is very wide, with maxima ranging between -0.3 per cent for Germany and France and -3.6 per cent for Italy and Ireland. In between, there is a group of countries for which the impact is moderate (Belgium, Netherlands and Finland) and another group with maxima close to -2 per cent (Greece, Spain, Austria, Luxembourg and Portugal). Negative responses of investment are very persistent in the AWM and the models for Greece and Ireland.

The impact of the monetary policy shock on *unemployment* is a crucial element in the process of monetary policy transmission on prices in the medium and long term. Unemployment acts on prices via the wage formation process (see Section 6.2). In most countries the supply of labour is largely determined by demographics and thus the

[23]In the Belgian model, the consumption is derived from the Blanchard-Buiter type of model, in which the Ricardian equivalence does not hold.

development of unemployment closely reflects movements in labour demand. The latter responds with some lag to changes in output and real product wages. Hence, countries with moderate GDP effects such as Germany, France, and Belgium also show relatively small changes of unemployment. In the case of the Netherlands discouraged worker effects on labour supply help to mitigate the impact on unemployment. Similar mechanisms are at work in Italy, Portugal and Spain. The overall impact on unemployment is relatively large in Spain, followed by Greece, Austria and Finland. In the latter country employment seems to react much less sluggishly to output.

6.4 Comparison with BIS (1995)

As in the present study, the channels of monetary transmission and their similarities and differences across countries were the main focus of attention in the central bank model comparison project carried out under the auspices of the BIS in 1994. As touched upon in the Introduction, the design of the current exercise and that of the BIS comparison project have one important point in common, namely the type of shock under investigation: a two-year 100 basis points increase in the policy controlled interest rate, after which the policy rate immediately returns to baseline. Another common element should be mentioned too: a full-model decomposition method was used to identify each single transmission channel.

However, there are also many important differences in the two exercises. In the BIS project, the response pattern of long-term interest rates reflected the NCB's model equation explaining the representative long-term rate; now, the expectations theory of the term structure, with no change in risk premia, is taken as a common workhorse to pin down the response of the long rates. In the BIS project, it was assumed that the nominal exchange rates between the ERM countries Germany, France, the Netherlands, Belgium and Luxembourg remain fixed.[24] Moreover, with the exception of Italy the response pattern of the effective exchange rate is much more backward looking than it is now. Furthermore, the individual country results in the BIS project did not include international spillover effects.

[24] The exchange rate of the Austrian shilling, which at the time did not yet participate in the ERM, also remained fixed vis-á-vis these countries. The Italian lira was floating freely.

There are also differences in coverage of the results as this study presents results for all individual euro-countries (and for the euro-area as a whole), while of this group the BIS project included only Germany, France, Italy, Spain, the Netherlands, Belgium and Austria (in addition to several non euro area countries). Furthermore, BIS (1995) only presents a channel decomposition for the effects on real GDP, not for prices or other variables.

Because of the differences in the design of the exercise, and because the NCB models have undergone changes in the course of time which may partly reflect changes in economic and financial structures but also revisions of old data (ESA95), the comparison with the BIS project has to be mainly qualitative in nature. In order not to complicate the analysis any further the comparison will be based on the results excluding the international spillover effects.

Table 6.4 Total effect on real GDP: BIS (1995) versus WGEM (2001)

	Year 1	Year 2	Year 3	Year 4	Year 5
Germany					
- BIS (1995)	-0.15	-0.37	-0.30	-0.07	0.09
- WGEM (2001)	-0.26	-0.26	0.00	0.20	0.26
France					
- BIS (1995)	-0.18	-0.36	-0.20	0.01	0.07
- WGEM (2001)	-0.13	-0.22	-0.15	-0.07	-0.02
Italy					
- BIS (1995)	-0.32	-0.53	-0.22	-0.08	-0.13
- WGEM (2001)	-0.24	-0.55	-0.50	-0.16	0.10
Spain					
- BIS (1995)	-0.05	-0.02	0.03	-0.17	-0.17
- WGEM (2001)	-0.10	-0.37	-0.51	-0.44	-0.28
Netherlands					
- BIS (1995)	-0.10	-0.18	-0.15	-0.09	-0.01
- WGEM (2001)	-0.17	-0.18	-0.13	-0.10	-0.08
Belgium					
- BIS (1995)	-0.03	-0.12	-0.23	-0.15	0.02
- WGEM (2001)	-0.10	-0.21	-0.13	-0.07	-0.08
Austria					
- BIS (1995)	-0.08	-0.14	-0.02	0.04	0.01
- WGEM (2001)	-0.21	-0.38	-0.37	-0.26	-0.25

Table 6.4 summarises the effects of a monetary policy shock on real GDP for BIS (1995) and the current exercise (WGEM (2001)).

With the exception of Germany and Italy, the negative output effects tend to be more persistent now compared to BIS (1995). As to the magnitude of the negative output effects, these are substantially larger now for Austria and Spain than in 1994/1995. In the case of Spain and Austria, new models have replaced old ones which hampers the assessment of the underlying causes. The German results now show a much faster recovery effect than in BIS (1995), which is due to a significantly stronger impact of the monetary channel in the latest model version (Bundesbank, 2000).

Table 6.5 Effect on consumption deflator: BIS (1995) versus WGEM (2001)

	Year 1	Year 2	Year 3	Year 4	Year 5
Germany					
- BIS (1995)	-0.03	-0.14	-0.31	-0.45	-0.55
- WGEM (2001)	-0.05	-0.17	-0.34	-0.50	-0.47
France					
- BIS (1995)	-0.05	-0.15	-0.25	-0.32	-0.32
- WGEM (2001)	-0.06	-0.08	-0.08	-0.09	-0.10
Italy					
- BIS (1995)	-0.48	-0.64	-0.53	-0.17	0.10
- WGEM (2001)	-0.14	-0.29	-0.43	-0.44	-0.29
Spain					
- BIS (1995)	-0.26	-0.54	-0.66	-0.95	-1.28
- WGEM (2001)	-0.03	-0.22	-0.39	-0.55	-0.67
Netherlands					
- BIS (1995)	-0.13	-0.35	-0.35	-0.23	-0.27
- WGEM (2001)	-0.10	-0.17	-0.16	-0.19	-0.21
Belgium					
- BIS (1995)	-0.14	-0.48	-0.79	-0.81	-0.55
- WGEM (2001)	-0.02	-0.07	-0.15	-0.29	-0.44
Austria					
- BIS (1995)	-0.02	-0.04	-0.05	-0.04	-0.02
- WGEM (2001)	-0.08	-0.11	-0.09	-0.07	-0.06

The response of the effective exchange rate plays a crucial role in understanding the effects on consumer prices and the differences in this respect between WGEM (2001) and BIS (1995), in particular in year 1 and 2 (Table 6.5). For countries such as Germany and Austria, the initial reaction of the exchange rate is more marked than in BIS (1995). As a result, consumer prices in these countries initially move more, despite the fact that in Austria the pass-through of exchange rate changes to consumer prices is somewhat smaller now. In the Netherlands, the initial price effects are smaller now because of a more sluggish pass-through of import prices in consumer prices. Another important factor driving the results relates to the fact that the euro-area is larger than the ERM-area was in 1994, so that effective exchange rates, and therefore import prices, exhibited a larger response in the BIS exercise than they do in the present setting. This explains the differences for Italy and also for Spain. In the case of Germany, the increased importance of the monetary channel in the new model version explains why prices stay down as much as in BIS (1995) despite the fact that the effective exchange rate moves less as of year 2.

6.5 A closer look at the individual channels

Due to the extension of ERM and its development into EMU, one would expect the overall response of the effective *exchange rate* of each of the individual countries to be less marked than it was in BIS (1995). For Italy, France and Belgium, this indeed seems to be the case as can be inferred from Table A.5.1 in the Annex. However, for several reasons this result does not hold for all countries. First, in the BIS exercise the exchange rates responded according to the respective model equations; now, the response is an agreed upon common element in the design of the exercise. This difference in approach seems to be important for understanding the Austrian results, which are now somewhat more marked. Second, in the BIS exercise the nature of the exchange rate response was backward looking, reaching its largest deviation from base after eight quarters; now, the exchange rate immediately jumps to its largest deviation from base in the first quarter. Therefore, the response of the effective exchange rate may be even larger in the first year, despite the larger currency union. This holds for Germany and the Netherlands. In addition to this, the first year differences in the German outcomes reflect changes to the modelling of export volumes and import prices.

In Austria and France, the *direct substitution* channel on consumption (Table A.5.2) is now a stronger contributor to the reduction in real GDP than it was in BIS (1995). For France, this may be explained by the fact that the substitution effect only became significant after the financial liberalisation of the late eighties. In the model of Austria, the interest rate elasticity of private consumption in higher in the new model, which is in line with the increased interest-rate consciousness observed in Austria over the last decade. In Belgium and Germany, the substitution channel has become less important compared to BIS (1995). Again, this will be partly due to the smaller response of the long-term interest rate in the current exercise. More importantly, in the German model, the long rate has replaced the short rate in the equation for private consumption since BIS (1995).

For the cost-of-capital channel a very diverse picture emerges (Table A.5.3). For three euro-countries, the importance of the cost-of-capital channel has become stronger since BIS (1995): Italy, Spain and the Netherlands. In the new model for Spain, investment is much more sensitive to changes in interest rates. In the Netherlands the same is true for non-residential investment. In the case of France, the cost-of-capital channel is now only operating on inventory formation, which may explain why, overall, it has become weaker. For Germany, the differences are not very marked: the scope for monetary transmission via the cost-of-capital channel still is virtually absent. One aspect which may underpin the likeliness of the reduced importance of the cost-of-capital for Belgium, France and Austria vis-à-vis BIS (1995) is that, in the design of the current exercise, long-term interest rates generally move less than they did in BIS (1995).

The *income and cash flow* channels now play a quantitatively very limited role in the monetary policy transmission process (Table A.5.4). For Belgium, Germany, and France this channel has become less important compared to BIS (1995). For Belgium and Germany, the positive income effects reported in BIS (1995) no longer exist. The disappearance of the income channel in Germany reflects the fact that household debt has increased considerably since the BIS exercise. For Belgium, this development is in line with the fact that firms have been cumulating more net debt over the last decade. In the case of France, one could point to increased household indebtedness. For Italy, Spain, the Netherlands and Austria no significant changes in the strength of the income/cash channel have occurred since BIS (1995).

Wealth channels are lacking in the current NCB models for Spain, Germany and France (Table A.5.5). For the latter two, this was also the case in BIS (1995). In the case of Italy, a wealth channel has now been included in the BIQM model, while it was absent in 1994/1995. In the case of Austria, the wealth channel has become more important and now explains about one third of the fall in real GDP. The more prominent role of wealth in Austria is related to the broadening of the wealth concept compared to BIS (1995), now comprising money holdings, bonds and shares rather than money holdings only. Moreover, interest rate changes affect the valuation of shares. In the Netherlands, the wealth channel lost some of its force compared to BIS (1995). This is due to the fact that asset prices mainly react to changes in long-term interest rates, which now respond less. For the case of Germany, one may add that only in the second half of the 1990s shareholding became more important and wide-spread among the larger public. In the process of the reform of the pension system, which will imply tax benefits for investment into private funds, this development is expected to progress further. All in all, an increase in the importance of wealth as a channel of monetary policy transmission is a possibility to consider for the near future. This holds not only for Germany but also for other euro-countries.

All in all, for reasons mentioned before it is difficult to draw precise conclusions from the comparison with BIS (1995). Despite the difficulties, some tentative statements could be made, however. First, in a number of countries the positive output effect of the income channel has reduced or disappeared altogether. Quite generally, the reason for this is a weakening of the financial position of households and firms. Second, one conclusion one perhaps would have expected beforehand to come out of this comparison exercise would be an increased importance of the wealth channel. However, this conclusion can only be drawn for Austria. For Germany and France the empirical evidence in support of (increased) wealth effects is weak or not very robust yet. This may be due to the fact that the holdership and valuation of wealth components have been changing rapidly only since the mid 1990s.

7. Validation of the results

To assess the validity of the results presented in the previous sections, it is worth considering whether they are consistent with the stylised facts reported in the literature, how

they compare with other studies and also whether or not cross-country differences in the channel decomposition correspond to differences in the economic structures.

According to Bernanke and Gertler (1995), who mainly rely on VAR evidence, the following four stylised facts characterise the response of the economy to monetary policy shocks: (i) a monetary tightening induces, in the short run, a sustained decline in both output and the price level; (ii) the fall in aggregate demand leads the contraction in production, with inventories acting as a buffer; (iii) the component of aggregate demand which responds more promptly to the deterioration in financing conditions is residential investment, with spending on consumer goods (including both durables and non-durables) close behind; (iv) fixed business investment eventually declines, but its fall lags behind the contraction in both aggregate demand and supply.[25]

Most of these features are to be found in the WGEM results. In all countries output and prices decline after the rise in interest rate: the contraction persists for a few years, despite the fact that the policy action is by assumption a temporary one. With regard to the consumption deflator, in no case there is any evidence of a "price puzzle" although a cost-push effect is apparent in Germany, where the increase in production costs pushes the GDP deflator temporarily above the baseline. The lead-lag relationship between demand and supply is implicit in the theoretical underpinnings of all models, which are demand-driven in the short run. However, the response of production to the policy impulse is prompt and non-negligible, so that inventories fall as well. So does consumer spending, which is, in a few countries (Greece, France Austria and Portugal), the component of aggregate demand which drives the slowdown in economic activity. The only significant difference with the picture described by Bernanke-Gertler involves capital accumulation: business investment rather than residential investment is most immediately and to the greatest extent affected by the rise in interest rates. Whether this is a shortcoming is open to question. It may well reflect the fact that within the euro area the elasticity of investment to the cost of capital is quite high,

[25] Such a response of fixed business investment – in terms both of timing and size - is possible if capital accumulation has a zero (or very low) elasticity to the cost of capital or, alternatively, if the cost of capital is not affected, even in the short-run, by changes in the monetary policy stance: investment would then move only because of the accelerator effect and because there exists a credit channel. This is by no means a piece of undisputed empirical evidence. Taylor (1995), for instance, forcefully rejects this claim.

which is witnessed by other empirical studies as well, for instance BIS (1995) and Taylor (1993).

The WGEM results also square satisfactorily with the evidence presented in Peersman and Smets (2001). A direct comparison is difficult because the size of the shock and the implied profile of the interest rate[26] are different. However a number of similarities are worth mentioning. Output starts declining well in advance of prices and reaches its low by the end of the first year; by allowing for a more sustained monetary shock, the trough would be reached between the second and third year. Prices respond more sluggishly and continue to fall until the fourth or fifth year (depending on the model considered). Both features replicates quite closely the pattern outlined in the WGEM experiment. Back of the envelope calculations suggest that the size of the output contraction (and possibly the fall in the price level) is quite comparable as well.[27]

Concerning channel decomposition, Table 7.1 reports the ranking for each country and lists a few variables which may be used to cross-check the WGEM results. The ranking is computed in terms of the (cumulated) output losses caused by each channel in the first five years of the simulation.

The variables included in the table are: (1) intra EU-15 exports as a share of GDP; (2) the labour share of employees in employment; (3) short-term firm liabilities; (4) the import share; (5) net interest received/paid by households as a share of disposable income. The first indicator is related to the intra-area trade and should therefore be high for countries where the spillover effect is large. The (complement to the) labour share proxies for the size of the self-employed sector, which is likely to be less regulated and more affected by cyclical conditions. The larger the share of self-employment, the larger labour income uncertainty

[26] The monetary policy shock, corresponding to one standard deviation, lasts one period and amounts to roughly 30 basis points. The working of the policy rules induces some persistence in the response of the interest rate, which returns to the baseline only in the third period.

[27] The "proof" goes as follows. Consider model 1 and graph 1 at page 6 and focus on the first year, that is the time interval in which output reaches a trough. In the first year, output is on average 0.07-0.08 p.p below the baseline, while the rate of interest is 20 basis points above. Exploiting the linearity of the VAR model, a shock of 100 basis points should yield a decline in output of around 0.4 p.p., which is more or less the size of the trough in real GDP which is obtained in the average of the euro area, as shown in table A.2. The same thought-experiment replicated for the price level confirms the similarity of the results derived with two very different methodologies.

and the more important the consumption channel.[28] The proportion of firm liabilities which are short-term helps to quantify the extent of firms' exposure to a tightening of financing conditions. The import share measures the direct effect of the exchange rate on prices (and hence competitiveness, net trade and output). The last indicator, net interest payments received by households (as a share of disposable income), measures how important is the income effect of a change in interest rates.

TABLE 7.1 - OUTPUT RESPONSE: CHANNEL DECOMPOSITION

	E	C	S	W	I	SP	Intra EU-15 export share		Labour share‡		Short term debt (firms) ¥		Import share ¤		Interest inc. (households)€	
							1990	2000	1990	2000	1990	2000	1990	2000	1990	2000
Belgium	2	3	5	6	4	1	44.6	52.4	0.52	0.51	33.2	29.8	59.2	76.1	9.8	7.7
Germany	1	4	3		5	2	16.9	15.5	0.56	0.54	26.6	22.1	23.2	31.7	-1.2	-2.5
Greece	3	4	1			2	6.5	4.7	0.32	0.33		70.3	22.3	32.1		
Spain	3	1	4		5	2	7.7	14.2	0.50	0.50		50.0	17.8	32.5	3.1	0.5
France	4	3	1		5	2	11.3	14.4	0.52	0.52	21.4	27.8	18.9	27.2	0.7	1.3
Ireland	2	1	3	5		4	39.1	47.2	0.46	0.40	19.3	20.8	51.0	87.3		
Italy	4	1	2	6	5	3	9.6	11.4	0.46	0.41	65.7	57.2	21.1	28.5	10.4	5.4
Netherlands	3	2	5	4	6	1	33.4	31.4	0.51	0.51	23.8	34.0	47.8	61.4	-3.9	-7.1
Austria	2	5	1	4	6	3	17.5	20.8	0.53	0.52		28.7	35.4	47.6		
Portugal	4	2	1		5	3	18.6	17.5	0.44	0.42		19.8	36.4	45.9		0.4
Finland	2	1	5	6	4	3	11.7	20.0	0.56	0.47		73.0	26.3	35.1		-2.6

The channels have been coded as follows: E stands for exchange-rate, C for the cost-of-capital, S means substitution-in-consumption, W is wealth, I is income and SP stands for spillover. In a few cases, figures for Belgium aggregates data for Luxembourg as well.
‡ The starting value for DE is 1991, for LUX, the NL, PT and GR is 1995; the ending figure for PT is 1999.
¥ The starting value is 1991 for DE, 1995 for FR and 1994 for NL; the ending date for AT is 1999; for ES the figure refers to credit which is at variable rates and for PT debt are considered short-term if they come due within a year.
¤ The starting for PT is 1995.
€ Net interest payments as a share of GDP, households. The starting value for DE is 1993 and for NL is 1995; the ending figure for DE, BE and IT is 1999.

A few results are worth some comments. As expected the spillover channel is relevant for Belgium, Luxembourg and the Netherlands, where intra area trade is a large share of GDP; despite its openness to trade, this is not true for Ireland, presumably reflecting the high trade with the United Kingdom for which no spillover effects are included. Self-employment is large in Greece and Portugal, where the consumption channel is the most important, and is sizeable also in Italy and Ireland, where it ranks second and third respectively. The share of short-term liabilities in firms' balance sheet helps explaining the magnitude of the cost-of-capital channel in Finland, Italy, Spain and the Netherlands, but does not help to explain the results for Greece. The import share supports the influence of the exchange rate in Belgium

[28] For the share of self-employment to affect the size of the substitution-in-consumption channel rather than being just an amplification mechanism which does not influence the ranking of the channels, it is necessary that self-employed are more sensitive to interest rates changes, possibly through the interaction of liquidity constraints and precautionary saving (see next paragraph).

and Ireland, but is not helpful in understanding why this channel is so important in Germany. Finally, the amount of interest payments to households is consistent with the relatively larger role played by the income channel in Belgium.

The comparisons and assessments made in this section seek to determine whether the WGEM results, which are driven by the specification choices made by model builders, are also in line with the economic structures of the EMU countries. The evidence, whilst admittedly noisy and far from conclusive, appears to be quite supportive.

8. Policy issues

As discussed in the Introduction, the move to a single currency and the centralisation of the responsibility of policy decisions has made the understanding of the transmission mechanism a key issue. As shown clearly in Tables A.1 and A.2, the responsiveness of output and prices to a standardised increase in the monetary policy instrument is not uniform across the euro area; on the contrary, there appear to be clusters of countries which are quite homogeneous internally but different from each other. The same evidence is presented in Figure 8.1, where a scatter plot of the maximum deviation from baseline of real GDP and the consumption deflator is reported. The location of Greece and Portugal in the right-lower bottom of the graph contrasts sharply with the position of Germany, Finland and the Netherlands in the left-upper top.

The distinction, made in a number of previous studies, between a "core" region and a "periphery", is partially consistent with the WGEM evidence, though in fact more than two clusters are present. At one extreme there are countries, like Germany, Benelux and Finland, where a policy tightening is effective in curbing inflationary pressures at mild costs in terms of output losses, while there are other EMU members, in particular Greece and Portugal, where the increase in interest rates engenders a marked contraction in economic activity and only a modest restraint on price developments. The remaining countries are located in-between, though somewhat closer to the core region.[29]

[29] The results for Austria and Spain do not fit convincingly the core-periphery story. Austria seems to share the same features as Greece and Portugal, namely low responsiveness of prices coupled with large fluctuations

The literature on European integration has tended to explain this dichotomy between core and periphery by relying on supply side factors. Bean (1992), for instance, stresses the relevance of intra-industry trade, which is especially prevalent within the core, while there is more inter-industry trade between the core and the periphery. The WGEM results provide a somewhat different picture, with both demand and supply factors playing a prominent role, as one can see by comparing the polar cases of Germany on one hand and Portugal on the other hand. Indeed, if one looks at the response of real compensation, there is no evidence from the models that the wage bargaining framework works more smoothly in the former country. Both consumer and producer real wages remain persistently above the baseline notwithstanding the contraction in output and the ensuing rise in the unemployment rate, while in the latter country the fall in real wages begins only a few quarters after the policy tightening. Though somewhat surprising, the evidence for Germany may reflect a large degree of nominal inertia, which dominates the downward impulse on wages engendered by labour market slackness. Any presumption that goods markets are more flexible in Germany than in Portugal is also not supported. Indeed, the mark-up falls more in the latter than in the former country.

What could instead account for the unfavourable inflation-unemployment trade-off may be the adjustment of labour demand. Average productivity turns out to be much more procyclical in the periphery than in the core, implying that the extent of labour hoarding is much larger within the first set of countries, possibly because of more stringent hiring and firing restrictions or because of the large share of self-employed workers. A low output elasticity of employment tends to dampen fluctuations in marginal costs and hence to reduce the incentives for firms to set new prices, which in turn shifts the burden of adjustment on real variables. This interpretation is consistent with the evidence presented in OECD (1999), which reports that Southern Europe is characterised by a more stringent employment protection legislation than the rest of the continent, though the gap is gradually reducing.[30]

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in real variables; Spain, on the contrary, qualifies in all respects as a core country, with smoothly-working labour and goods markets. In both cases, priors and external evidence seem to be somewhat at odds with the picture which is drawn from the results of the WGEM experiment.

[30] See OECD (1999), page 66.

In addition. demand factors appear to have some importance: in both Portugal and Greece, consumer spending is quite sensitive to changes in the real rate of interest and the effects of the monetary policy tightening persist even after the initial shock has been reversed. Similar considerations apply also to Austria, another country in which the dominant channel in monetary policy transmission is intertemporal substitution in consumption. With regard to this high interest-rate elasticity of households' spending, some role might be played by the interaction of capital market imperfections and precautionary saving.[31]

There is less support for the existence of marked asymmetries between euro area countries when the sacrifice ratio[32] is used to gauge the cost of disinflating, as shown in Figure 8.2. Only Austria and, to a lesser extent, Greece clearly stand out as the countries in which the unemployment loss required to curb inflationary pressures is higher, but for the other countries, Portugal included, the existing differences do not seem to be dramatic.

[31] In principle, one would expect that liquidity constraints affect consumption by increasing the sensitivity to changes in disposable income and by reducing interest rate elasticity. However, the reverse could also happen. Indeed, if individuals face a limit to the amount they can borrow and such limit is not fixed but depends on collateral or income prospects, households which are net borrowers could be forced to revise their expenditure plans when the monetary policy stance changes. Liquidity constraints could also interact with prudence, since the inability to borrow when financing conditions deteriorate is an additional reason to accumulate precautionary balances, which could induce some spurious correlation between interest rate and consumption if the precautionary motive is not properly accounted for in the econometric specification of household spending. The latter factor could also contribute to explain why consumption does not rebound when the monetary policy tightening ceases.

[32] There is no an unambiguous way to compute the sacrifice ratio. Cecchetti and Rich (1999), for instance, use the ratio of the long-run response to a monetary policy shock of the level of log-output to the long-run response of the level of inflation, which requires an assumption that both variables are unit-root processes. In our experiment, the level on inflation is in general not permanently affected by a change in the short-term interest rate and no long-run multipliers are available. As a consequence, attention was focused on the first five years of the simulation and the following additional assumptions were used: (1) the sacrifice ratio was computed with reference to domestic channels only; (ii) as a price variable, the GDP deflator was considered; (iii) the cumulated unemployment loss was computed for the first j* years, where j* is the year in which the unemployment rate reaches a peak; (iv) the cumulated reduction in inflation is computed for the first k* years, where k* is the year in which the level of the GDP deflator reaches a trough.

Figure 8.1 Real GDP – consumption deflator trade-off

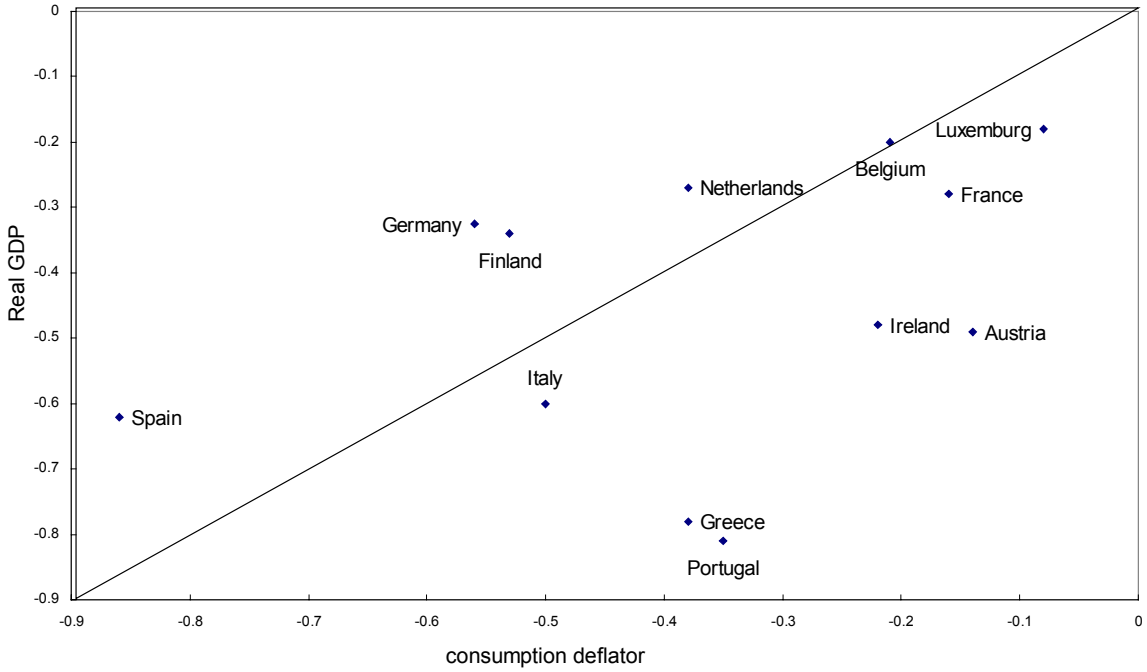
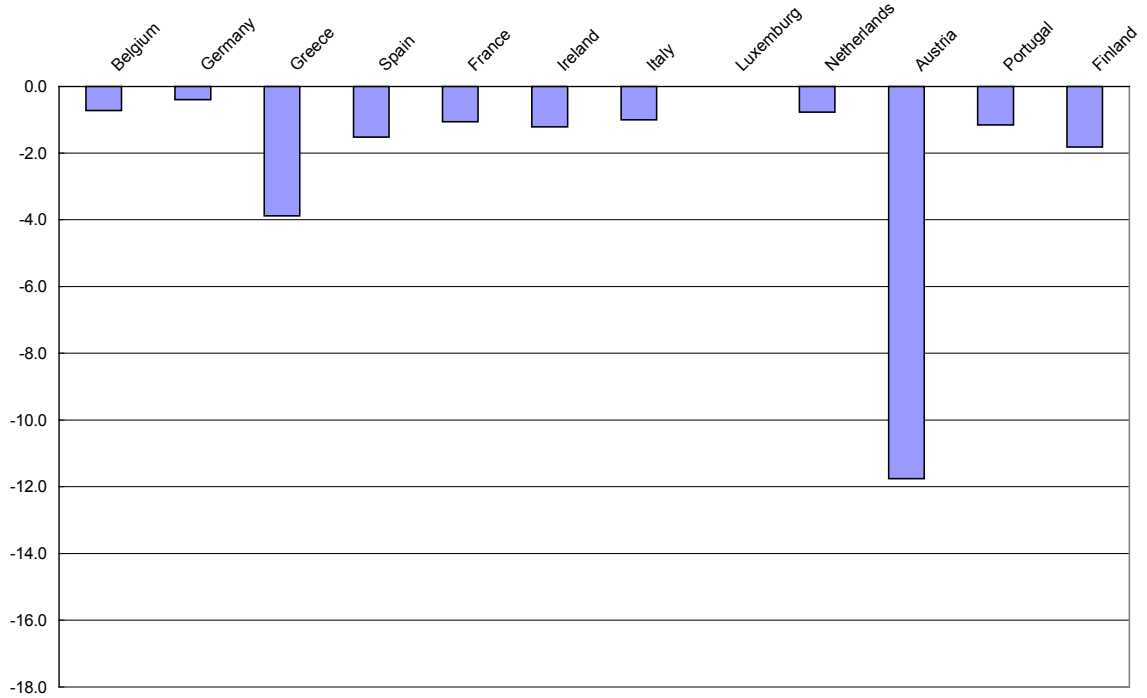
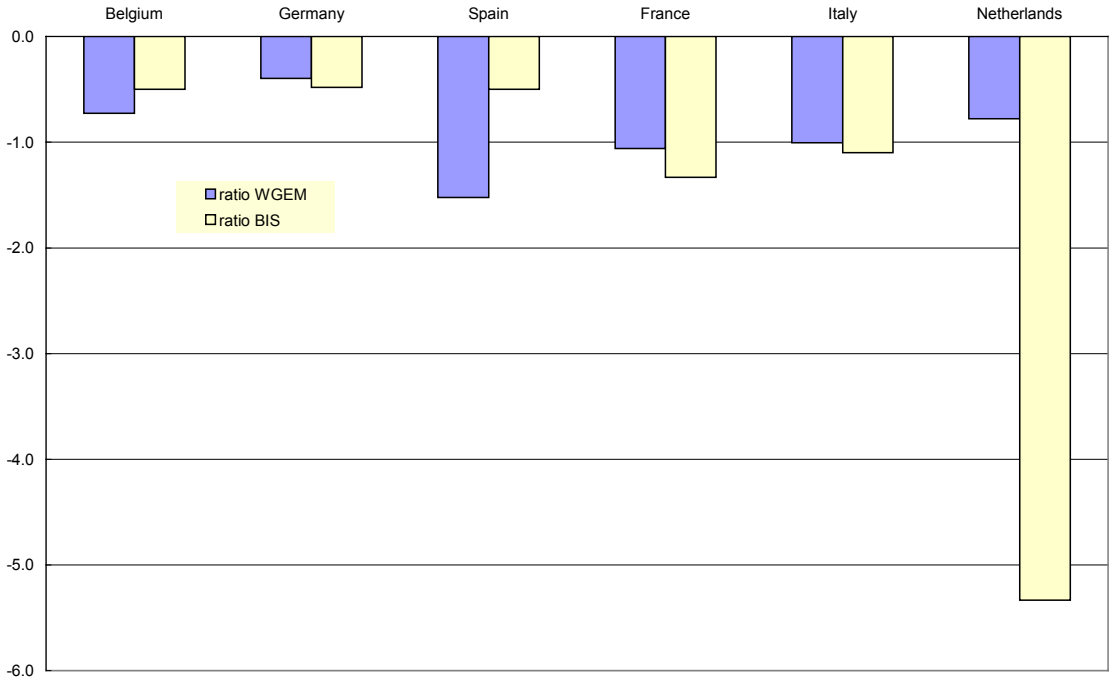


Figure 8.2 Sacrifice ratios: WGEM



In addition, when compared with the BIS results (Figure 8.3), in the majority of cases the trade-off seems to have evolved in a favourable way in the last few years, possibly as a consequence of the process of integration which has taken momentum in the last decade and because of the shift to a more coordinated policy.

Figure 8.3 Sacrifice ratios: WGEM vs BIS



9. Conclusions

This paper has reported the results of a common monetary policy experiment that has been undertaken using large scale macroeconomic models at the disposal of the ECB and the NCBs of the Eurosystem. As discussed in the paper, considerable attention has been paid to undertaking a genuinely comparable experiment that reflects the existence of monetary union.

On the basis of the results provided a number of conclusions can be drawn. In terms of the impact of monetary policy on output, a 1 percentage point rise in short-term interest rates is found to have a maximum aggregate effect in NCBs models of –0.4 per cent after 2 years.

The maximum aggregate effect on prices is also –0.4 per cent but in this case it occurs 2 years later, reflecting the fact that in most of the models prices react more slowly and largely in response to changes in economic activity. The dominant channel of transmission in the first two years – both in terms of its impact on output and on prices – is the exchange rate channel. However, in terms of the impact on output, from the third year of the simulation onwards the user cost of capital channel becomes dominant.

Inevitably these aggregate responses mask some notable variations in the results across models. There are variations with respect to both the magnitude and timing of the effects and the relative contributions of each of the channels of transmission. The impacts on output and prices were found to be relatively modest in Belgium, France, the Netherlands and Luxembourg and relatively strong in Italy, Spain, Portugal and Greece. Some models also incorporate special features not included in the other models – for example the P-star effects included in the German model – which lead to differences in the patterns of adjustment to the monetary policy experiment. There are also noteworthy differences between the aggregate results from the NCBs models and the results from the ECBs Area Wide Model. The latter tends to show more pronounced and prolonged impacts of monetary policy on economic activity and prices.

Tables

Table A.1 Effects on prices

Consumption deflator

	2001	2002	2003	2004	2005
Belgium	-0.10	-0.18	-0.21	-0.17	-0.12
Germany	-0.05	-0.19	-0.38	-0.56	-0.56
Greece	-0.16	-0.24	-0.29	-0.35	-0.38
Spain	-0.04	-0.25	-0.46	-0.68	-0.86
France	-0.07	-0.10	-0.12	-0.14	-0.16
Ireland	-0.09	-0.15	-0.15	-0.17	-0.22
Italy	-0.15	-0.33	-0.47	-0.50	-0.37
Luxemburg	-0.02	-0.05	-0.06	-0.09	-0.13
Netherlands	-0.12	-0.20	-0.22	-0.30	-0.38
Austria	-0.10	-0.14	-0.14	-0.13	-0.12
Portugal	-0.07	-0.22	-0.26	-0.27	-0.35
Finland	-0.53	-0.50	-0.17	-0.02	-0.08
Aggregate	-0.09	-0.21	-0.31	-0.40	-0.40
AWM	-0.15	-0.30	-0.38	-0.49	-0.66

GDP Deflator

	2001	2002	2003	2004	2005
Belgium	-0.05	-0.14	-0.18	-0.15	-0.11
Germany	0.05	-0.14	-0.41	-0.57	-0.53
Greece	-0.15	-0.26	-0.35	-0.42	-0.45
Spain	-0.02	-0.23	-0.47	-0.72	-0.92
France	-0.04	-0.12	-0.18	-0.21	-0.23
Ireland	-0.02	-0.12	-0.24	-0.34	-0.40
Italy	-0.16	-0.38	-0.53	-0.49	-0.33
Luxemburg	-0.08	-0.14	-0.14	-0.17	-0.15
Netherlands	0.01	-0.20	-0.30	-0.36	-0.39
Austria	-0.09	-0.18	-0.15	-0.12	-0.12
Portugal	-0.07	-0.25	-0.29	-0.30	-0.39
Finland	-0.44	-0.46	-0.15	-0.01	-0.09
Aggregate	-0.04	-0.20	-0.35	-0.43	-0.41
AWM	-0.10	-0.31	-0.44	-0.57	-0.76

Table A.1 Effects on prices (ctd.)

Import deflator

	2001	2002	2003	2004	2005
Belgium	-0.51	-0.41	-0.18	-0.11	-0.06
Germany	-0.38	-0.27	-0.06	-0.08	-0.09
Greece	-0.66	-0.36	-0.16	-0.16	-0.13
Spain	-0.51	-0.58	-0.27	-0.12	-0.08
France	-0.41	-0.34	-0.18	-0.12	-0.10
Ireland	-0.82	-0.56	-0.17	-0.09	-0.06
Italy	-0.78	-0.52	-0.36	-0.31	-0.14
Luxemburg	-0.07	-0.12	-0.10	-0.13	-0.16
Netherlands	-0.71	-0.30	-0.04	-0.07	-0.08
Austria	-0.41	-0.22	-0.10	-0.10	-0.10
Portugal	-0.35	-0.40	-0.13	-0.10	-0.12
Finland	-0.74	-0.57	-0.25	-0.16	-0.11
Aggregate	-0.51	-0.38	-0.17	-0.14	-0.10
AWM	-0.96	-0.67	-0.23	-0.24	-0.35

Export deflator

	2001	2002	2003	2004	2005
Belgium	-0.43	-0.34	-0.16	-0.09	-0.05
Germany	-0.02	-0.06	-0.11	-0.15	-0.20
Greece	-1.20	-0.60	-0.20	-0.21	-0.21
Spain	-0.22	-0.30	-0.29	-0.37	-0.45
France	-0.26	-0.23	-0.17	-0.17	-0.17
Ireland	-1.16	-0.48	0.09	-0.06	-0.16
Italy	-0.42	-0.50	-0.52	-0.44	-0.24
Luxemburg	-0.08	-0.09	-0.06	-0.08	-0.08
Netherlands	-0.43	-0.34	-0.16	-0.15	-0.14
Austria	-0.28	-0.19	-0.10	-0.09	-0.09
Portugal	-0.34	-0.33	-0.21	-0.16	-0.18
Finland	-0.73	-0.50	-0.13	-0.03	-0.07
Aggregate	-0.27	-0.26	-0.22	-0.22	-0.21
AWM	-0.51	-0.62	-0.46	-0.52	-0.70

Table A.2 Effects on real activity

Real GDP

	2001	2002	2003	2004	2005
Belgium	-0.15	-0.20	-0.10	-0.05	-0.03
Germany	-0.28	-0.33	-0.09	0.15	0.26
Greece	-0.41	-0.78	-0.69	-0.72	-0.74
Spain	-0.12	-0.43	-0.62	-0.56	-0.39
France	-0.15	-0.28	-0.25	-0.16	-0.08
Ireland	-0.25	-0.48	-0.43	-0.38	-0.32
Italy	-0.26	-0.60	-0.55	-0.21	0.05
Luxemburg	-0.17	-0.25	-0.27	-0.23	-0.15
Netherlands	-0.20	-0.27	-0.25	-0.22	-0.16
Austria	-0.25	-0.47	-0.49	-0.36	-0.32
Portugal	-0.12	-0.56	-0.81	-0.74	-0.61
Finland	-0.34	-0.24	-0.15	-0.22	-0.25
Aggregate	-0.22	-0.38	-0.31	-0.14	-0.02
AWM	-0.34	-0.71	-0.71	-0.63	-0.57

Real private consumption

	2001	2002	2003	2004	2005
Belgium	0.02	0.04	0.03	0.01	0.00
Germany	-0.07	-0.06	0.01	0.11	0.14
Greece	-0.44	-0.85	-0.64	-0.52	-0.43
Spain	-0.02	-0.21	-0.40	-0.40	-0.37
France	-0.18	-0.34	-0.27	-0.17	-0.10
Ireland	-0.29	-0.37	-0.11	-0.03	-0.04
Italy	-0.15	-0.37	-0.17	0.29	0.51
Luxemburg	-0.21	-0.49	-0.63	-0.65	-0.61
Netherlands	-0.08	-0.11	-0.18	-0.23	-0.22
Austria	-0.11	-0.50	-0.79	-0.76	-0.71
Portugal	-0.31	-0.94	-1.34	-1.29	-1.06
Finland	-0.23	0.05	0.12	-0.08	-0.21
Aggregate	-0.12	-0.23	-0.19	-0.06	0.01
AWM	-0.27	-0.58	-0.54	-0.43	-0.37

Table A.2 Effects on real activity (ctd.)

Real total investment

	2001	2002	2003	2004	2005
Belgium	-0.32	-0.55	-0.15	0.10	0.07
Germany	-0.20	-0.29	-0.11	0.09	0.18
Greece	-0.35	-1.59	-1.92	-2.27	-2.57
Spain	-0.53	-2.00	-2.36	-1.85	-1.16
France	-0.10	-0.29	-0.34	-0.27	-0.09
Ireland	-0.96	-2.80	-3.55	-3.51	-3.48
Italy	-0.53	-2.50	-3.57	-2.21	-0.78
Luxemburg	-0.10	-1.41	-2.00	-1.12	-0.63
Netherlands	-0.37	-0.86	-1.00	-0.78	-0.42
Austria	-0.95	-1.86	-1.42	-0.93	-0.79
Portugal	-0.45	-1.89	-2.13	-1.19	-0.85
Finland	-1.02	-1.05	-0.63	-0.65	-0.66
Aggregate	-0.34	-1.04	-1.22	-0.80	-0.39
AWM	-0.81	-2.37	-2.96	-2.63	-2.42

Unemployment rate (% points)

	2001	2002	2003	2004	2005
Belgium	0.02	0.06	0.06	0.03	0.02
Germany	0.05	0.09	0.14	0.13	0.03
Greece	0.11	0.20	0.23	0.28	0.31
Spain	0.06	0.31	0.52	0.52	0.38
France	0.02	0.07	0.11	0.08	0.04
Ireland	0.01	0.05	0.10	0.13	0.15
Italy	0.01	0.06	0.16	0.20	0.15
Luxemburg	0.00	0.00	0.00	0.00	0.00
Netherlands	0.05	0.12	0.14	0.12	0.08
Austria	0.08	0.22	0.32	0.31	0.28
Portugal	0.01	0.07	0.16	0.16	0.10
Finland	0.17	0.26	0.08	0.05	0.07
Aggregate	0.04	0.11	0.17	0.17	0.11
AWM	0.10	0.39	0.58	0.62	0.58

Table A.3 Decomposition price effects, including spillovers (% deviations from baseline)

Decomposition consumption deflator 2001

	Total effect	Exchange rate	Substitution	Cost of capital	Income	Wealth	Monetary channel	Expectations	Spillover	Sum	Discrepancy
Belgium	-0.10	-0.06	0.00	0.01	0.00	0.00			-0.02	-0.07	-0.03
Germany	-0.05	-0.03	0.00	0.00	0.00		-0.01		0.00	-0.04	-0.01
Greece	-0.16	-0.13	0.00	0.00					-0.03	-0.16	0.00
Spain	-0.04	-0.03	0.00	0.00	0.00				0.00	-0.03	-0.01
France	-0.07	-0.06	-0.01	0.00	0.00				-0.01	-0.08	0.01
Ireland	-0.09	-0.08	0.00	0.00		0.00			0.00	-0.08	-0.01
Italy	-0.15	-0.13	0.01	-0.01	0.00	0.00		-0.01	-0.01	-0.15	0.00
Luxemburg	-0.02	-0.01	0.00	0.00		0.00			-0.01	-0.02	0.00
Netherlands	-0.12	-0.10	0.00	0.00	0.00	0.00			-0.01	-0.11	-0.01
Austria	-0.10	-0.07	0.00	-0.01	0.00	0.00			-0.02	-0.10	0.00
Portugal	-0.07	-0.06	0.00	0.00	0.00				-0.01	-0.07	0.00
Finland	-0.53	-0.41	-0.02	-0.03	-0.01	0.00			-0.06	-0.53	0.00
Aggregate	-0.09	-0.07	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.09	0.00
AWM	-0.15	-0.13	-0.01	-0.02	-0.01	-0.01				-0.18	0.03

Decomposition consumption deflator 2002

	Total effect	Exchange rate	Substitution	Cost of capital	Income	Wealth	Monetary channel	Expectations	Spillover	Sum	Discrepancy
Belgium	-0.18	-0.08	0.00	0.02	0.00	0.00			-0.07	-0.13	-0.05
Germany	-0.19	-0.09	-0.02	0.00	0.00		-0.07		-0.01	-0.19	0.00
Greece	-0.24	-0.17	-0.01	0.00					-0.06	-0.24	0.00
Spain	-0.25	-0.17	-0.01	-0.04	0.00				-0.03	-0.25	0.00
France	-0.10	-0.06	-0.02	0.00	0.00				-0.02	-0.10	0.00
Ireland	-0.15	-0.13	-0.01	0.00		0.00			-0.01	-0.15	0.00
Italy	-0.33	-0.20	0.00	-0.04	0.01	0.00		-0.06	-0.03	-0.32	-0.01
Luxemburg	-0.05	-0.02	0.00	0.00		0.00			-0.02	-0.04	-0.01
Netherlands	-0.20	-0.16	0.00	-0.01	0.00	0.00			-0.03	-0.20	0.00
Austria	-0.14	-0.08	-0.01	-0.01	0.00	-0.01			-0.03	-0.14	0.00
Portugal	-0.22	-0.15	-0.02	-0.01	0.00				-0.05	-0.23	0.01
Finland	-0.50	-0.40	0.00	0.00	-0.02	0.01			-0.09	-0.50	0.00
Aggregate	-0.21	-0.12	-0.01	-0.01	0.00	0.00	-0.02	-0.01	-0.02	-0.20	0.00
AWM	-0.30	-0.18	-0.03	-0.12	0.00	-0.01				-0.34	0.04

Decomposition consumption deflator 2003

	Total effect	Exchange rate	Substitution	Cost of capital	Income	Wealth	Monetary channel	Expectations	Spillover	Sum	Discrepancy
Belgium	-0.21	-0.08	0.00	0.02	0.01	0.00			-0.11	-0.16	-0.05
Germany	-0.38	-0.13	-0.03	0.00	0.00		-0.18		-0.03	-0.37	-0.01
Greece	-0.29	-0.18	-0.02	0.00					-0.09	-0.29	0.00
Spain	-0.46	-0.21	-0.03	-0.16	0.01				-0.07	-0.46	0.00
France	-0.12	-0.05	-0.03	-0.01	0.00				-0.03	-0.12	0.00
Ireland	-0.15	-0.09	-0.03	-0.01		0.00			-0.01	-0.14	-0.01
Italy	-0.47	-0.19	-0.04	-0.10	0.02	-0.01		-0.13	-0.05	-0.50	0.03
Luxemburg	-0.06	-0.03	0.00	0.00		0.00			-0.03	-0.06	0.00
Netherlands	-0.22	-0.12	0.00	-0.03	-0.01	0.00			-0.06	-0.22	0.00
Austria	-0.14	-0.07	-0.01	0.00	0.00	-0.01			-0.05	-0.14	0.00
Portugal	-0.26	-0.13	-0.05	-0.02	0.01				-0.08	-0.27	0.01
Finland	-0.17	-0.20	0.05	0.07	0.00	0.01			-0.10	-0.17	0.00
Aggregate	-0.31	-0.13	-0.03	-0.03	0.00	0.00	-0.06	-0.02	-0.05	-0.31	0.00
AWM	-0.44	-0.12	-0.02	-0.26	0.03	0.00				-0.37	-0.07

Table A.3 Decomposition price effects, including spillovers (ctd.)

Decomposition consumption deflator 2004

	Total effect	Exchange rate	Substitu-tion	Cost of capital	Income	Wealth	Monetary channel	Expec-tations	Spillover	Sum	Discre-pancy
Belgium	-0.17	-0.06	0.00	0.02	0.01	0.00			-0.11	-0.14	-0.03
Germany	-0.56	-0.18	-0.03	0.00	0.00		-0.28		-0.06	-0.55	-0.01
Greece	-0.35	-0.19	-0.05	0.00					-0.12	-0.36	0.01
Spain	-0.68	-0.20	-0.05	-0.31	0.00				-0.13	-0.69	0.01
France	-0.14	-0.05	-0.04	-0.01	0.00				-0.05	-0.15	0.01
Ireland	-0.17	-0.06	-0.06	-0.03		0.01			-0.03	-0.17	0.00
Italy	-0.50	-0.17	-0.07	-0.12	0.05	-0.03		-0.15	-0.06	-0.55	0.05
Luxemburg	-0.09	-0.03	-0.01	0.00		0.00			-0.05	-0.09	0.00
Netherlands	-0.30	-0.12	-0.01	-0.06	-0.01	-0.01			-0.11	-0.32	0.02
Austria	-0.13	-0.05	-0.01	0.00	0.00	-0.01			-0.06	-0.13	0.00
Portugal	-0.27	-0.09	-0.07	-0.02	0.00				-0.10	-0.28	0.01
Finland	-0.02	-0.11	0.06	0.10	0.01	0.01			-0.09	-0.02	0.00
Aggregate	-0.40	-0.13	-0.04	-0.05	0.01	-0.01	-0.09	-0.03	-0.07	-0.41	0.01
AWM	-0.57	-0.10	-0.01	-0.42	0.04	0.01				-0.48	-0.09

Decomposition consumption deflator 2005

	Total effect	Exchange rate	Substitu-tion	Cost of capital	Income	Wealth	Monetary channel	Expec-tations	Spillover	Sum	Discre-pancy
Belgium	-0.12	-0.03	0.00	0.01	0.00	0.00			-0.09	-0.11	-0.01
Germany	-0.56	-0.17	-0.02	0.00	0.00		-0.29		-0.08	-0.56	0.00
Greece	-0.38	-0.18	-0.08	0.00					-0.13	-0.39	0.01
Spain	-0.86	-0.20	-0.05	-0.42	0.00				-0.19	-0.86	0.00
France	-0.16	-0.05	-0.05	-0.01	0.00				-0.06	-0.17	0.01
Ireland	-0.22	-0.06	-0.09	-0.05		0.01			-0.04	-0.23	0.01
Italy	-0.37	-0.15	-0.08	-0.06	0.08	-0.02		-0.12	-0.08	-0.43	0.06
Luxemburg	-0.13	-0.03	-0.01	0.00		0.00			-0.08	-0.12	-0.01
Netherlands	-0.38	-0.11	-0.01	-0.08	-0.01	-0.02			-0.17	-0.40	0.02
Austria	-0.12	-0.05	-0.01	0.00	0.00	0.00			-0.06	-0.12	0.00
Portugal	-0.35	-0.07	-0.12	-0.04	0.01				-0.12	-0.34	-0.01
Finland	-0.08	-0.08	0.01	0.07	0.01	-0.01			-0.08	-0.08	0.00
Aggregate	-0.40	-0.13	-0.04	-0.06	0.01	0.00	-0.09	-0.02	-0.09	-0.42	0.01
AWM	-0.66	-0.11	-0.01	-0.60	0.06	0.01				-0.65	-0.01

Table A.4 Decomposition real GDP effects, including spillovers

Decomposition real GDP 2001

	Total effect	Exchange rate	Substitution	Cost of capital	Income	Wealth	Monetary channel	Expectations	Spillover	Sum	Discrepancy
Belgium	-0.15	-0.06	0.01	-0.02	-0.01	0.00			-0.07	-0.15	0.00
Germany	-0.28	-0.21	-0.04	-0.01	0.00	0.00	0.00		-0.02	-0.28	0.00
Greece	-0.41	-0.16	-0.21	0.00	0.00	0.00			-0.04	-0.41	0.00
Spain	-0.12	-0.05	-0.01	-0.05	0.01	0.00			-0.01	-0.11	-0.01
France	-0.15	-0.03	-0.10	-0.02	0.01	0.00			-0.02	-0.16	0.01
Ireland	-0.25	-0.04	-0.14	-0.06	0.00	0.01			-0.03	-0.26	0.01
Italy	-0.26	-0.08	-0.07	-0.09	0.02	-0.01		-0.03	-0.02	-0.28	0.02
Luxemburg	-0.17	-0.11	-0.02	0.00	0.00	0.00			-0.04	-0.17	0.00
Netherlands	-0.20	-0.10	-0.01	-0.05	0.00	0.00			-0.03	-0.19	-0.01
Austria	-0.25	-0.13	-0.03	-0.02	0.00	-0.03			-0.04	-0.25	0.00
Portugal	-0.12	-0.02	-0.09	0.00	0.01	0.00			-0.02	-0.12	0.00
Finland	-0.34	-0.15	-0.06	-0.08	-0.02	-0.01			-0.02	-0.34	0.00
Aggregate	-0.22	-0.11	-0.06	-0.04	0.01	0.00	0.00	-0.01	-0.02	-0.23	0.00
AWM	-0.34	-0.17	-0.09	-0.20	-0.02	-0.05				-0.53	0.19

Decomposition real GDP 2002

	Total effect	Exchange rate	Substitution	Cost of capital	Income	Wealth	Monetary channel	Expectations	Spillover	Sum	Discrepancy
Belgium	-0.20	-0.08	0.01	-0.03	0.02	0.00			-0.13	-0.21	0.01
Germany	-0.33	-0.24	-0.04	-0.01	0.00		0.03		-0.07	-0.33	0.00
Greece	-0.78	-0.13	-0.47	-0.09					-0.09	-0.78	0.00
Spain	-0.43	-0.13	-0.04	-0.22	0.01				-0.06	-0.44	0.01
France	-0.28	-0.03	-0.20	-0.05	0.02				-0.07	-0.33	0.05
Ireland	-0.48	-0.08	-0.18	-0.17		0.03			-0.07	-0.47	-0.01
Italy	-0.60	-0.10	-0.18	-0.28	0.06	-0.05		-0.07	-0.05	-0.67	0.07
Luxemburg	-0.25	-0.07	-0.04	-0.01	0.00	0.00			-0.12	-0.24	-0.01
Netherlands	-0.27	-0.04	-0.01	-0.11	0.00	-0.02			-0.09	-0.27	0.00
Austria	-0.47	-0.14	-0.12	-0.02	0.00	-0.10			-0.09	-0.47	0.00
Portugal	-0.56	-0.06	-0.34	-0.12	0.06				-0.09	-0.55	-0.01
Finland	-0.24	-0.08	0.00	-0.13	-0.01	0.01			-0.02	-0.23	-0.01
Aggregate	-0.38	-0.13	-0.11	-0.10	0.02	-0.01	0.01	-0.01	-0.07	-0.41	0.02
AWM	-0.71	-0.16	-0.03	-0.54	0.05	0.00				-0.68	-0.03

Decomposition real GDP 2003

	Total effect	Exchange rate	Substitution	Cost of capital	Income	Wealth	Monetary channel	Expectations	Spillover	Sum	Discrepancy
Belgium	-0.10	-0.03	0.00	0.00	-0.01	0.00			-0.08	-0.12	0.02
Germany	-0.09	-0.08	0.00	0.00	0.00		0.08		-0.08	-0.08	-0.01
Greece	-0.69	-0.04	-0.46	-0.09					-0.11	-0.70	0.01
Spain	-0.62	-0.11	-0.05	-0.35	0.00				-0.10	-0.61	-0.01
France	-0.25	0.00	-0.15	-0.03	0.01				-0.10	-0.27	0.02
Ireland	-0.43	-0.10	-0.07	-0.21		0.03			-0.08	-0.43	0.00
Italy	-0.55	-0.05	-0.15	-0.38	0.11	-0.07		-0.05	-0.06	-0.65	0.10
Luxemburg	-0.27	-0.01	-0.05	-0.04	0.00	0.00			-0.18	-0.28	0.01
Netherlands	-0.25	-0.02	-0.01	-0.09	0.00	-0.02			-0.12	-0.26	0.01
Austria	-0.49	-0.07	-0.19	-0.01	0.00	-0.11			-0.12	-0.50	0.01
Portugal	-0.81	-0.04	-0.47	-0.20	0.04				-0.14	-0.81	0.00
Finland	-0.15	-0.05	0.05	-0.16	0.00	0.01			-0.02	-0.17	0.02
Aggregate	-0.31	-0.05	-0.09	-0.12	0.02	-0.02	0.02	-0.01	-0.09	-0.33	0.02
AWM	-0.71	-0.02	0.08	-0.70	0.11	0.06				-0.47	-0.24

Table A.4 Decomposition real GDP effects, including spillovers (ctd.)

Decomposition real GDP 2004

	Total effect	Exchange rate	Substitu-tion	Cost of capital	Income	Wealth	Monetary channel	Expec-tations	Spillover	Sum	Discre-pancy
Belgium	-0.05	0.01	0.00	-0.01	-0.04	0.00			-0.03	-0.07	0.02
Germany	0.15	0.05	0.01	0.00	0.00		0.14		-0.05	0.15	0.00
Greece	-0.72	-0.02	-0.50	-0.08					-0.12	-0.72	0.00
Spain	-0.56	-0.07	-0.02	-0.34	-0.01				-0.12	-0.56	0.00
France	-0.16	0.00	-0.07	-0.02	-0.01				-0.09	-0.19	0.03
Ireland	-0.38	-0.12	0.00	-0.20		0.02			-0.07	-0.37	-0.01
Italy	-0.21	-0.01	-0.05	-0.33	0.17	0.01		0.02	-0.05	-0.24	0.03
Luxemburg	-0.23	0.00	-0.04	-0.03	0.00	0.00			-0.17	-0.24	0.01
Netherlands	-0.22	-0.02	0.00	-0.06	-0.01	-0.01			-0.11	-0.21	-0.01
Austria	-0.36	0.01	-0.19	-0.01	0.00	-0.09			-0.10	-0.38	0.02
Portugal	-0.74	-0.01	-0.40	-0.16	-0.03				-0.14	-0.74	0.00
Finland	-0.22	-0.04	0.02	-0.20	0.00	0.00			-0.01	-0.23	0.01
Aggregate	-0.14	0.00	-0.04	-0.11	0.02	0.00	0.04	0.00	-0.07	-0.15	0.01
AWM	-0.63	-0.01	0.05	-0.70	0.07	0.02				-0.57	-0.06

Decomposition real GDP 2005

	Total effect	Exchange rate	Substitu-tion	Cost of capital	Income	Wealth	Monetary channel	Expec-tations	Spillover	Sum	Discre-pancy
Belgium	-0.03	0.01	0.00	-0.02	-0.03	0.00			-0.01	-0.05	0.02
Germany	0.26	0.09	0.01	0.00	0.00		0.15		0.00	0.25	0.01
Greece	-0.74	-0.01	-0.55	-0.08					-0.10	-0.74	0.00
Spain	-0.39	-0.02	0.01	-0.26	-0.01				-0.11	-0.39	0.00
France	-0.08	0.01	-0.02	-0.01	-0.02				-0.06	-0.10	0.02
Ireland	-0.32	-0.11	0.02	-0.18		0.00			-0.05	-0.32	0.00
Italy	0.05	0.04	0.02	-0.25	0.17	0.07		0.09	-0.05	0.09	-0.04
Luxemburg	-0.15	0.01	-0.03	-0.01	0.00	0.00			-0.12	-0.15	0.00
Netherlands	-0.16	-0.01	0.00	-0.05	-0.02	-0.01			-0.06	-0.15	-0.01
Austria	-0.32	0.00	-0.17	-0.01	0.00	-0.08			-0.07	-0.33	0.01
Portugal	-0.61	0.00	-0.32	-0.13	-0.03				-0.13	-0.61	0.00
Finland	-0.25	-0.02	0.00	-0.22	0.00	0.00			-0.01	-0.25	0.00
Aggregate	-0.02	0.03	-0.02	-0.09	0.02	0.01	0.05	0.02	-0.04	-0.02	0.00
AWM	-0.57	0.00	0.02	-0.68	0.05	0.01				-0.60	0.03

Table A.5.1 Effect on real GDP: exchange rate channel BIS (1995) versus WGEM (2001)

	Year 1	Year 2	Year 3	Year 4	Year 5
Germany					
- BIS (1995)	-0.09	-0.24	-0.22	-0.08	0.03
- WGEM (2001)	-0.21	-0.24	-0.08	0.05	0.09
France					
- BIS (1995)	-0.09	-0.21	-0.14	-0.01	0.04
- WGEM (2001)	-0.03	-0.03	0.00	0.00	0.01
Italy					
- BIS (1995)	-0.21	-0.24	0.02	0.05	-0.02
- WGEM (2001)	-0.08	-0.10	-0.05	-0.01	0.04
Spain					
- BIS (1995)	-0.03	-0.06	-0.05	0.00	0.03
- WGEM (2001)	-0.05	-0.13	-0.11	-0.07	-0.02
Netherlands					
- BIS (1995)	-0.07	-0.07	-0.02	-0.02	0.01
- WGEM (2001)	-0.10	-0.04	-0.02	-0.02	-0.01
Belgium					
- BIS (1995)	-0.05	-0.12	-0.13	-0.08	0.03
- WGEM (2001)	-0.04	-0.08	-0.05	-0.04	-0.07
Austria					
- BIS (1995)	-0.06	-0.05	0.01	0.01	0.01
- WGEM (2001)	-0.13	-0.14	-0.07	0.01	0.00

Table A.5.2 Effect on real GDP: direct substitution channel BIS (1995) versus WGEM (2001)

	Year 1	Year 2	Year 3	Year 4	Year 5
Germany					
- BIS (1995)	-0.06	-0.14	-0.13	-0.10	-0.05
- WGEM (2001)	-0.04	-0.04	0.00	0.01	0.01
France					
- BIS (1995)	0.00	-0.01	0.00	0.01	0.00
- WGEM (2001)	-0.10	-0.20	-0.15	-0.07	-0.02
Italy					
- BIS (1995)	-0.05	-0.10	-0.05	0.00	0.03
- WGEM (2001)	-0.02	-0.06	-0.06	-0.05	-0.02
Spain					
- BIS (1995)	-0.02	-0.02	-0.01	0.01	0.01
- WGEM (2001)	-0.01	-0.04	-0.05	-0.02	0.01
Netherlands					
- BIS (1995)	-0.01	-0.03	-0.02	0.00	0.00
- WGEM (2001)	-0.01	-0.01	-0.01	0.00	0.00
Belgium					
- BIS (1995)	-0.02	-0.14	-0.21	-0.11	0.01
- WGEM (2001)	0.01	0.01	0.00	0.01	0.01
Austria					
- BIS (1995)	-0.03	-0.02	0.03	0.00	0.00
- WGEM (2001)	-0.03	-0.12	-0.19	-0.19	-0.17

Table A.5.3 Effect on real GDP: cost-of-capital channel BIS (1995) versus WGEM (2001)

	Year 1	Year 2	Year 3	Year 4	Year 5
Germany					
- BIS (1995)	0.01	-0.01	-0.01	0.00	0.01
- WGEM (2001)	-0.01	-0.01	0.00	0.00	0.00
France					
- BIS (1995)	-0.13	-0.17	-0.05	-0.02	-0.02
- WGEM (2001)	-0.02	-0.04	-0.02	-0.01	0.00
Italy					
- BIS (1995)	-0.06	-0.21	-0.28	-0.28	-0.30
- WGEM (2001)	-0.14	-0.40	-0.47	-0.33	-0.21
Spain					
- BIS (1995)	0.01	0.00	-0.02	-0.04	-0.09
- WGEM (2001)	-0.05	-0.22	-0.35	-0.34	-0.26
Netherlands					
- BIS (1995)	-0.01	-0.05	-0.08	-0.06	-0.01
- WGEM (2001)	-0.05	-0.11	-0.09	-0.06	-0.05
Belgium					
- BIS (1995)	0.01	-0.03	-0.14	-0.12	-0.05
- WGEM (2001)	-0.02	-0.03	0.00	-0.01	-0.01
Austria					
- BIS (1995)	0.00	-0.08	-0.04	0.03	0.00
- WGEM (2001)	-0.02	-0.02	-0.01	-0.01	-0.01

Table A.5.4 Effect on real GDP: income/cash flow channel BIS (1995) versus WGEM (2001)

	Year 1	Year 2	Year 3	Year 4	Year 5
Germany					
- BIS (1995)	0.02	0.05	0.08	0.06	0.04
- WGEM (2001)	0.00	0.00	0.00	0.00	-0.01
France					
- BIS (1995)	0.10	0.07	0.00	0.01	-0.01
- WGEM (2001)	0.01	0.02	0.01	-0.03	-0.03
Italy					
- BIS (1995)	-0.01	0.02	0.12	0.19	0.20
- WGEM (2001)	0.02	0.06	0.11	0.17	0.17
Spain					
- BIS (1995)	0.00	0.00	0.00	0.00	0.00
- WGEM (2001)	0.01	0.01	0.00	-0.01	-0.01
Netherlands					
- BIS (1995)	0.00	0.00	0.00	0.00	-0.02
- WGEM (2001)	0.00	0.00	0.00	-0.01	-0.02
Belgium					
- BIS (1995)	0.01	0.15	0.25	0.20	0.07
- WGEM (2001)	-0.01	0.00	0.00	-0.03	-0.04
Austria					
- BIS (1995)	0.01	0.01	0.00	-0.01	-0.01
- WGEM (2001)	0.00	0.00	0.00	0.00	0.00

Table A.5.5 Effect on real GDP: wealth channel BIS (1995) versus WGEM (2001)

	Year 1	Year 2	Year 3	Year 4	Year 5
Germany					
- BIS (1995)	-	-	-	-	-
- WGEM (2001)	-	-	-	-	-
France					
- BIS (1995)	-	-	-	-	-
- WGEM (2001)	-	-	-	-	-
Italy					
- BIS (1995)	-	-	-	-	-
- WGEM (2001)	-0.01	-0.05	-0.07	0.01	0.07
Spain					
- BIS (1995)	-0.01	0.02	0.02	-0.04	-0.02
- WGEM (2001)	-	-	-	-	-
Netherlands					
- BIS (1995)	-0.01	-0.03	-0.03	-0.01	0.01
- WGEM (2001)	0.00	-0.02	-0.02	-0.01	-0.01
Belgium					
- BIS (1995)	0.00	0.00	0.01	0.03	0.04
- WGEM (2001)	0.00	0.00	0.00	0.00	0.00
Austria					
- BIS (1995)	0.00	0.02	-0.01	-0.03	-0.01
- WGEM (2001)	-0.03	-0.10	-0.11	-0.09	-0.08

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