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Abstract

This paper examines possible explanations for observed differences in the transmission of euro area monetary policy in central bank large-scale macroeconomic models. In particular it considers the extent to which these differences are due to differences in the underlying economies or (possibly unrelated) differences in the modelling strategies adopted for each country. It finds that, against most yardsticks, the cross-country variations in the results are found to be plausible in the sense that they correspond with other evidence or observed characteristics of the economies in question. Nevertheless, the role of differing modelling strategies may also play a role. Important features of the models –for instance in the treatment of expectations or wealth– can have a major bearing on the results that may not necessarily reflect differences in the underlying economies.

JEL: C53; E52; E37
Keywords: monetary transmission; macroeconometric models; euro area differences

Non Technical Summary

This paper seeks to examine possible explanations for observed differences in the transmission of euro area monetary policy in central bank large-scale macroeconomic models. To this end, it draws on the results of a carefully designed common monetary policy simulation experiment prepared within the Working Group on Econometric Modelling (WGEM) and reported by Van Els et al. (2001). As these results are based on a harmonised simulation experiment, observed cross-country differences in results can be due to either differences in the underlying economies or (possibly unrelated) differences in the modelling strategies adopted for each country. The paper adopts two complementary strategies for examining the sources of differences in monetary policy transmission in these model simulation results. First it examines various measures of these differences, and assesses whether they appear plausible on economic grounds. Second, it considers the role played by differences in model design.

With regard to the plausibility of the results, a broadly based approach is adopted, whereby results are compared with structural and institutional characteristics of the respective national economies and with established business cycle properties. Financial structures and the fiscal policy framework appear to make some contribution to explaining part of the heterogeneity in the responses of countries to a monetary policy shock. There also appears to be a role for the credit channel as various financial indicators show some relationship with the pattern of results. In addition, entry barriers and the pervasiveness of the employment protection legislation appear to raise the economic costs of adjusting after a monetary policy shock. Industrial structure does not seem to explain much of the reported cross-country differences in the transmission mechanism. In relation to the decomposition into channels of transmission, the magnitude of most channels appear to bear at least some relation to prior beliefs based on information about the respective economies.

With regard to business cycle properties, there appears to be some evidence that the transmission results corresponded to cross-country differences in various business cycle 'stylised facts'. In particular, a high volatility of consumption observed in the business cycle data may be indicative of a greater sensitivity of consumption to changing interest rates. This pattern is observed in the WGEM results, where the magnitude of the substitution channel seems to correspond to the volatility of private consumption.

As a further robustness check, the results from the WGEM exercise are compared with some existing VAR evidence. However, it should be noted that the two sets of results are only partially comparable, as there are important differences in their treatment of monetary policy, and, indeed, the quantitative results differ quite markedly. The cross-country distribution of the maximum impact on prices is broadly similar across the two competing methodologies. However, the cross-country differences in maximum output effects obtained using the VAR model do not correspond well with those generated in the WGEM simulations.

With regard to the role of differences in model design, it is found that the existence of alternative forward-looking elements in the models is one of the reasons for finding sizeable differences across model results, particularly with regard to the speed of adjustment. For the models that have explicitly incorporated market valuation of assets, the wealth channel becomes more significant. Irrespective of the way the NAIRU is modelled, the presence of the unemployment rate in the wage equation (or of other variables describing the non-competitive environment in the labour market) is a factor that influences how monetary policy affects the inflation rate. The monetary channel that is incorporated into the German model has an important impact on the transmission of monetary policy in this model.

To summarise, against most yardsticks, the cross-country variation in the WGEM results are found to be plausible. The results broadly correspond to the differences in business cycle properties across countries and most –but not all– economic, financial and structural statistics. When compared against the VAR evidence, the results are more mixed with similarities in the pattern of price –but not output– responses. Nevertheless, despite these signs that the results may reflect underlying economic differences, the role of differing modelling strategies should not be ignored. Important features of the models –for instance in the treatment of expectations or wealth– can have a major bearing on the results that may not necessarily reflect differences in the underlying economies.

1 Introduction

The aim of this paper is to examine possible explanations for observed differences in the transmission of euro area monetary policy in central bank models. To this end, the paper draws on the results of a carefully designed common monetary policy simulation experiment prepared within the Working Group on Econometric Modelling (WGEM) and reported by Van Els et al. (2001). As these results are based on a harmonised simulation experiment, observed cross-country differences in results can be due to either differences in the underlying economies or (possibly unrelated) differences in the modelling strategies adopted for each country.

Central bank models are in many respects highly informative tools for analysing monetary policy transmission, since they incorporate the 'local wisdom' on the response of the domestic economy to a policy impulse. In order to maximise their effectiveness as tools for analysing the working of a common monetary policy, they should meet a few requirements. First, they should distinguish the direct effects on output and prices of a change in interest rates from the indirect ones that work through the exchange rate. Second, they should allow for a simultaneous change in the policy instrument in all countries, as this will always be the case inside EMU. Third, they should allow some understanding of the sources and statistical significance of the cross-country differences detected in the transmission mechanism. The first two requirements are already met by the models used in the WGEM experiment, whilst the aim of this paper is to address the third.

The models used in the WGEM exercise, being large scale, offer a detailed description of the working of the economy, in particular of the labour and goods markets and the channels of monetary policy transmission, and therefore it is possible to examine the sources of the cross-country asymmetries. The statistical significance of the differences is more problematic as the models have been designed independently, are not linked and there is no comprehensive set of information about the error-bounds attached to each simulation result. Nevertheless, to the extent possible, we also try to shed some light on this issue.

This paper is structured in three sections. In Section 1, we examine the extent to which monetary policy transmission differs across countries, with a detailed analysis of the results which draws on measures of their distribution. In Section 2, we ask whether the observed differences are reliable. To this end, we compare the WGEM results with data on the business cycle properties of euro area countries, evidence from VAR models of monetary policy transmission and information on economic structures and institutions. The latter is done for both the overall results and the decomposition into channels of transmission. Finally, in Section 3, there is an assessment of the key features of model design that have an important impact on the results.

2 To What Extent Does Monetary Policy Transmission Differ Across Countries?

We begin the analysis of cross-country differences in monetary policy transmission by seeking to identify how large these differences are in the WGEM results. Since the differences in monetary policy transmission cannot be inferred by a single measure, we examine a number of statistics[1]. In particular, we examine its impact on output, consumer spending, the sacrifice ratio and the deflators of consumption and GDP. However, in order to compare cross-country responses, it is first necessary to impose some structure on the data.

The WGEM results express the endogenous variables in the monetary policy simulations (Y_t) in terms of percentage deviations from baseline values ($\overline{Y}_t$)

$$\frac{Y_t - \overline{Y}_t}{\overline{Y}_t} \cong \log Y_t - \log \overline{Y}_t \equiv y_t - \overline{y}_t .$$

On the assumption that $\overline{y}_t$ may be represented as a linear function of disturbances and (logs of the) exogenous variables[2], then it is possible to compute the moving average representation of both $\overline{y}_t$ and y_t[3], and isolate the effects of the monetary policy shock, which is the only disturbance which distinguishes the two simulations. For the generic *l-th* endogenous variable of the *k-th* country,

$$y_{l,t}^k - \overline{y}_{l,t}^k = \underbrace{\sum_i \sum_j \alpha_{l,i,j}^k \eta_{i,t-j} + \sum \delta_{l,j}^k \varepsilon_{t-j}}_{y_t} - \underbrace{\sum_i \sum_j \alpha_{l,i,j}^k \eta_{i,t-j}}_{\overline{y}_t}$$

where $\eta_{i,t}$ represents the generic *i-th* disturbance and ε_t is the monetary policy shock. The set of coefficients $\left\{\delta_{l,j}^k\right\}$ and the related country-aggregate $\left\{\delta_{l,j}\right\}$, which measures the response of $y_{l,t}^k$ and $y_{l,t}$ to a discretionary change in the short-term interest rate, are determined by the structure of the euro area countries and can be used to detect whether there exist differences in the way the economies work. Because the experiment is designed so that the 100 basis point interest rate rise lasts for eight periods, $\varepsilon_{t+j} = .01$ for $0 \le j \le 7$ and zero otherwise, so that the impulse response coefficients can be recovered by means of the set of deviations[4] $y_{t+j}^k - \overline{y}_{t+j}^k$. In particular, for $0 \le j \le 7$, $y_{t+j}^k - \overline{y}_{t+j}^k \propto \sum_{u=0}^{j} \delta_u^k$ while for $7 < j$, $y_{t+j}^k - \overline{y}_{t+j}^k \propto \sum_{u=j-7}^{j} \delta_u^k$, where the proportionality factor is given by the size of the monetary policy shock.

1. Nevertheless, we recognise the difficulty in obtaining formal tests of cross country differences given the small number of countries in our sample. An alternative avenue is the one considered by Dedola and Lippi (2000) that study monetary policy heterogeneity both across industries and countries.

2. This assumption is not at all restrictive for behavioural and technical equations but implies that accounting identities hold only as an approximation.

3. Exogenous variables do not cause any problem: they are, by construction, not Granger-caused by the endogenous variables and may therefore be separately solved in terms of their fundamental shocks. Somewhat more problematic is the interpretation of the change in the short-term interest rate as entirely due to a discretionary policy impulse, since this abstracts from the feed-back existing between the state of the economy and the systematic component of the monetary stance. A possible way out is the recognition that the policy interest rate does not move continuously but piecemeal, when changes in fundamentals are large enough to justify an adjustment. Accordingly, if the initial shock and the ensued response of the economy are small, the assumption of a fixed interest rate is a viable one.

4. In order to reduce notation at a minimum, henceforth no index is used to distinguish variables across countries. The subscript *l* is therefore dropped.

The set of parameters $\left\{\delta_j^k\right\}$ can then be compared across countries and related to the response of the euro area as a whole. The (scaled) *interim* variance $\widetilde{\sigma}_k^2 = \frac{\sum_{i=1}^{T}\left(\delta_i^k\right)^2}{\sum_{i=1}^{T}\left(\delta_i\right)^2}$ can be used to gauge the relative size of the fluctuation induced by the change in the monetary stance. The correlation coefficient $\frac{\sum_{j=0}^{T}\delta_j\delta_j^k}{\sqrt{\sum_{j=0}^{T}\left(\delta_j\right)^2}\sqrt{\sum_{j=0}^{T}\left(\delta_j^k\right)^2}}$ between the country and aggregate responses can be used to assess whether the timing, direction and size of the adjustment in each country is similar to the one displayed at the aggregate level.

Tables 1 to 4 report the values of these statistics for output, household consumer spending, the consumption deflator and the GDP deflator[5]. The statistical significance of the two statistics is also tested and the related results are shown in column 3 and 6[6]. Figures 1 to 3 provide graphical evidence of the extent to which the country responses of prices and quantities deviate from the average reaction within the euro-area.

A few features of the simulation results stand out. Table 1 shows that the amplitude of GDP fluctuations is different across countries, as witnessed by the range of values taken by the interim (20 periods) standard deviation of output, which is 5 times larger in Finland than in Belgium. Finland, Portugal, Greece and Italy appear to exhibit larger output volatility than their EMU partners: confidence bounds suggest that the discrepancy is statistically significant. Even if the interpretation of the measure of significance is open to question, these asymmetries cannot go unnoticed.

A similar, though not identical pattern emerges from the correlation between country and aggregate movements, which is reported in the 4th column and plotted in Figure 1. A low coefficient indicates that the timing of the output response in a particular country diverges from that of the euro area as a whole. A country deviating from the aggregate is represented in Figure 1 by a point which is close to the centre of the circle. Again, Finland stands out as the EMU member whose response is furthest apart from the aggregate one, while the response for France differs little from the average response for the euro area. Overall, the correlation coefficients tend to be quite large, indicating that the differences in timing of the responses do not seem to be that large. With the exception of Finland, GDP responses are hump-shaped and reach a maximum between the second and the third year, so that the timing of the response is quite uniform across the whole EMU.

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5. The correlations reported in the tables are computed without excluding the country to which the coefficient refers from the euro area aggregate. This procedure induces an upward bias in the estimates for the larger countries. However, it could be argued that this is an appropriate measure as the monetary policy stance is based on developments at the euro area level and the cost of losing monetary independence is proportionate to the asymmetries existing between each country and the whole of the currency area. In the case of Germany, the adoption of the alternative solution of excluding the country from the area average would have generated some small differences.

6. Country variances scaled by the aggregate variance have an F distribution; the correlation coefficients ρ, transformed into the quantity $\frac{\rho}{\sqrt{1-\rho^2}}\sqrt{n-2}$, are distributed as a Student-*t* random variable. The distribution of these statistics is based on assumptions which are not likely to be satisfied in the present case. In particular, the hypothesis that both the variances and the covariances are computed on a random sample rather than on a set of estimated coefficients is unrealistic: since there is just one observation to estimate each impulse-response parameter, this is by no means an irrelevant assumption and puts inference procedures on shaky foundations. The results reported are therefore better viewed as suggesting some kind of metric which makes it possible to compare country results rather than as providing a reliable inference procedure to assess the statistical significance of the detected asymmetries.

More sizeable differences are apparent if one considers the volatility of consumer spending as a measure of the welfare effect of the monetary policy tightening. France is the country where the magnitude and timing of the consumption response is most in line with the aggregate one. The comparatively small response of consumption (in relation to the impact on output) in Belgium is indicative of a large degree of consumption smoothing. There is little sign of this in Portugal, Finland, Italy and Greece where movements in consumption are much larger. In Finland, the Netherlands and Belgium, household spending follows a pattern which is markedly different from the aggregate, as witnessed by the negative correlation coefficient. In the euro area, consumption reaches a trough between the second and the third year after the interest rate shock and starts increasing thereafter. However, in Finland and Belgium, the response of household spending is hump-shaped rather than U-shaped.

Turning to nominal variables, the deflationary effect of the monetary policy shock on prices appears to be more evenly distributed across the euro-area than is the case for the aggregate demand components (Tables 3 and 4). Again, Finland behaves somewhat differently from the other countries. The timing and magnitude of the response of the consumption deflator are unlike that exhibited elsewhere, being more rapid and consistently larger. With regard to the consumption deflator, Austria also deviates somewhat from the average response, as shown in Figure 2, as inflation barely reacts to the policy stimulus and the maximum effect is visible in advance of that elsewhere. This behaviour is noteworthy since it is not matched by a similarly asymmetric response of output.

Figure 4 combines the evidence concerning output and price responses. In order to highlight the importance of the degree of stickiness in the goods and labour markets in determining the effects of monetary policy, a number of indices, which are intended to represent the sacrifice ratio, are plotted[7]. The first is defined as the ratio between the size of the contraction in output and in the consumption deflator at the trough (sr1). The second uses the GDP rather than the consumption deflator (sr2), so as to separate the contribution of domestic channels of transmission. The figures for Finland point to relatively quick adjustment in goods and labour markets, which contributes to keeping the output cost of a monetary contraction well below the area average. Also Germany, Netherlands and Spain exhibit a balanced response of prices and quantities to the interest rate increase, while Portugal, Austria[8] and Luxembourg appear to be characterised by values of the sacrifice ratio which are on average higher than those prevailing in the rest of the euro area.

Figure 4 also presents an additional set of indices summarising the cost of adjusting to a monetary policy impulse, this time computed with reference to the variance in output and prices. The two series are the ratios between the variances of output and, alternatively, the consumption (sr3) and GDP deflators (sr4); the last one is the sacrifice ratio (sr5) computed in Van Els et al. (2001). These measures are broadly consistent with the earlier ones but suggest that, apart from the extreme cases (i.e. Germany and the Netherlands on the one hand; Austria, Portugal and Luxembourg on the other), an assessment of the distribution within the euro area of the cost of the policy action depends on the index which is chosen, which is tantamount to saying that the evidence is somewhat noisy.

Cross country comparisons suggest that there are signs of asymmetries in monetary transmission in the euro area. While there is some evidence of differences in the way interest rate changes affect GDP, the differences seem more pronounced for consumption, where it seems that the extent of consumption smoothing varies between countries[9]. In addition, it

7. A range of statistics is presented as any individual measure may not accurately reflect the degree of persistence of the effect of the policy shock and the extent to which the response to the shock is prompt or delayed. Hence we look for results which are robust across a range of measures.
8. The high sacrifice ratio in Austria is due to a particularly weak response of prices rather than a strong response of output.
9. One possible explanation for this evidence might be that the financial structure of the EMU members is still quite different and does not provide sufficient risk sharing mechanisms to households, who are therefore unable to adequately

appears that there is a group of countries whose economic structure is quite homogenous, but there are others where the transmission mechanism appears to work differently[10]. Unlike previous studies (see previous footnote), however, the WGEM results suggest that the size of the *core* has become larger, now including countries such as Italy and Spain, who have not usually been considered to be part of it. The detected differences are likely to be statistically significant, at least in a few cases, and in the next section we consider whether they have any significance from an economic standpoint.

ensure against income fluctuations. Nevertheless, other recent evidence finds a weak response of consumption across euro area countries compared with the US [see Angeloni, Kashyap, Mojon and Terlizzese (2003)].

10. A number of other studies come to similar findings. Kouparitsas (1999), relying on VAR estimates, claims that Finland and Ireland form a sort of periphery within EMU and respond to monetary policy impulses differently from the other countries. Bean (1999) lists several studies which find asymmetries in the transmission mechanism and which, as the seminal paper by Eichengreen and Bayoumi (1993) does, distinguish a core and a periphery within the EU.

3 Are Cross-Country Differences in Monetary Policy Transmission Reliable?

3.1 Comparing the WGEM Results with Business Cycle Properties

We now examine the extent to which the cross-country differences in the transmission results reflect differences in business cycle fluctuations among euro area countries. An important caveat to keep in mind here is that business cycle differences may be caused by many other shocks hitting the economy apart from monetary policy. For example, cyclical swings in economic activity may also result from changes in the fiscal stance, commodity prices (oil), and the exchange rate. Nevertheless, business cycle differences remain potentially informative as long as cross-country differences in both the frequency and size of the other shocks and their impact on economic activity are sufficiently small.

The cyclical behaviour of macroeconomic time series from euro area economies has been documented in the literature, see for instance, Angeloni and Dedola (1999) and Agresti and Mojon (2001). Generally speaking, although business cycles may gradually have become more synchronised across Europe, there appear to be substantial differences in terms of the volatility of these macroeconomic time series[11], as shown in Table 5[12]. This raises the possibility that these differences can be used to shed some light on the plausibility of the WGEM transmission results. With this aim, we examine a number of 'hypotheses'.

The first hypothesis assumes that in those countries where the volatility of private consumption is high, private consumption will react more swiftly and strongly to a change in the interest rate. As a result, the importance of the substitution channel may be enhanced in these cases (the channel decomposition in the central bank models will be explained in more detail in Section 3). The importance of the substitution channel (and of the other channels analysed below) is gauged with two measures. The impact of this channel on prices and output after one year (in absolute value) describes its importance in the short run. In addition, the cumulated absolute impact on prices and output after five years is used to trace the influence of the substitution channel in the long run. Figure 5 plots the volatility of private consumption against the short-run output effects. In line with the hypothesis, there appears to be a significant (at 84% level) positive relationship in the short-run, although such a relationship is not found in the long-run[13]. The short-run impact on prices is negligible in most countries and hence unrelated to the volatility of consumption[14]. Nevertheless, in the long-run, the impact on prices and the volatility of private consumption are significantly (at 95% level) correlated (see Figure 6).

The second hypothesis assumes that, in those countries where the volatility of investment is higher, investment should be more responsive to changes in the interest rate, which in turn should lead the cost-of-capital channel to play a more dominant role in the monetary transmission process. Generally, this hypothesis is refuted by the data. However, if Greece and Luxembourg, countries for which investment is rather volatile but the cost-of-capital channel is of little importance, are dropped from the sample, a significant relationship (at 89% level) between the volatility of investment and the short run impact on output can be obtained (see Figure 7).

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11. The data used in this section are taken from a macroeconomic time series dataset, which was build for the Eurosystem Monetary Transmission Network of the Eurosystem, and which is described in detail in Agresti and Mojon (2001). Data on compensation per employee (which is used as a proxy for wages) and total employment (used in the calculation of labour productivity) are from BIS. When quarterly observations are unavailable, yearly observations are employed.

12. Unconditional volatility measures have been computed as the standard deviation of year-on-year changes. We chose not to use a filter, like the HP- or Baxter-King filter, because some of the series are relatively short.

13. Spearman's rank order correlation coefficient is used to measure correlation between the two variables involved. P-values are obtained by linear interpolation of the exact small sample distribution.

14. To save space, only graphs indicating a significant relationship are shown.

Lastly, we investigate the extent to which the impact on prices is related to the components of labour costs, in particular wages and labour productivity. The idea here is that, if wages or labour productivity is more volatile, labour costs may be potentially more responsive to changes in the monetary policy stance. More volatile labour cost components may then translate into a larger impact on prices from changes in the interest rate. Here, we only take into account the domestic channels of transmission. We can only get a significant relationship (at 92% level) between the volatility of wages and the long run impact on prices if we drop Ireland from the sample. Ireland has wages that are relatively volatile and domestic channels of transmission that are comparatively weak (see Figure 8)[15].

In sum, there appears to be some evidence that the transmission results correspond to cross-country differences in business cycles properties. In particular, the magnitude of the substitution channels seems to correspond to the volatility of private consumption.

3.2 Comparing the WGEM Results with VAR evidence

VAR models have been widely used to study the monetary transmission mechanism in euro area countries [see Mojon and Peersman (2001) and the references cited therein]. Hence, it is of interest to examine how the WGEM results compare with the impact on output and prices of monetary policy shocks calculated from VAR models. This comparison is however hampered by the fact that VAR models tend to differ in terms of variables included, the number of euro area countries covered and the identification strategy used. In the context of cross-country analyses in the euro area, two issues are particularly important. First, in VAR models both the sizes of the initial monetary policy shocks as well as the subsequent monetary policy responses usually differ across countries. By implication, even if the transmission mechanism is the same across countries, differences may show up as the result of differences in monetary policy reaction functions. Therefore, any meaningful comparison requires that similar monetary policy reaction functions and policy shocks be imposed across models. Second, particularly in the euro area the issue of spillover effects is important. The WGEM simulations allow for spillover effects, and, to be comparable, the VAR models should be analysed under a similar assumption. These factors significantly restrict the number of VAR model studies available in the literature that can potentially act as a benchmark[16].

One VAR study that does seem well suited to compare with the WGEM results is that of Peersman (2002). The WGEM simulations and the analysis by Peersman have two important points in common. First, both studies allow for spillover effects. In the latter this is done by simultaneously modelling euro area aggregates and macroeconomic variables from individual euro area countries, allowing for feedback from euro area aggregates to the country variables. Second, both studies present results for a common monetary policy shock across all euro area countries (this is Peersman's second simulation).

However, there is also an important difference between the two studies. In the WGEM simulations, the monetary impulse is implemented as a sustained increase in the policy controlled interest rate by 100 basis points for two years, after which the policy rate immediately returns to baseline. In contrast, in Peersman's model, the short-term interest rate is initially raised by 30 basis points, after which the monetary policy reaction function, which is estimated implicitly in the VAR, is allowed to operate. Figure 9 provides the time profile of the short-term interest rate in both studies.

To facilitate a comparison between the two studies, we therefore re-scale the time profile of the policy controlled interest rate in the WGEM in such a way as to make the time

15. The fact that Ireland is an outlier here can to some extent be explained by its pattern of trade. A very large proportion of output is exported and a very large proportion of consumption is met by imports. Therefore, changes in domestic unit labour costs will not affect domestic consumer prices much, but will instead impact on competitiveness. In addition, the Irish retail sector has traditionally been heavily influenced by UK retailers' pricing in sterling, so that domestic factors are also not important in affecting these prices.

16. Due to a lack of information on the behaviour of the interest rate after the monetary policy shock, a proper comparison with the structural models results is made impossible in a number of VAR studies.

profile identical to that of the short-term interest rate in Peersman's VAR model. Implicitly, the assumption is made that the responses of GDP and prices in the WGEM simulations are (approximately) linear in the policy controlled interest rate[17]. However, it should be noted that the two sets of results are still not strictly comparable. Most importantly, in the WGEM simulations monetary policy is kept fixed, whereas in the VAR model monetary (and fiscal) authorities are allowed to respond to changes in the economic stance implicitly. This explains why the quantitative results may differ quite markedly. The main results can be summarised as follows (see Table 6 and Figure 10). First, using both models, the maximum impact on output is reached after approximately one year, although the size of the effects in the VAR exceed those of the WGEM simulations. This result is not specific to Peersman's VAR, but pertains to most VAR models surveyed in Mojon and Peersman (2001)[18]. Second, the maximum impact on output for each country is not significantly correlated across models, indicating that the cross-country differences obtained using the VAR model do not correspond to those generated in the WGEM simulations. This is in line with Mojon and Peersman's conclusion that –on the basis of a representative set of VAR studies– the literature does not point to any country within the euro area as experiencing either weaker or larger effects of monetary policy than the euro area average. Third, the maximum impact on prices are weakly positively correlated (at 63% level) across models, suggesting that the cross-country differences obtained using the two competing methodologies to some extent broadly match. Fourth, the maximum impact on inflation is attained much quicker in the WGEM simulations than in the VAR model.

3.3 Comparing the Overall WGEM Results with Economic Structures

We now seek to assess the plausibility of cross-country differences in monetary policy transmission in the euro area by examining how they correspond with the economic structures of EMU countries. We focus on asymmetries potentially arising in two areas: financial markets, which affect the transmission mechanism from interest rates to aggregate demand, and goods and labour markets, which determine the extent to which inflation reflects excess demand or supply. A third source of divergence across economies relates to preferences: countries may have differing attitudes to the variability of output and inflation, which translate into social insurance schemes which differ in terms of coverage and effectiveness[19]. We take up this issue first before proceeding to the analysis of the role of financial market or goods and labour market factors.

While the role of financial structures and of price and wage flexibility is well understood, only a few studies have dealt with the links between social preferences and the

17. The method of re-scaling used here is most easily explained by means of a simplified example. Assume that in study A (B) the interest rate is raised by s1 (σ1) % point in the first period and with s2 (σ2) % point in the second period. The response of output in study A (B) equals a1 (b1) in period one and a2 (b2) in period two. Clearly, a1 and a2 cannot be compared to b1 and b2 directly, since the monetary policy shocks differ across studies. To make responses comparable, the responses in study A are manipulated in the following way. First, we determine δ=(δ1, δ2) such that $S\delta = \begin{bmatrix} s_1 & 0 \\ s_2 & s_1 \end{bmatrix} \times \begin{bmatrix} \delta_1 \\ \delta_2 \end{bmatrix} = \begin{bmatrix} \sigma_1 \\ \sigma_2 \end{bmatrix}$. Then ã1 and ã2, the responses in study A that are comparable to those in study B, are obtained by $\begin{bmatrix} \tilde{a}_1 \\ \tilde{a}_2 \end{bmatrix} = \begin{bmatrix} a_1 & 0 \\ a_2 & a_1 \end{bmatrix} \times \begin{bmatrix} \delta_1 \\ \delta_2 \end{bmatrix} = A \times \delta$. To make the interest rate profiles equal over the five year horizon, the matrices A and S and the vector δ have to be expanded to included s1 to s20, a1 to a20, and δ1 to δ20.

18. The behaviour of the euro exchange rate is a likely explanation for the responses of output and prices in the WGEM simulations being more limited. The WGEM simulations impose a theoretical UIP relationship, whereas in Peersman's VAR the reaction of the euro exchange rate to a change in the interest rate is estimated from the data. The latter reaction appears to be more pronounced initially than the re-scaled UIP relationship.

19. Bean (2000) and Cecchetti (1999) include discrepancies in social preferences among the sources of asymmetries in monetary policy transmission.

effectiveness of monetary policy[20]. One reason might be that the effects of social preferences on the economic structure are pervasive and it is therefore far from clear how to derive formal tests of their relevance in shaping the transmission mechanism. As a tentative solution, we focus on the fiscal policy framework, which is one of the features which may reflect the degree of aversion to income fluctuations. As regards fiscal policy, automatic stabilisers exert a damping effect on the cycle, and may therefore reflect more reliably the extent to which society accepts slower adjustment to shocks in order to avoid large swings in output and income[21].

In order to have an indicator of the degree of economic stabilisation stemming from automatic fiscal mechanisms, it is necessary to isolate the component of the budget balance which is linked to fluctuations in economic activity and to estimate the responsiveness of fiscal surpluses to changes in aggregate demand. The higher the elasticity to changes in the output gap, the more the fiscal budget moves counter-cyclically and acts as a stabiliser. The lower the response of net lending, the more fiscal policy amplifies the business cycle. Van den Noord (2000) provides estimates of the size of the automatic stabilisers for most OECD countries. He computes the cyclical element of the budget balance by subtracting from actual levels the structural components of tax revenues and expenditure, with the latter being defined as the levels corresponding to potential output. The elasticity of net lending to the output gap is therefore defined as the weighted average of the elasticity of the main budget items. Using the figures provided by Van den Noord[22], it is possible to test whether there is a systematic relationship between the size of the automatic stabilisers and the ratio between the standard deviations of output and inflation. Figure 11 presents the relationship between the two variables for the EMU members and plots the straight line which best fits the cluster of points[23]. The curve is downward sloping, as expected. Therefore, those countries whose budget is more responsive to changes in the output gap, i.e. more contractionary in booms and more expansionary in recessions, are thought to dislike income volatility to a greater extent. Hence, they exhibit a lower ratio of the volatility of output with respect to that of inflation. The regression coefficient is statistically significant at the 5% confidence level, the corrected R square is slightly higher than 0.25 and the fit is fairly good, with the exception of Spain and Portugal.

The evidence is admittedly weak and the interpretation is not straightforward. As witnessed by the statistical properties of the regression, the relationship between social preferences and the size of automatic stabilisers is quite noisy and, in addition, several factors which are likely to determine the relative size of output and inflation variability are not properly accounted for in the regression. Nevertheless, the evidence for this narrow measure of social preferences suggests that differences in these preferences do contribute to explaining some of the observed differences in the transmission mechanism.

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20. De Grauwe (1995) asserts that two arguments, both related to time inconsistency, may be used to explain how divergent preferences may be a source of disagreement over the conduct of monetary policy. The first is the usual Barro-Gordon claim, that policymakers have incentives to indulge in surprise inflation in order to push activity above potential. The second relies on the inflation-tax revenues which the government can reap by reducing the real value of outstanding nominally-denominated public debt. Bean (2000) claims that these arguments are irrelevant for countries in which the central bank is independent. Instead, he suggests that social preferences matter in the choice of the optimal trade-off between output and inflation variability and are therefore responsible for the different degree of activism of central banks in responding to inflationary shocks.

21. Van den Noord (2000) claims that, over the 1990s, automatic fiscal stabilisers have worked to dampen cyclical fluctuations in the average OECD country by about 25 per cent. This results is due to the rise in taxes and government transfers, which have increased significantly as a share of total income in most OECD countries over the past 40 years. Average results however, should be interpreted with caution, since data show considerable cross-country variation.

22. See Van den Noord (2000), Table A.1, page 19. No figures for Luxembourg are provided.

23. The approach usually taken in the literature is somewhat different and tends to relate social preferences to the behaviour of the central bank. Most studies focus on the coefficients of estimated interest rate rules and use them to infer the form of the central bank's welfare function. Evidence is in general inconclusive, since, as stressed in Bean (2000), under plausible specifications of the economy, the volatility trade-off is quite sharply curved and there is a wide range of relative weights on output variability vis-a-vis inflation variability that can generate rather similar optimal points on the volatility frontier. Even sharply different preferences do not result in very different policy choices.

We now turn to the role of the financial structure in shaping the way in which the economy responds to monetary policy impulses. Capital markets and the banking system determine the speed and the extent to which policy impulses are transmitted to longer-term interest rates, equity prices and the exchange rate. The net asset position of households, firms and the government sector then determines the impact on aggregate demand of the new combination of asset yields. The presence of imperfections in financial markets and the associated existence of a credit channel, by amplifying the response to the initial change in interest rates, provides additional leverage to the policy action[24].

There is a lack of hard evidence concerning the way in which the financial structure affects the transmission mechanism. The extent to which credit constraints bite on households and the size of the external finance premium which is charged on small firms can not be easily measured. Accordingly, even in the literature no clear-cut conclusions are available. Cecchetti (1999) analyses the factors affecting the strength of the monetary transmission mechanism, focusing on the importance of small banks, the health of the banking sector and the availability of alternative sources of financing. He finds that the countries in which the lending channel is expected to be strongest have the largest sacrifice ratios and show the most sizeable impact of interest rate movements on output. He then finds that cross-country differences in the financial structure have their source in the strength of shareholder and creditor rights and in the rigor with which these rights are enforced. Mihov (2001) replicates Cecchetti's analysis and does not find much evidence supporting the relevance of the financial structures. On the contrary, he finds that industrial structure is a much more powerful factor in explaining the non-uniform responses of the euro-area countries. However, Bean (1999) contrasts the transmission mechanism in the UK and in the rest of western Europe and finds that, the high value of households' indebtedness and the large share of private sector debt which is at variable rates, account for the larger than average response of UK output to a monetary policy shock.

Table 7 reports a few statistics highlighting selected characteristics of the financial structures of the EU-12 countries[25]. These variables are compared with the cost of the policy tightening as measured by the sacrifice ratio[26]. The table shows the results obtained by means of univariate regressions[27]. The evidence is, to say the least, mixed. Market capitalisation, as a share of GDP, helps to discriminate between bank-oriented and market-oriented financial structures. It is expected to be higher wherever capital markets are developed and well functioning and where the cost of adjusting to a monetary policy shock is moderate. Market capitalisation is indeed low in Portugal and Austria, where the sacrifice ratio is relatively large, and high in France and the Netherlands, where the effects of the monetary shock are moderate. Germany and Finland do not fit convincingly into this story, and Greece is completely at odds with it. The size of MFI loans to firms (as a percentage of GDP), which may reflect the extent to which credit constraints bite on investment spending, does appear to have some explanatory power, especially when the share of loans which are short-term is considered.

24. A credit channel exists when, due to information asymmetries and moral hazard problems, banks and non-financial firms are not uniformly affected by monetary policy actions, since small units have limited access to financial markets. Macroeconometric models are not well-suited for gauging the relevance of the credit channel in monetary transmission, since usually they do not distinguish firms according to size and health.

25. Homogeneous data are hard to find for all countries and in most cases statistics are available only for a subset of countries, which explains the low figures for the regression degrees of freedom.

26. As in Van Els et al. (2001), in the present study the sacrifice ratio has been computed focusing on the response of the unemployment rate and the GDP deflator in the first five years of the simulation experiment. The following additional assumptions has been used: (i) the sacrifice ratio is computed with reference to domestic channels only; (ii) the cumulated unemployment loss is computed for the first j^* years, where j^* is the year in which the unemployment rate reaches a peak; (iii) 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.

27. In addition to univariate regression, the Spearman rank order correlation coefficient has also been computed and the results are available upon request from the authors. All in all, the two methods provide very similar evidence. The use of regression methods facilitates comparisons with the available literature on monetary transmission within the euro area.

The concentration of the banking sector provides some help in understanding the sources of asymmetries in the transmission mechanism. Focusing on concentration may be appropriate if one assumes that the larger the average size of banks, the higher their ability to attract funds from capital markets and the lower their exposition to a credit squeeze. The Herfindahl index[28] and the market share of the five largest banks do not contribute to explaining the size of the sacrifice ratio, while the variables related to the number of credit institutions operating in the euro-area countries do. Indeed, the smaller the average size of banks, the larger the sacrifice ratio. The variable measuring the penetration of credit institutions from countries outside the euro area has a negative sign. This would be justified if these banks were less affected by monetary policy shocks due to their ability to exploit alternative sources of funding. Looking at non-financial firms, the results tend to be less informative. The sacrifice ratio seems to be positively related to the number of firms issuing shares and inversely related to their average capitalisation, which is inconsistent with the notion that, the higher the information asymmetry, the lower the capacity of enterprises to access non-bank finance. The size of firms, as proxied by the number of employees in their payrolls, is not significant. All in all, even allowing for the uncertainty due to the noise present in the data, the differences in the financial structure do not seem able to explain all of the observed asymmetries in the transmission mechanism.

It is widely accepted that most asymmetries in monetary transmission are to be found in the working of labour and goods markets. While there are a huge number of studies directed to understanding the role played by the former, only a handful of papers deal with the latter, and most of them focus on the size of the manufacturing sector, paying brief attention to issues like customer-supplier relationships and inertia in nominal price setting. There are two aspects of the labour and goods markets that are of particular interest in understanding how costly it is to adjust to a monetary policy shock: nominal inertia and real rigidity. The higher they are, the less reactive are prices and wages to changes in the output gap and the less effective is interest rate policy. It is well known that nominal inertia –at least with respect to wages– is lower in Europe and higher in the US, while the opposite is true for real (wage) rigidities. However, it is not well documented how both of them are distributed across countries in the euro area[29]. Given the lack of available estimates, both kind of rigidities are measured only indirectly. It is assumed that nominal inertia and real price-wage rigidity are functions of a small number of variables which, by shaping workers' and employers' behaviour, ultimately determines the size of both parameters. Real rigidity inversely depends on the responsiveness of the price and wage mark-ups to product and labour market slackness. The former is related to market contestability and depends on the extent of state control, the incidence of regulations and the size of barriers to entrepreneurship and trade. The latter is affected by the institutional features which maintain a high degree of bargaining power for the insiders and which reduce the degree of centralisation and coordination of wage bargaining.

Table 8 shows the results of regressing the sacrifice ratio (sr5), assumed to measure the cost of adjusting after a monetary shock[30], on proxies of both nominal inertia and real rigidity. Given the small number of available observations, regressions are univariate. The first rows are aimed at assessing the importance of product market flexibility. The openness of the economy and the weight of the manufacturing sector in total value added provide proxies of the share of the economy which is exposed to international competition and are therefore used along with the other variables, which are more directly related to the degree of flexibility

28. A measure of concentration of production in an industry, calculated as the sum of the squares of market shares for each firm.
29. Layard et al. (1991) report estimates for both parameters for most of the current EMU members (9 out of 12), but the figures are by now somewhat outdated, given the extensive reforms in labour market institutions which have taken place in the last decade.
30. The sacrifice ratio is defined as in Van Els et al. No figure for Luxembourg is available.

of product markets. Regression results indicate that neither variable seems to be significantly related to the size of the sacrifice ratio; in addition both have the wrong sign[31]. The coefficients on the dimension of the barriers to trade and investment and employment protection legislation are significant and correctly signed. The latter turns out to be relevant in explaining the high sacrifice ratio in Portugal and, at the other extreme, the low one in Germany. The other variables (nominal wage inertia, the index of product market flexibility, state control, barriers to trade and investment and economic regulation) are either insignificant or wrongly signed and so are those related to the wage mark-up.

3.4 Comparing the Channel Decomposition from WGEM Results with Economic Structures

We now turn to explaining the channel decomposition in the WGEM Monetary Transmission Results. The approach taken is to compare the pattern of results for each channel with a number of prior judgements based on theoretical or empirical considerations. Six channels of transmission are identified, at least some of which are present in all the participating models. In each case we describe the channel and consider what factors may influence its magnitude[32]:

— *The substitution-effect-in-consumption channel.* The real interest rate represents the relative cost of present versus future consumption. Following a policy tightening, it becomes more rewarding to delay consumption and increase saving, which exerts a negative impulse on the current level of economic activity. The effects of this channel on output would be expected to depend on the proportion of GDP accounted by consumers' expenditure and the sensitivity of consumption to changes in interest rates. The latter may be linked to the financial strategies adopted by consumers (e.g. whether they feel the need to maintain precautionary balances) and the financial conditions they face (e.g. whether they face credit constraints).

— *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 accordingly. A similar mechanism operates for investment in housing 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[33]. The magnitude of this channel might be expected to depend on the financial structure and the conditions faced by firms. For instance, effects may be larger in countries where firms are more indebted or where they borrow on short-term interest rates. As with consumers, firms may also face credit constraints, and these may be more important for smaller firms with less easy access to capital markets. Finally, industrial structure may matter as some industries may be more affected by changes in interest rates due to either their capital requirements or the nature of the goods they produce (e.g. durables, non-durables, intermediate or investment goods).

31. The correct sign of the share of manufacturing in value added is actually not clear. Mihov (2001) assumes that manufacturing firms are more exposed to financing problems and are more heavily damaged by the credit squeeze following a monetary tightening. His prediction is therefore that the size of the manufacturing sector is positively related to the output loss engendered by an increase in interest rates. Dedola and Lippi (2000) find that the industry structure matters, because the sectors producing investment and durable goods –which are part of manufacturing– are more sensitive to changes in the monetary policy stance. In both cases, the presumption is that the correlation between the sacrifice ratio and the share of the manufacturing sector is positive and indeed Mihov finds that this variable has a non-negligible explanatory power, when the cumulated output loss rather than the sacrifice ratio is used as the endogenous variable. Notice however, that the sample used by Mihov (2001) excludes a few EMU countries, but includes the US, the UK, Japan and Canada, which means that his results are not entirely comparable to those presented in this paper.

32. As discussed in Section 3, 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.

33. 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.

— *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 importance of the cash-flow channel is likely to be linked to the financial structure of the economy. It may also depend on the relative propensity of borrowers and lenders to spend.

— *The wealth channel.* A rise in the cost of borrowing 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 and household spending falls accordingly. The impact of the wealth channel would be expected to be affected by the magnitude of household wealth and the sensitivity of consumers' expenditure to changes in wealth.

— *The exchange rate channel.* In most models of exchange rate determination, a monetary policy tightening leads to an appreciation of the currency. A stronger exchange rate causes a fall in export volumes 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. For both the price and output effects it would be expected that the proportion of trade outside the euro area, which will thus be affected by a change in the euro exchange rate, would help to explain the pattern of results. The extent and the speed of the pass-through of changes in the exchange rate into trade and domestic prices will also be important. This will depend on the pricing strategies of importers and the extent to which they 'price-to-market' or passively accept exchange rate induced price changes.

— *The spillover channel.* Models were initially operated in 'isolated' mode without intra-euro area spillovers. 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. The variables affected were export demand and competitors' export and import prices. It would be expected that the extent to which countries trade within the euro area would be an important factor in determining the magnitude of the spillover channel.

Table 9 provides an overview on which of the channels of monetary policy transmission are present in each of the models. The substitution, cost of capital, exchange rate and spillover channels are present in all models. However, the cash flow/income channel is not present in Greece or Ireland, whilst the wealth channel is only present in half of the models. As is discussed later in this note, the limited number of results for the wealth channel makes it difficult to identify the factors affecting the magnitude of this channel.

For each channel we report the average impacts on output and prices in the first two years. In principle any horizon could have been chosen, but two years reflected the timing of the change in monetary policy. As an alternative, results have also been derived using a horizon of five years, although these are not shown. Broadly speaking, most of the following results still hold with a five-year horizon.

3.4.1 DOMESTIC CHANNELS

Substitution in Consumption

The substitution-effect-in-consumption channel exists in all models (Table 10 gives more details on the interest rate effects on consumers' expenditure). In most cases consumption is

directly affected by changes in the short-term interest rate, although in the case of Greece, Ireland and Portugal it is the *real* short-term rate. In Spain and the Netherlands, consumption is affected by the long-term interest rate and in the case of Germany and Luxembourg it is the *real* long-term rate. In Italy, short-term interest rates affect the consumption of durables whilst long-term rates affect the consumption of non-durables. The magnitude of the substitution channel is given in Figure 12. Average output effects in the first two years are largest in Greece (-0.25%) and Portugal (-0.2%), whereas in Belgium there is a small positive output effect. Price effects are generally much smaller, with the largest effects reported in Austria and Portugal (-0.02%) with a small positive effect observed in Italy.

As highlighted earlier, the output effects would be expected to depend on the proportion of GDP accounted for by consumers' expenditure and the sensitivity of consumption to changes in interest rates. To examine the first issue we have plotted the output effects against the share of consumers' expenditure in total GDP (Figure 13). This shows a clear relationship with a greater consumption share being associated with a larger substitution effect on output.

As discussed, the sensitivity of consumer spending to changes in interest rates may be expected to depend on the extent to which consumers' feel the need to make precautionary savings and the extent to which they face credit constraints. A rise in interest rates would increase the return to precautionary balances and, if it led to a worsening in economic conditions, would also be expected to increase the need for such balances, inducing additional saving and a fall in consumer spending. The need for precautionary savings may be higher for the self-employed who would be expected to enjoy less employment security than permanent employees. In addition, as the self-employed are less likely to have a regular and reliable pattern of income, they may more readily encounter credit constraints than permanent employees. A rise in interest rates may increase the number of credit-constrained consumers as collateral declines and may worsen short-term income prospects. As is shown in Figure 13, there is a reasonably clear relationship between the self-employment share and the output effects of the substitution channel. In those countries where self-employment is more prevalent, the output effects of the substitution channel are larger in magnitude.

Similar arguments could be advanced with respect to certain labour market institutions. For instance trade unions might be expected to reduce the likelihood of employees facing significant wage cuts or facing redundancy. If people do lose their jobs, a generous unemployment benefit system would reduce the income loss from redundancy. Therefore, both institutions might be expected to be associated with a lower need for precautionary savings. As shown in Figure 14, there are some signs that the magnitude of the substitution channel is diminished in those countries where these institutions are stronger.

Cost of Capital

The cost-of-capital channel is present in all models but there are differences between the various models in the way this channel is incorporated. As Table 10 reveals, 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. Figure 15 gives details of the magnitude of the cost of capital channel. Italy is the country with the strongest reported cost of capital impact on output (-0.18) followed by Portugal (-0.15), with Luxembourg reporting the smallest effects. The largest impact on prices is also observed in Italy and Portugal (-0.025), with Belgium reporting a small rise in prices.

As discussed, the magnitude of the cost of capital channel might be expected to depend on the financial structure and the conditions faced by firms and the industrial structure. To consider the first of these we have examined the links between the results and the proportion of firms' financing which is short-term, the size of firms' interest payments and the proportion of small firms. No role is found for the proportion of firms using short-term-financing, but as Figure 16 shows, there is some relationship between the magnitude of non-financial firms' interest payments and the cost of capital channel, with greater interest payments being associated with a more influential cost of capital channel. However this relationship is largely driven by one observation (Italy)[34]. A relationship is also found between the share of small firms and the output effects of the cost of capital channel. As discussed, the argument here is that small firms may be subject to greater capital market frictions than larger ones and more affected by the credit channel. Finally, as was highlighted in the Introduction, it might be expected that the magnitude of the cost of capital channel might be affected by industrial structure. For instance, it may be the case that manufacturing, particularly of durables and investment goods, would be more significantly affected than other sectors. As shown in the figure, there appears to be some relationship with a larger manufacturing sector being associated with a larger magnitude of the cost of capital channel.

It is clear that the figures presented in Figure 16 can explain only a limited amount of the cross-country variation in the cost of capital channel. It may well be the case that the results are driven by country-specific factors, such as traditional patterns of behaviour in the finance industry. For example, in Germany there is a tradition 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).

Income

The combined cash flow/income channel exists in all models except in those for Greece and Ireland. The impact of this channel will depend on the financial position of households and firms at the time of the policy action[35]. The magnitude of the income channel is shown in Figure 17. Portugal and Finland report negative income channel effects on output in the first two years, whilst Belgium, Spain, France and Italy report positive effects. Only in the case of Finland (negative) and Italy (positive) do these output effects translate into any noticeable price effects in the first two years.

The magnitude of the income effect may depend on the net amount of interest receipts by households and also household's exposure to interest changes through short-term debt. The first chart in Figure 18 plots net interest receipts as a proportion of net income against the magnitude of the income channel. It does appear to be the case that where net interest receipts are negative, the income channel exerts a negative effect on output, and where net interest receipts are positive, the output effects are also positive. 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 the Netherlands, households are net debtors. Hence, the income channel tends to reinforce the drop in output in these countries.

The second chart links the proportion of financing that is short-term with the magnitude of the output effects from the income channel. It does appear to be the case that, where more household borrowing is short-term the income channel is more negative (for example in Portugal).

34. In fact this firms' net interest payments measure may be more directly related to the income channel than to how credit constraints affect the cost of capital channel.
35. The change in interest payments sums up to zero, when taking into account the rest of the world.

Wealth

The wealth channel is not present in the models for Austria, 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 Finland (house prices), Italy (house and bond) and the Netherlands (house, share and bond prices). In the models for Finland and the Netherlands, wealth not only affects consumption directly, but also residential investment through changes in house prices.

Figure 19 gives details of the magnitude of the wealth channel, although the results are rather sparse as only Italy, the Netherlands, Ireland and Finland report any noticeable wealth effects in the first two years. Wealth effects on output are negative in Italy and the Netherlands and positive in Ireland[36]. The results for Finland give no perceptible impact on average output in the first two years and a tiny (positive) impact on prices.

To examine these wealth channel results we have plotted the output effects against the market capitalisation as a % of GDP (Figure 20). The idea here is, that countries with a more significant equity market may report more significant wealth effects. As can be seen from the chart, no clear relationship is observed which is not too surprising given the paucity of the results from the wealth channel.

The weakness of the wealth channel is perhaps surprising, given the increased importance of stocks and bonds in portfolios of households and firms. One reason why wealth effects may be moderate, even when explicitly accounted for in the models, relates to the fact that, by assumption, the interest rate shock is a rather short-lived so that forward looking long-term interest rates respond only partially, limiting the impact on asset prices. Nevertheless, for those countries that consider endogenous asset valuation effects, the total real effects (not only the wealth effect) of the monetary disturbance seems to be more relevant (see section 3.2).

3.4.2 FOREIGN CHANNELS

Exchange Rate

The exchange rate channel 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 euro initiates a change in domestic prices, which will spread through the price and wage system. The importance of the exchange rate channel in each of the countries is given in Figure 21. As the charts indicate, the largest price effects are recorded in Finland with an average fall of 0.4% in the first 2 years. In contrast, the smallest price effects are observed in Luxembourg with an average fall of 0.015% over this period. However, the distribution of output effects is rather different. In this case the largest output effects are recorded in Germany (-0.225%) and the smallest in Portugal (-0.02%).

A number of factors may underlie these results. Campa and González-Mínguez (2002) find that openness and sectoral composition are relevant determinants of differences in the exchange rate pass through in euro area countries. Hence, for both the price and output effects it would be expected that the proportion of trade outside the euro area, which will thus be affected by a change in the euro exchange rate, should help to explain the pattern of results, at least in the short run. However, in neither case are the results supportive of the notion that trade patterns can explain the exchange rate channel. A number of additional factors maybe at work. In the case of the effects on domestic prices, the extent and the speed of the pass-through will also be important. This will depend on the pricing strategies of importers and the extent to which they 'price-to-market' or passively accept exchange rate

36. In the latter case this is due to the deflator attached to the wealth variable (the consumption deflator), being more affected than the nominal wealth variable and leading to a rise in *real* wealth.

induced price changes. For instance it might be expected that changes in the price of raw materials and fuels, which are determined on international markets, would be passed through into domestic prices. If this was the case, then a high share of such items in total imports may be reflected in a larger change in domestic prices, following the change in the exchange rate. As shown in Figure 22, this relationship appears to hold for the price effects of the exchange rate channel.

In relation to the output effects of the change in exchange rate it might be expected that the presence of multinational firms might lead to larger effects from the exchange rate channel as such firms may be more easily able to relocate production. To proxy this effect, the figure plots the relationship between the share of large firms and the output effects of the exchange rate channel. There appears to be a weak relationship, with larger firms being associated with a larger output effect from the change in the exchange rate.

Spillovers

The magnitude of the spillover channel is reported in Figure 23. Finland is the country with the largest impact on prices via the spillover channel (-0.075%) whilst Germany and Ireland report minimal price effects. In terms of output, the largest effects are reported in Belgium (-0.1%) and Luxembourg (-0.08%).

The magnitude of the spillover channel on prices may depend on how import price changes feed through into domestic prices. This will depend, at least in part, on how important intra-euro area imports are in relation to GDP. Figure 24 relates intra-EU-12 imports (of goods) as a % of GDP to the magnitude of the spillover effects on prices. A slight relationship is observed (whereby more intra EU-12 trade is associated with a larger price effect from the spillover channel). However, these results are greatly affected by one outlier (Finland), and if this is removed, a stronger relationship is observed.

As regards the output effects, we have linked these to total intra-EU-12 trade as a proportion of GDP. Here, a clear relationship is observed, with greater intra-EU-12 trade being associated with larger spillover effects on output.

4 Model-Based Explanations

Thus far we have examined the plausibility of the WGEM monetary policy transmission results with respect to other evidence. In this section we adopt a different approach of looking for differences in modelling strategy as even the same economy may be characterised by alternative models. Therefore, it is also important to analyse the distinct features of model design across the macroeconometric models used for the monetary policy experiment. Ultimately, it would be an empirical task to decide which is the best representation of the statistical regularities and the structural features of a single economy. The classic way to do that is to compare the fit of the estimated models. However, in this section we abstract from differences in results due to economic differences and study the key features of the models and what the implications may be for the differences in the simulation results.

Most models use the marginal conditions that arise from a well-defined supply-side model to determine the long-run equilibrium conditions. These conditions are consistent with the neoclassical equilibrium properties whereby transitory nominal shocks are neutral in the long run. Therefore, the main differences in the case of a temporary monetary shock should be reflected in the dynamic adjustment of the variables to their long-run equilibrium. Thus, we will concentrate on four properties of the models with respect of the mechanism of propagation of shocks: (1) The treatment of expectations; (2) The measurement of wealth valuation; (3) The determinants of the labour market variables and (4) The existence of specific monetary and expectational channels in some country models[37].

4.1 Treatment of Expectations

Modern quantitative models are explicit about how the expectations of the future value of relevant variables are solved by agents to form their optimal decision plans. The macroeconometric models whose results are reviewed here are used not only for forecasting purposes but also to address relevant policy questions. This has led some model proprietors to attempt to incorporate forward-looking expectations into their structures. In Table 11 we see that fewer than half of the central bank models have incorporated some type of forward-looking behaviour into agents' decisions. They are Germany, Italy, Belgium, Finland and the two models for the euro area, the Area Wide Model (AWM) and the Euro area Dynamic General Equilibrium (EDGE). The remaining models implicitly assume that the formation of expectations is captured by current and lagged values of the observable variables. The way this is usually done, is by fitting the unrestricted lags of those variables to the data when estimating single behavioural equations.

Three models, those for Germany, Italy and the AWM, consider the expectations on the aggregate price or wage equation and/or on the price of specific asset markets. These are usually long-term interest rates and exchange rates. Since the simulation exercise we are considering already incorporates an exogenous path for these two financial variables consistent with the expectational theory of interest rates and the UIP, that aspect of forward-lookingness will not make a difference with respect to the models that are completely backward-looking.

In Table 12 we present the key features of the remaining three models (i.e. Belgium, Finland and EDGE) that are more fully forward-looking. The magnitude and shape of the responses of all the nominal and real variables will be affected since these models do not consider expectations in an isolated way. The theoretical foundations that give rise to the presence of expected values on the agents' decision functions are in the spirit of

37. Other mechanisms of propagation such as the existence of financial frictions or the modelling of the intertemporal decisions of the public sector are potentially important, but are beyond the scope of this analysis.

Blanchard's (1985) stochastic lifetime approach and profit-maximising firms with some monopoly power. This gives consumption and investment decision rules that are a function of relevant current and expected variables. The models for Belgium and Finland are the only ones that have been estimated and are used both for projection as well as for simulation exercises. On the other side of the spectrum is the EDGE model that has been calibrated and is mainly used for policy analyses.

The most relevant characteristic of the two estimated models is that they combine model-consistent expectations with backward-looking expectations that arise when the optimal decisions of the agents are embedded in some type of optimal adjustment plan problem. The main reason for replacing the usual rational expectations dynamics by these ad hoc dynamics is to improve the goodness of fit of the models. This is probably why there are no models with purely model-consistent expectations used for forecasting purposes. A novel feature of the Belgian model is that the expectations needed to perform the estimations and simulations are consistent with those provided by an auxiliary VAR model[38].

As is shown by the simulation results in Table 13, the two estimated models have some special features. In Finland, the response of prices and output to a monetary shock reaches a maximum value within the first year. Moreover, the magnitude of this contractionary shock in the first year is higher than in any other country[39]. Belgium has relatively moderate real and nominal effects but its maximum output response is during the second year and almost disappears in the fourth year, whereas the maximum price response occurs in the third year. It is not surprising that the shape of the Belgium's responses was found to be consistent with those found in the VAR literature (see Section 1) since an estimated VAR has been used to fit the dynamics of the model.

In any case, it seems that a common shared property of both estimated models is the fast real and nominal transmission of the monetary shock. This is in spite of the classification of Finland and Belgium as having a small output effect on average compared with the aggregate of the euro area models [see Van Els et al. (2001)]. That result also holds with other macroeconometric models. For example, McAdam and Morgan (2001) find that the inclusion of forward looking elements in the NIGEM model tends to increase the initial impact and to hasten the return to baseline values of the macroeconomic variables after a monetary shock.

A similar pattern can be seen in the calibrated model for the euro area (EDGE). This can be seen by comparing the results of the monetary shock with the EDGE model, which is forward-looking, and the AWM, which is backward-looking[40]. In the first case, the maximum output effect occurs during the first year of the simulation period whereas in the AWM it occurs in the third year. Similarly, in the EDGE model the greater changes in prices occur in the first three years whereas in the AWM they are equally distributed over the five years of the simulation period.

4.2 Treatment of Wealth Valuation

Another source of differences in macroeconometric modelling that may be relevant for understanding the simulation results is how wealth is treated in the models. As we can see from Table 14, most countries' models have a wealth variable (except Austria, Greece, France and Portugal) defined as the sum of the financial and non-financial assets owned by private agents. Those models that have a wealth variable include it jointly with real disposable income to determine the long-term trend of consumption. The Belgian model, given its forward-looking character, can also incorporate human wealth measured as the present value

38. This estimation method is discussed for example by Brayton and Tinsley (1995), and has also been considered by the FRB/US econometric model.
39. This was also discussed in Section 1.
40. Since the path of the effective nominal exchange rates is very similar, but not equal, in both models we do a qualitative comparison.

of future wage income. Still, even in this case, current income is a long-run determinant of total consumption since the model assumes the existence of liquidity-constrained consumers. An exception is the model of Ireland which does not include an income variable as a determinant of long-run consumption; the latter being determined by wealth alone.

Although there is a wide range of assets to be considered, the most common definition includes government debt, the stock of capital and the net foreign asset position (i.e. Ireland, Luxemburg, Spain, EDGE and the AWM). Some models also include in the financial assets definition real balances or liquid assets (i.e. Italy, Finland and the Netherlands). Finally, housing is also considered in the models of Belgium, Italy, the Netherlands and Finland. Nevertheless, Table 14 also shows that there are only a limited number of countries that have modelled the determinants of prices in stock markets or housing markets. For those models that consider asset prices as endogenous variables, they are valued as the discounted present value of future dividends. In the case of backward-looking models (i.e. Italy and the Netherlands) this is usually approximated by the real (long-term) interest rates, some measure of current profitability and a time trend.

Table 15 analyses the implications of modelling asset prices in terms of the monetary policy simulation. We report both the output effect and the contribution of wealth to that output effect for the three euro area economies that incorporate the market price valuation of their wealth and for other three euro area models that report some wealth effect but that only consider changes in asset holdings. From Table 15 we conclude that the contribution of the wealth effect to the monetary transmission seems to be more relevant in those countries for which changes in wealth valuation are endogenous. This is a relevant channel of monetary transmission since changes in interest rates will affect the price of those assets, incrementing the wealth effect on consumption.

4.3 Labour Market Equations

A common characteristic of all the models is that they assume some form of imperfectly competitive labour market. The way this is usually formulated is considering first that, in addition to, productivity, the unemployment rate also affects nominal wage setting. Nevertheless, for some specifications the long-run unemployment rate, the NAIRU, remains exogenous, whereas in others there is a long-run relationship between wages and unemployment that will help to determine the equilibrium rate of unemployment as a function of third variables that measure structural properties of the labour market (i.e. Netherlands, Italy and Spain). Secondly, in most models the firm's labour demand is consistent with a price mark-up function over unit labour costs. Finally, another relevant modelling factor that will drive the dynamics of the labour market variables is how expectations affect wage formation. If those expectations are explicitly introduced, this is done through the consideration of wage contracts (i.e. Finland) or through inflation expectations equations (i.e. Germany, Italy and Belgium). The description of the wage setting is completed with a labour demand relationship derived from the production function.

Figure 25 shows the responses of unemployment to the monetary shock across the euro area models as well as the aggregate value. For comparison, we have displayed separately the countries with larger and moderate effects[41]. The maximum effect appears in Spain, followed by Portugal, Greece and Italy. Finland also shows a very large response, but contrary to the other countries, here the adjustment occurs in the first two years. A similar ranking would appear if it were considered the employment response instead of the unemployment rate.

Figure 26 displays the responses of real wages after the monetary tightening. The expected fall in real wages, derived from the reduction in aggregate demand, takes more than

41. The splitting of countries is based on the comparison of the maximum response of unemployment. The same classification appears when considering the accumulated effect over the simulation period.

two years to become significant for most countries[42]. Moreover the aggregate effect for the euro area is small compared with the estimated responses of unemployment. This is contrary to what is observed among the euro-area models (both the EDGE and the AWM) that display a much higher response of real wages which becomes significant two years after the shock.

Finally, Figure 27 shows the real unit labour cost responses to the monetary shock. This is a very relevant variable, given its direct effect on the inflation rate. In general, unit labour costs do not fall on impact and take at least two years before starting to fall. The main reason may be that during the first two years the existing labour hoarding prompts a fall in productivity greater than that in real wages[43]. Once the rise in the unemployment rate exerts some pressure on real wages, this helps to reduce marginal costs and, therefore, the inflation rate.

It is not clear how the results in Figures 25-27 square with the alternative ways the labour market variables have been modelled. In part, this is due to the fact that the differences in the way the NAIRU has been modelled, will not be important in the face of temporary changes in aggregate demand. In addition, as mentioned above, there are not large differences in the short-run specification of wages and employment equations across models. Nevertheless we find that the group of countries with larger unemployment effects (i.e. Spain, Greece, Italy, Portugal) is not too dissimilar from the corresponding group with with large GDP effects [see Van Els et al. (2001)], showing the relevance of the labour market variables in the propagation of the shock[44]. The degree of real wage rigidity, as an important source of inefficiency in the labour markets, should be reflected both by different estimated unemployment elasticities to wages and by a different degree of sluggishness in employment. Moreover, the degrees of nominal inertia should be associated with the presence of different coefficients of expected and lagged prices as well as with acceleration terms in the wage equations. A combination of both features is likely to be captured by the range of wage and employment responses across countries. Still, in section 2.3 we did not find a significant relationship between the monetary results and some labour market variables.

4.4 The Monetary and Expectational Channels

Finally, we describe two country-specific channels of inflation expectations formation that are quantitatively relevant for the transmission of the monetary shocks: the monetary channel for Germany and the expectational channel for Italy.

In most of the models reviewed, money plays a passive role since it does not interact with other endogenous variables. The exception to that rule is the Deutsche Bundesbank model. It has a monetary sector for the euro area with a long-run money demand equation and a P-Star definition consistent with such an equation. In the short run, inflation is a function of backward-looking and forward-looking expectations as well as of the price gap. Moreover, there is an interest rate reaction function that depends on the deviations of current money growth from its long-run level.

After an interest rate shock, during the first two years prices and output rise in Germany, driven by the existence of a dominant exchange rate channel. This is common to other countries' transmission mechanisms (e.g. Netherlands, Belgium or Finland). But in the medium run (after the third year) there are significant effects caused by this monetary channel that are only present in the German model. Due to the strong fall in prices, real wages and consumption rise. Thus, the monetary channel is the main force reducing prices after the third year but it also contributes to a significant expansion in output.

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42. This pattern does not occur in Germany, as the fall in prices is much more marked than the fall in nominal wages.
43. There are some exceptions, such as Spain, where the substantial elasticity of labour demand to output generates acyclical labour productivity movements.
44. This pattern is not seen in Austria, where there is a above aggregate response of output, but a below aggregate response of unemployment.

In the Italian quarterly model the wage equation incorporates an inflation expectation term that is determined not only by cost variables, competitors' prices and demand measures, but also by the policy interest rate. This last term allows monetary policy to affect inflation expectations directly. As in the German case this is a channel that becomes important in the medium term, but quantitatively it plays a modest role in the total Italian output effect.

5 Conclusions

This paper has examined possible explanations for observed variations in the transmission of euro area monetary policy in central bank models. To this end, it has examined available measures of the significance of these differences, assessed whether they appear plausible on economic grounds and considered the role played by differences in model design. With regard to the plausibility of the results, a broadly based approach was adopted, whereby results were compared with structural and institutional characteristics of the respective national economies and with established business cycle properties.

Financial structures and the fiscal policy framework appear to make some contribution to explaining part of the heterogeneity in the responses of countries to a monetary policy shock. There also appears to be a role for the credit channel as various financial indicators show some relationship with the pattern of results. In addition, entry barriers and the pervasiveness of the employment protection legislation appear to raise the economic costs of adjusting after a monetary policy shock. Industrial structure does not seem to explain much of the detected cross-country differences in the transmission mechanism. In relation to the decomposition into channels of transmission, the magnitude of most channels appeared to bear at least some relation to prior beliefs based on information about the respective economies.

With regard to business cycle properties, there appeared to be some evidence that the transmission results corresponded to cross-country differences in various business cycle 'stylised facts'. In particular, a high volatility of consumption observed in the business cycle data may be indicative of a greater sensitivity of consumption to changing interest rates. This pattern was observed in the WGEM results, where the magnitude of the substitution channel seemed to correspond to the volatility of private consumption.

As a further robustness check, the results from the WGEM exercise were compared with some existing VAR evidence. However, it should be noted that the two sets of results are not strictly comparable, most importantly in their treatment of monetary policy actions, and, indeed, the quantitative results differ quite markedly. The cross-country distribution of the maximum impact on prices was broadly similar across the two competing methodologies. However, the cross-country differences in maximum output effects obtained using the VAR model did not correspond well to those generated in the WGEM simulations.

Finally, the role of differences in model design was also investigated. It was found that the existence of alternative forward-looking elements in the models was one of the reasons for finding sizeable differences across model results, particularly with regard to the speed of adjustment. For the models that have explicitly incorporated market valuation of assets, the wealth channel becomes more significant. Irrespective of the way the NAIRU is modelled, the presence of the unemployment rate in the wage equation (or of other variables describing the non-competitive environment in the labour market) is a factor that influences how monetary policy affects the inflation rate. The monetary channel, that is incorporated into the German model, has an important impact on the transmission of monetary policy in this model.

To summarise, against most yardsticks, the cross-country variation in the WGEM results was found to be plausible. The results broadly corresponded to the differences in business cycle properties across countries and most –but not all– economic, financial and structural statistics. When compared against the VAR evidence, the results were more mixed with similarities in the pattern of price –but not output– responses. Nevertheless, despite these signs that the results may reflect underlying economic differences, the role of differing

modelling strategies should not be ignored. Important features of the models –for instance in the treatment of expectations or wealth– can have a major bearing on the results that may not necessarily reflect differences in the underlying economies.

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Table 1. Common monetary policy simulation: Magnitude and Timing of the Response of GDP

	σ_i	*F-test*	*p-value*	ρ_i	*t-test*	*p-value*
Belgium	0.034	2.241	0.043	0.813	5.925	0.000
Germany	0.067	1.707	0.126	0.758	4.932	0.000
Greece	0.095	3.473	0.005	0.798	5.620	0.000
Spain	0.075	2.151	0.052	0.627	3.410	0.003
France	0.037	1.948	0.078	0.978	19.946	0.000
Ireland	0.067	1.754	0.115	0.873	7.577	0.000
Italy	0.090	3.131	0.008	0.830	6.314	0.000
Lux	0.050	1.026	0.478	0.682	3.955	0.001
Neth	0.057	1.266	0.306	0.657	3.696	0.002
Austria	0.057	1.255	0.313	0.701	4.172	0.001
Portugal	0.118	5.376	0.000	0.611	3.278	0.004
Finland	0.149	8.497	0.000	0.300	1.335	0.199

Note:
The first three columns report for each country the interim (20 periods) standard deviation (σ_i) of the response of output to a monetary policy shock, the value of the F-statistic and the corresponding p-value for testing whether output variability is the same in country i as in the aggregate of EMU. The next three columns show the correlation coefficients between output response in country i and in the average of the euro-area (ρ_i), the value of the t-statistics and the corresponding p-value for testing whether the patterns of responses at the country and aggregate level are the same.

Table 2. Common monetary policy simulation: Magnitude and Timing of the Response of Consumer Spending

	σ_i	*F-test*	*p-value*	ρ_i	*t-test*	*p-value*
Belgium	0.006	40.345	0.000	-0.984	-23.394	0.000
Germany	0.023	2.644	0.020	0.336	1.512	0.148
Greece	0.091	5.943	0.000	0.792	5.506	0.000
Spain	0.057	2.316	0.037	0.555	2.832	0.011
France	0.045	1.490	0.196	0.880	7.850	0.000
Ireland	0.067	3.253	0.007	0.476	2.296	0.034
Italy	0.102	7.461	0.000	0.834	6.408	0.000
Lux	0.083	4.996	0.000	0.568	2.930	0.009
Neth	0.040	1.149	0.383	-0.080	-0.340	0.738
Austria	0.048	1.634	0.147	0.735	4.600	0.000
Portugal	0.264	50.229	0.000	0.879	7.835	0.000
Finland	0.174	21.965	0.000	-0.416	-1.938	0.068

Note:

As in Table 1

Table 3. Common monetary policy simulation: Magnitude and Timing of the Response of the Consumption Deflator

	σ_i	*F-test*	*p-value*	ρ_i	*t-test*	*p-value*
Belgium	0.029	2.610	0.021	0.829	6.280	0.000
Germany	0.057	1.518	0.185	0.956	13.815	0.000
Greece	0.071	2.327	0.037	0.855	6.995	0.000
Spain	0.091	3.771	0.003	0.822	6.131	0.000
France	0.026	3.164	0.008	0.859	7.133	0.000
Ireland	0.031	2.228	0.044	0.902	8.865	0.000
Italy	0.057	1.492	0.195	0.936	11.288	0.000
Lux	0.015	9.869	0.000	0.824	6.168	0.000
Neth	0.048	1.054	0.455	0.935	11.200	0.000
Austria	0.031	2.331	0.036	0.293	1.299	0.210
Portugal	0.046	1.049	0.459	0.900	8.780	0.000
Finland	0.159	11.603	0.000	0.435	2.050	0.055

Note:
As in Table 1

Table 4. Common monetary policy simulation: Magnitude and Timing of the Response of the GDP

	σ_i	*F-test*	*p-value*	ρ_i	*t-test*	*p-value*
Belgium	0.022	4.724	0.001	0.881	7.915	0.000
Germany	0.065	1.787	0.107	0.913	9.522	0.000
Greece	0.067	1.907	0.084	0.708	4.259	0.000
Spain	0.095	3.839	0.003	0.940	11.687	0.000
France	0.027	3.293	0.006	0.966	15.935	0.000
Ireland	0.041	1.412	0.229	0.964	15.397	0.000
Italy	0.059	1.474	0.203	0.812	5.902	0.000
Lux	0.024	4.116	0.002	0.635	3.487	0.003
Neth	0.075	2.368	0.034	0.774	5.193	0.000
Austria	0.016	8.975	0.000	0.701	4.174	0.001
Portugal	0.046	1.101	0.418	0.892	8.387	0.000
Finland	0.119	5.969	0.000	0.021	0.091	0.929

Note:

As in Table 1

Table 5. Cyclical Bahviour of the Euro Area Economics: Volatility of Macro Time Series[45]

Countries	*GDP*	*Consumption*	*Investment*	*Wages*
Belgium	1.85	1.67	7.35	2.42
Germany	2.03	1.92	4.81	3.36
Greece	2.15	2.35	8.06	5.27
Spain	2.27	2.63	7.15	4.05
France	1.61	1.79	4.51	4.41
Ireland	3.08	3.45	9.32	7.60
Italy	2.38	2.16	4.88	7.23
Luxembourg	3.17	2.19	10.01	1.73
Netherlands	1.48	1.86	4.51	1.84
Austria	1.73	2.08	5.86	2.16
Portugal	2.57	3.24	8.69	4.84
Finland	3.25	3.04	9.86	4.34

45. Standard deviation of year-on-year changes

Table 6. Comparing the WEGEM Simulations and the VAR Evidence

	Peersman (2002)		*WGEM (rescaled)*	
Real GDP	Maximum impact (%)	Lag (quarters)	Maximum impact (%)	Lag (quarters)
Belgium	-0.20	3	-0.05	3
Germany	-0.18	4	-0.09	3
Spain	-0.18	4	-0.07	5
France	-0.17	3	-0.05	3
Italy	-0.21	4	-0.11	4
Netherlands	-0.13	5	-0.07	3
Austria	-0.18	4	-0.10	4
Prices				
Belgium	-0.09	20	-0.03	3
Germany	-0.05	20	-0.05	11
Spain	-0.19	20	-0.07	14
France	-0.09	20	-0.02	2
Italy	-0.16	20	-0.05	3
Netherlands	-0.06	1	-0.05	3
Austria	-0.05	20	-0.03	1
Inflation				
Belgium	-0.08	10	-0.03	3
Germany	-0.10	10	-0.03	5
Spain	-0.12	4	-0.05	6
France	-0.06	11	-0.02	2
Italy	-0.14	5	-0.05	3
Netherlands	-0.01	12	-0.05	3
Austria	-0.09	8	-0.03	1

Note:

The maximum lag is equal to 20 quarters.

Table 7

Financial structure and monetary policy transmission

	slope	*t-stat*	*p-value*	*d.o.f*	R^2
Stock market capitalisation	-0.003	-0.594	0.284	9	0.038
MFI loans to non-financial sector	-0.005	-0.552	0.297	9	0.033
MFI loans to non-financial corporations	0.017	0.886	0.801	9	0.080
MFI loans to non-financial sector (< 1 year)	0.042	1.560	0.923	9	0.213
MFI loans to households	-0.015	-1.354	0.104	9	0.169
MFI morgages to households	-0.015	-1.205	0.129	9	0.139
Consumer credit	0.040	0.593	0.716	9	0.038
Total number of credit institutions	0.011	1.751	0.938	7	0.305
Credit institutions from other EA countries	0.092	0.587	0.712	7	0.047
Credit institutions from non EA countries	-1.669	-1.643	0.081	5	0.351
Herfindahl Index	1.080	0.288	0.609	6	0.014
Market share of the five largest banks	0.005	0.473	0.675	7	0.031
Total assets of the banking sector (% GDP)	-0.003	-1.212	0.128	9	0.140
Number of firms issuing shares	0.032	1.284	0.884	9	0.155
Average capitalisation of firms issuing shares	0.000	-2.639	0.013	9	0.436
Firms with less than 10 employees	-0.003	-0.130	0.450	9	0.002
Firms with less than 50 employees	0.001	0.036	0.514	9	0.000
Firms with less than 250 employees	0.011	0.540	0.699	9	0.031
Firms with 250 employees or more	-0.013	-0.628	0.273	9	0.042

Note:

This table reports the results from a regression where the sacrifice ratio (computed focusing on the response of the unemployment rate and the GDP deflator in the first five years of the simulation experiment) is regressed on each of the above variables in turn. The first column reports the slope coefficient, the second its t-statistic, the third the probability value, the fourth the associated degrees of freedom and the final column reports the R-squared from each pairwise regression.

Table 8

Sacrifice ratios, nominal inertia and real rigidities

	slope	*t-stat*	*p-value*	*d.o.f*	R^2
Share of manufacturing sector	-4.539	-0.933	0.375	9	0.088
Openness	-0.514	-0.909	0.387	9	0.084
Product market flexibility index	0.211	0.418	0.686	9	0.019
State control	0.239	0.966	0.359	9	0.094
Barriers to entrepreneurship	-0.540	-1.436	0.185	9	0.186
Barriers to trade and investment	1.252	2.013	0.075	9	0.311
Economic regulation	0.273	0.934	0.375	9	0.088
Administrative regulation	-0.531	-1.813	0.103	9	0.268
Replacement ratio	-2.422	-1.125	0.298	7	0.153
Employment protection legislation	0.036	1.916	0.104	6	0.380
Union density	0.008	0.707	0.502	7	0.067
Union coverage	0.007	0.262	0.801	7	0.010
Coordination in wage bargaining	0.005	0.008	0.994	7	0.000
Wage indexation	-0.111	-1.000	0.343	9	0.100

Note:

As in Table 7

Table 9. Conventional Channels of Monetary Transmission in ESCB Models[46]

	Substitution	Cost of capital	Cash-flow/ income	Wealth	Exchang e rate	Spillover
Belgium	S	P	S	P	P	P
Germany	P	P	P	N	P	P
Greece	P	P	N	N	P	P
Spain	P	S	P	N	P	P
France	P	S	P	N	P	P
Ireland	P	S	N	P	P	P
Italy	P	P	P	P	P	P
Luxembourg	P	P	P	P	P	P
Netherlands	P	P	S	S	P	P
Austria	P	S	P	N	P	P
Portugal	P	P	P	N	P	P
Finland	P	P	P	S	P	P

P (channel present), S (channel present, but has special feature) and N (channel not present).

46. Channels which were present at the time of the WGEM experiment in 2001.

Table 10. A summary of the direct interest rate effects in private investment and consumption

	Private investment	Private 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.	Real 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.

Source: Van Els et al. (2001).

Table 11. Euro area models' properties: Modelling expectations

Backward-looking	Forward-looking elements		
	On inflation	On financial markets	On financial markets and goods markets
Greece Spain France Ireland Luxembourg Netherlands Austria Portugal	Germany Italy	Area Wide Model (AWM)	Belgium Finland EDGE (Euro Area)

Table 12. Euro area models' properties: Highly forward looking models

	Estimated		Calibrated
Combine model-consistent expectations and backward-looking expectations	Belgium:	Polynomial adjustment cost consistent with an auxiliary VAR	EDGE
	Finland:	Quadratic adjustment costs	

Table 13. Euro area models' properties: Importance of the forward-lookingness in the two estimated euro models

Years after the shock	1	2	3	4	5
			Price effect (%)		
Finland	-0.53	-0.50	-0.17	-0.02	-0.08
Belgium	-0.10	-0.18	-0.21	-0.17	-0.12
Aggregate of the euro area models	-0.09	-0.21	-0.31	-0.40	-0.40
			Output efect (%)		
Finland	-0.34	-0.24	-0.15	-0.22	-0.25
Belgium	-0.15	-0.20	-0.10	-0.05	-0.03
Aggregate of the euro area models	-0.22	-0.38	-0.31	-014	-0.02

Table 14. Treatment of wealth valuation across the Euro Area models

No wealth variable considered	**Market value of wealth is exogenous** (only changes in asset holdings)	**Considers changes in wealth valuation** (financial assets and/or housing)
Greece	Belgium	Finland
France	Germany	Italy
Austria	Spain	Netherlands
Portugal	Ireland	EDGE
	Luxembourg	
	AWM	

Table 15. The importance of modelling the wealth channel

Output effect and wealth channel effect (in brackets)					
Year after the shock	1	2	3	4	5
Models that consider changes in wealth valuation					
Netherlands	-0.20	-0.27	-0.25	-0.22	-0.16
	(0.0)	(-0.02)	(-0.02)	(-0.01)	(-0.01)
Finland	-0.34	-0.24	-0.15	-0.22	-0.25
	(-0.01)	(0.01)	(0.01)	(0.00)	(0.00)
Italy	-0.26	-0.60	-0.55	-0.21	0.05
	(-0.01)	(-0.01)	(-0.07)	(0.01)	(0.07)
Models with exogenous wealth effects					
Belgium	-0.15	-0.20	-0.10	-0.05	-0.03
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Luxembourg	-0.17	-0.25	-0.27	-0.23	-0.15
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Ireland	-0.25	-0.48	-0.43	-0.38	-0.32
	(0.01)	(0.03)	(0.03)	(0.02)	(0.00)

Figure1

Common monetary policy simulation

Output and consumption responses: correlation between countries and the euro area

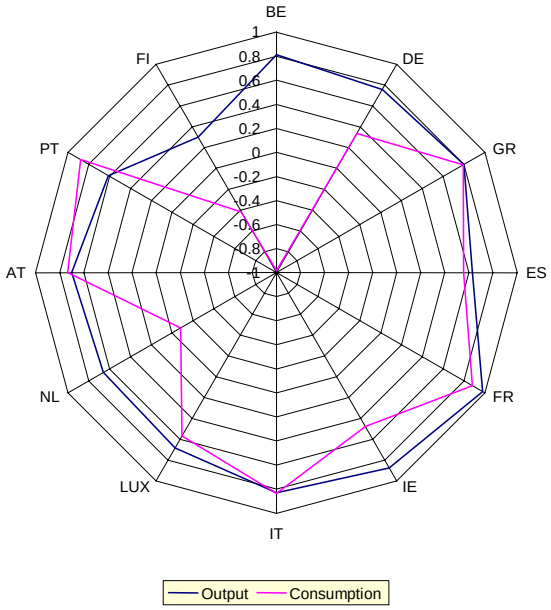


Figure 2

Common monetary policy simulation
Output and price responses: correlation between countries and the euro area

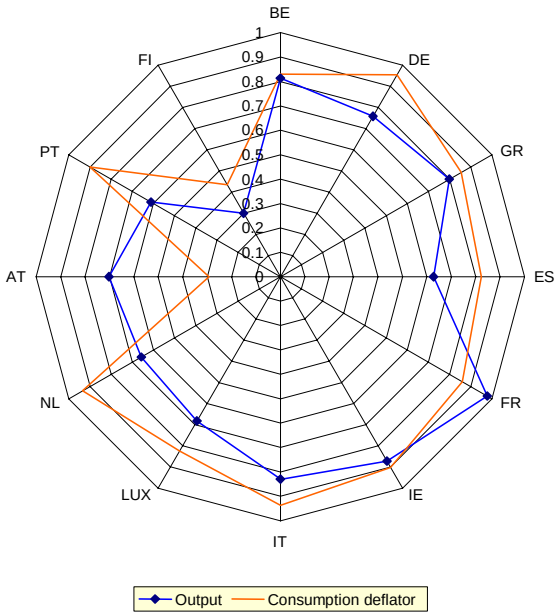
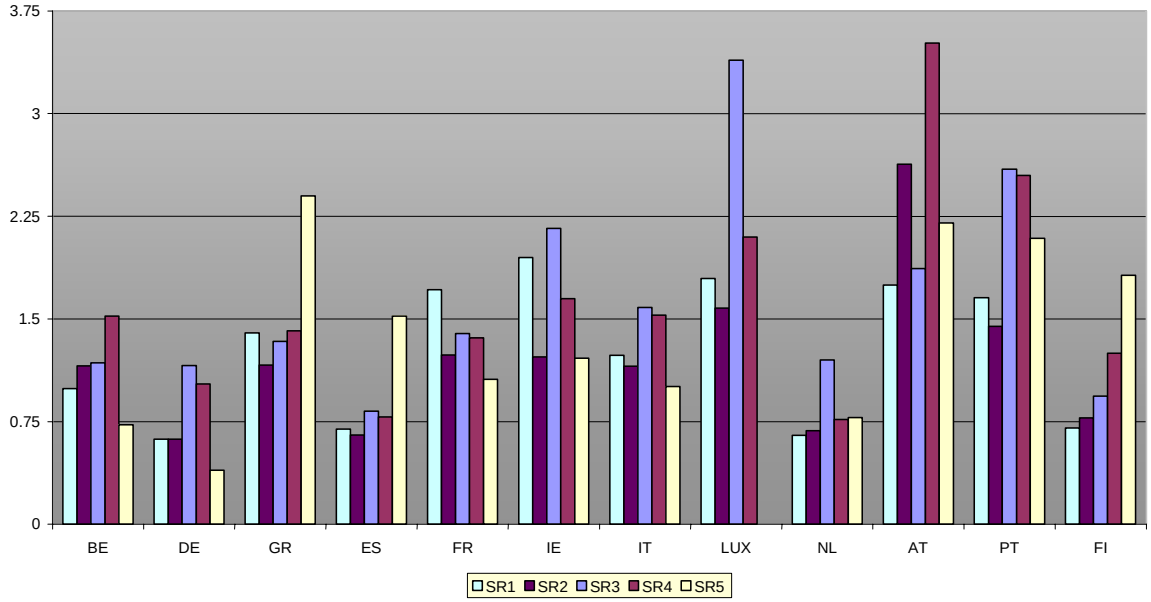


Figure 3

Common monetary policy simulation
Output and price responses: correlation between countries and the euro area

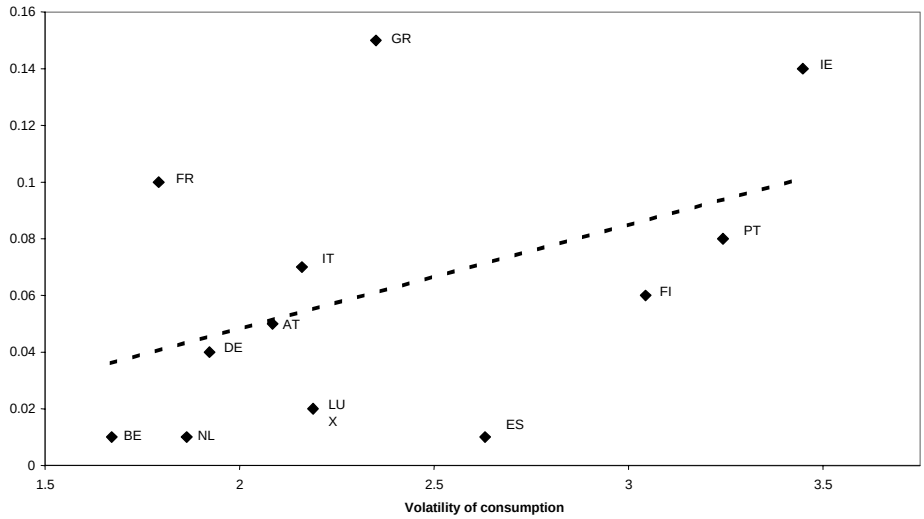
Figure 4

The cost of adjusting to a monetary policy impulse
Sacrifice Ratios for the Euro-area countries
(alternative definitions)



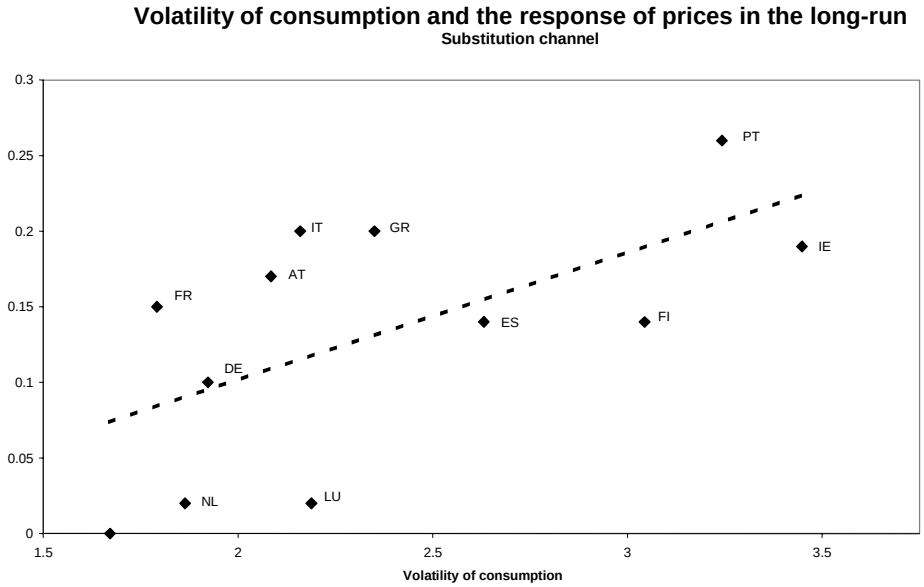
Note:
SR1 is the ratio between the output and the consumption deflator at the trough and SR2 uses the GDP deflator instead. SR3 is the ratio between the variances of output and the consumption deflator and SR4 uses the GDP deflator instead. SR5 uses the peak period for unemployment and the through period for the GDP deflator.

Figure 5



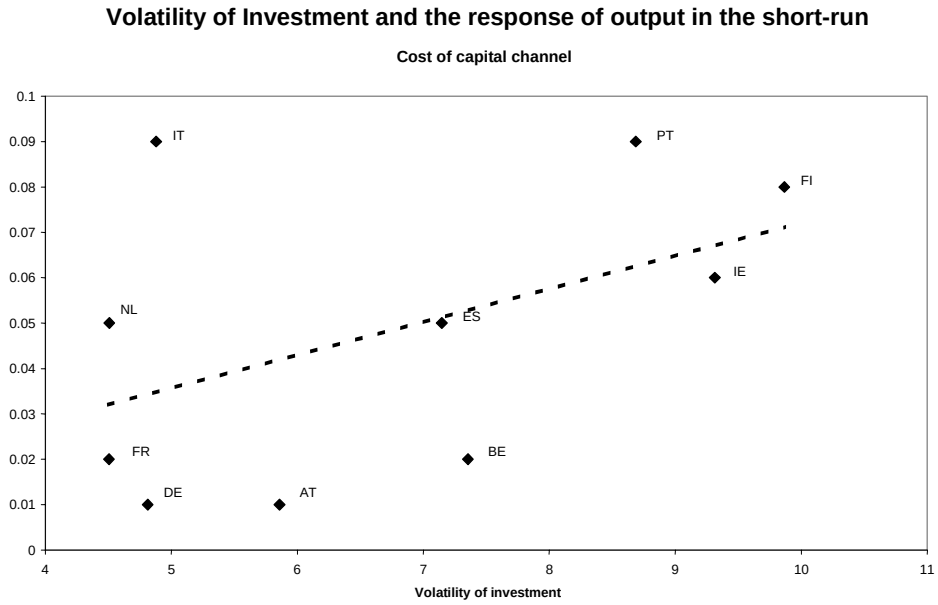
Note: Spearman rank correlation = 0.58 (p-value 0.05).

Figure 6



Note: Spearman rank correlation = 0.58 (p-value 0.05).

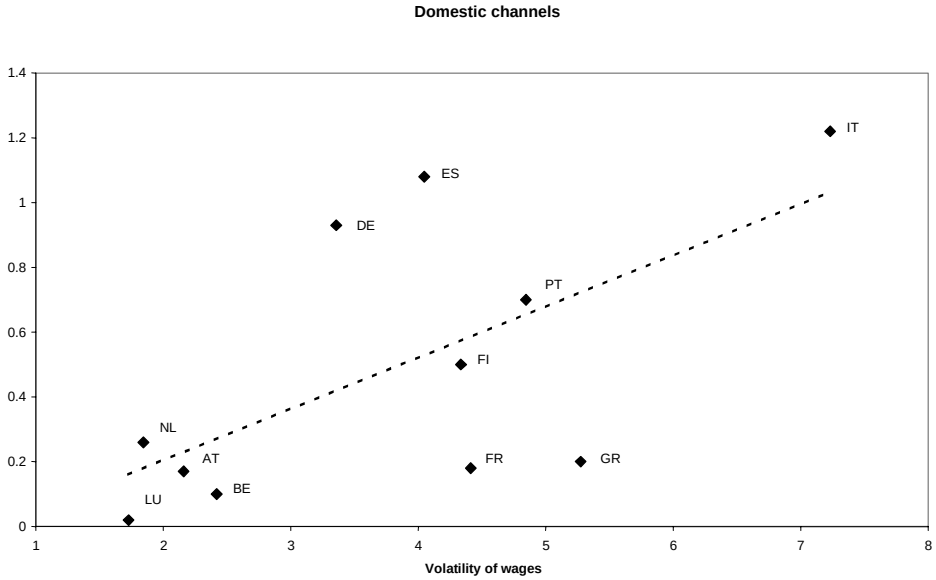
Figure 7



Note: Spearman rank correlation = 0.44 (p-value 0.11), excluding Greece and Luxembourg.

Figure 8

Volatility of wages and the response of prices in the long-run



Note: Spearman rank correlation = 0.57 (p-value 0.08), excluding Ireland.

Figure **9**

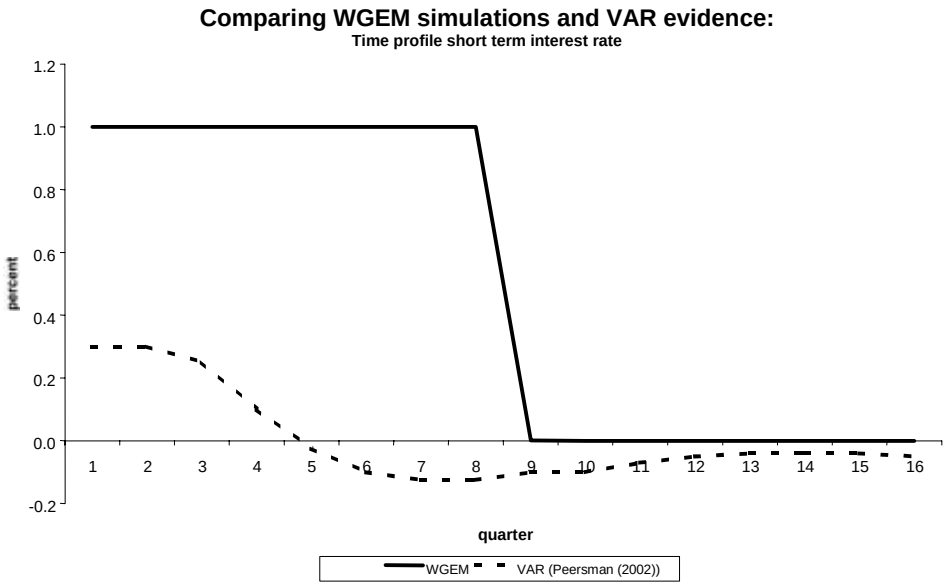
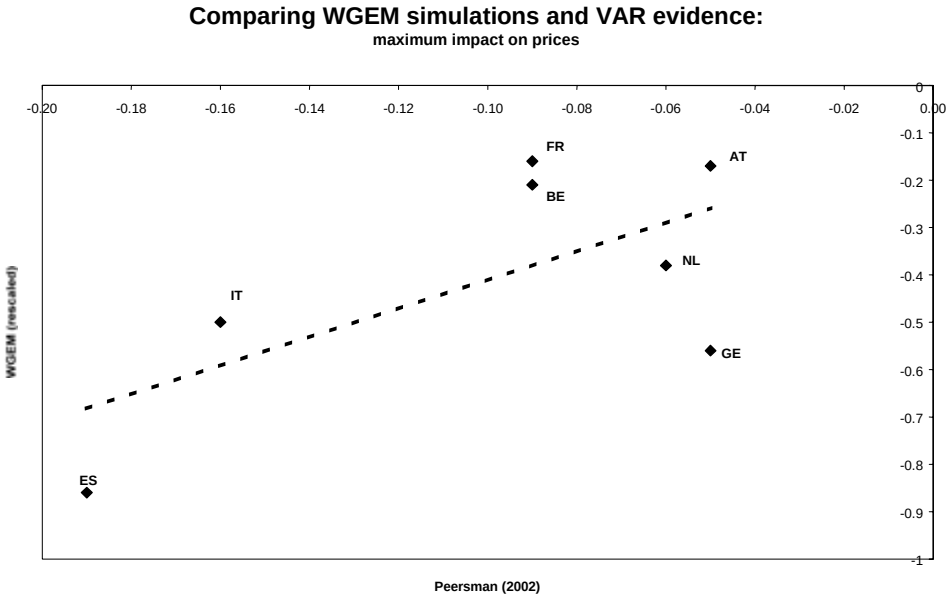

Comparing WGEM simulations and VAR evidence:
Time profile short term interest rate
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
percent
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
quarter
WGEM
VAR (Peersman (2002))

Figure 10



Note: Spearman rank correlation = 0.43 (p-value 0.37)

Figure 11

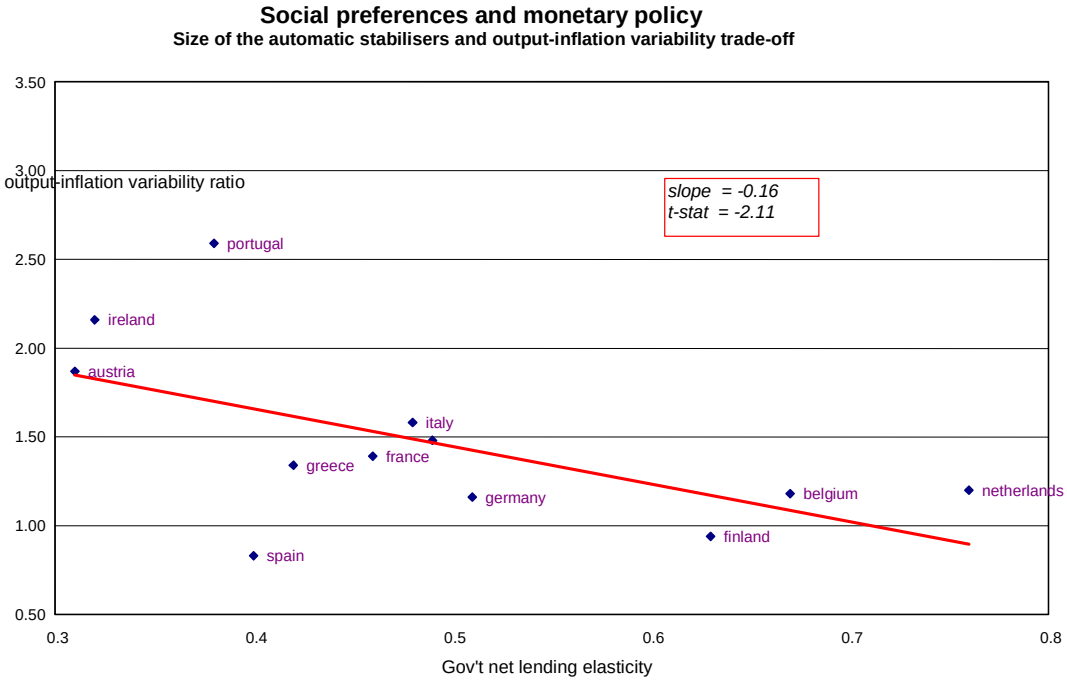

Social preferences and monetary policy
Size of the automatic stabilisers and output-inflation variability trade-off
output-inflation variability ratio
3.50
3.00
2.50
2.00
1.50
1.00
0.50
slope = -0.16
t-stat = -2.11
portugal
ireland
austria
italy
greece
france
germany
belgium
netherlands
finland
spain
0.3
0.4
0.5
0.6
0.7
0.8
Gov't net lending elasticity

Figure 12. Magnitude of the substitution channel

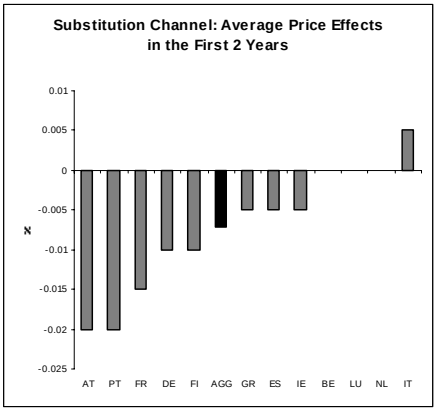
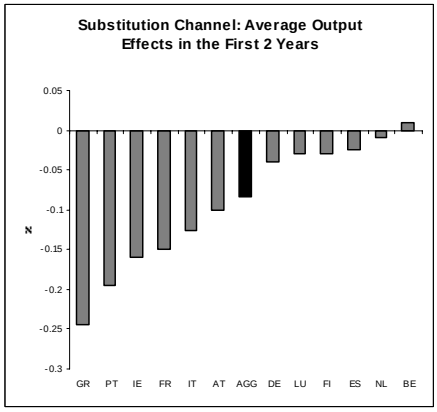
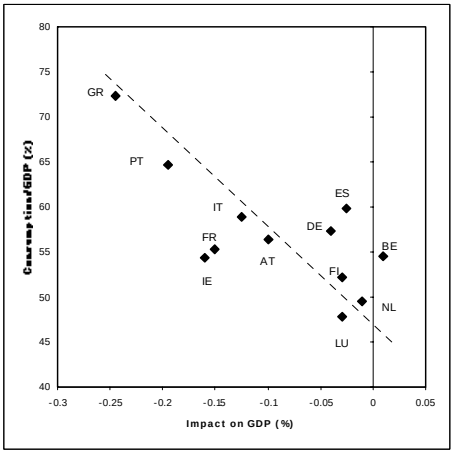
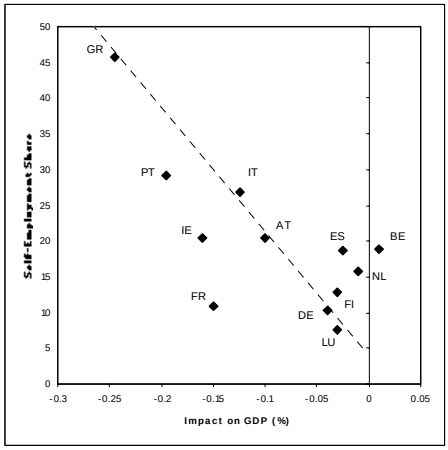
Price effects	*Output effects*
	

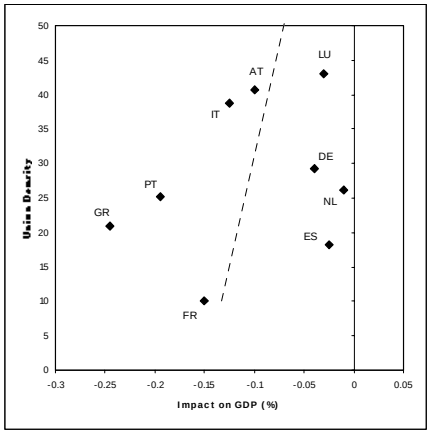
Figure 13. The substitution channel and the consumers' expenditure properties

(a) Share of consumers' expenditure in total GDP and the output effects of the substitution channel	(b) Self-employment share and the output effects of the substitution channel
	
Spearman Rank Correlation = -0.59	Spearman Rank Correlation = -0.61

(a) Eurostat (b) Self-employment as a proportion of total employment, Eurostat.

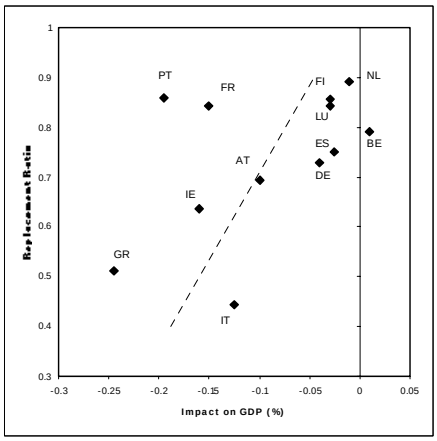
Figure 14. The substitution channel and the labour market

(a) Union density and the output effects of the substitution channel



Spearman Rank Correlation = 0.35

(b) Unemployment benefit replacement ratio and the output effects of the substitution channel

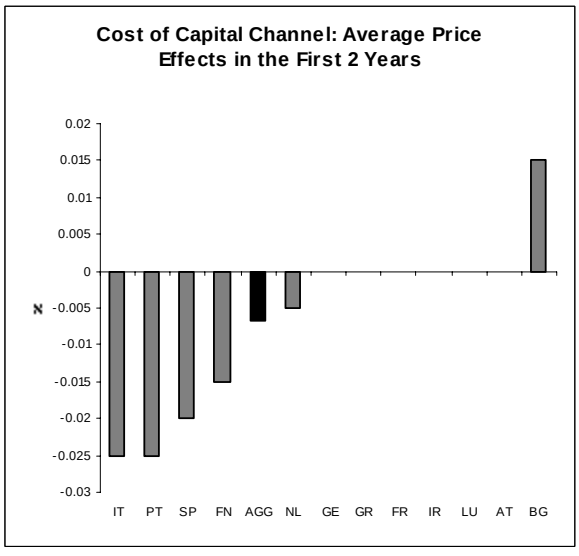


Spearman Rank Correlation = 0.39

(a) Trade union density ratio for 1994 (or nearest year), OECD (b) Average replacement ratio for 4 categories of workers expressed in relation to the average production wage, OECD.

Figure 15 Magnitude of the cost of capital channel

Price effects



Output effects

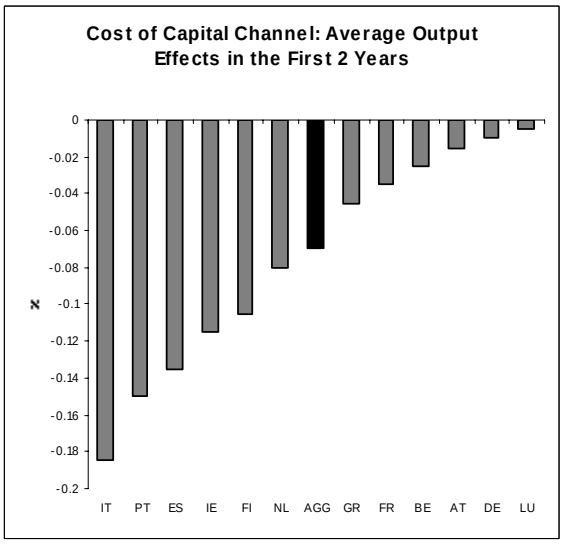
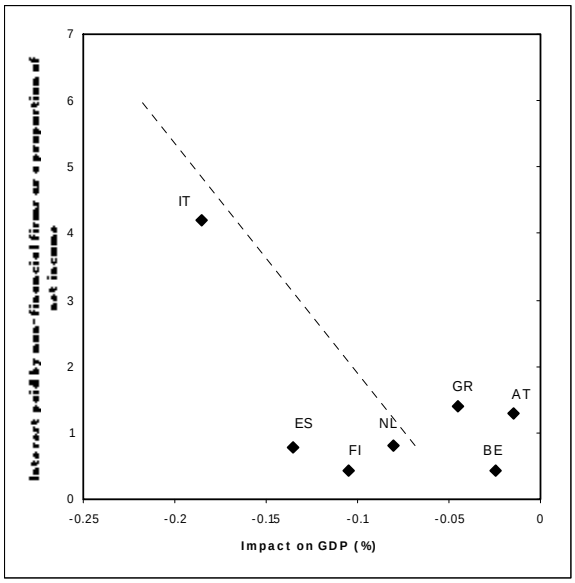


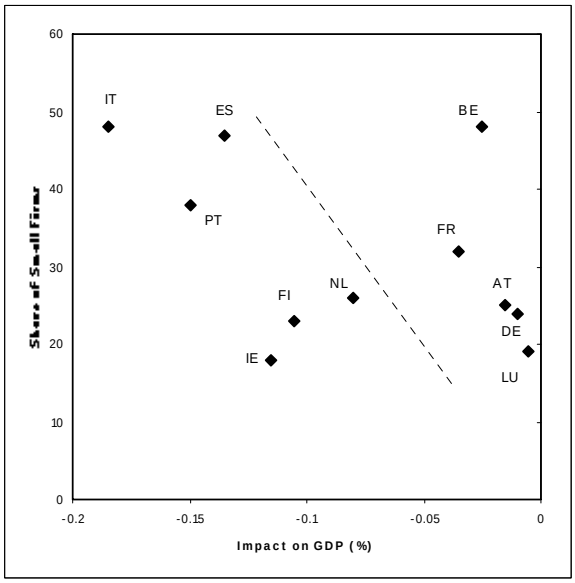
Figure 16 The cost of capital channel and the firms structure

(a) Non-financial firm's interest payments and the output effects of the cost of capital channel



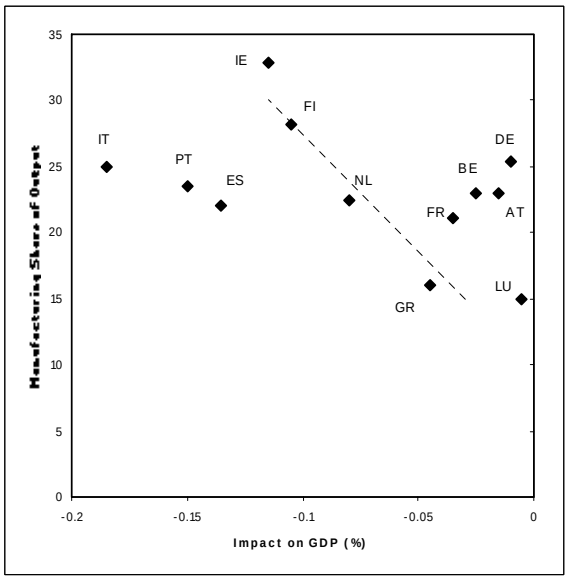
Spearman Rank Correlation = -0.31

(b) Share of small firms and the output effects of the cost of capital channel



Spearman Rank Correlation = -0.39

(c) Manufacturing share of output and the output effects of the cost of capital channel

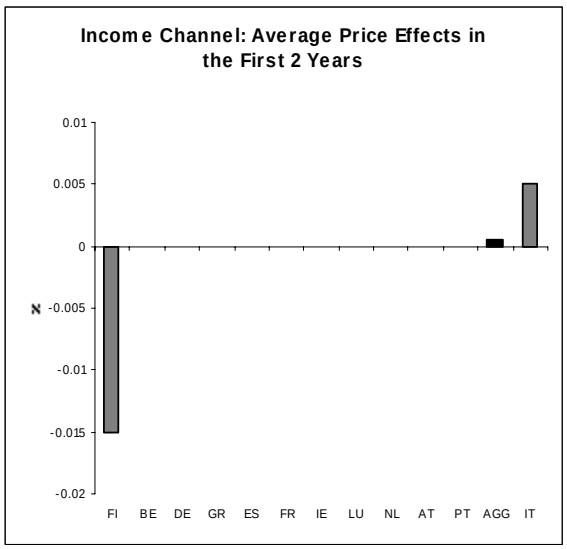


Spearman Rank Correlation = -0.38

(a) Net interest paid by non-financial firms as a percentage of the net disposable income (2000), Eurostat. (b) Employment in firms with 0-9 employees as percent of private sector employment, (1996), European survey on small and medium enterprises. (c) Value added in manufacturing as a proportion of total value added, Eurostat.

Figure 17 Magnitude of the income channel

Price effects



Output effects

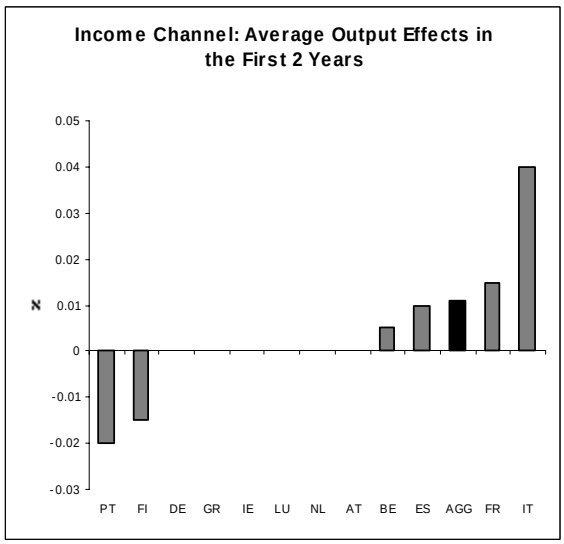
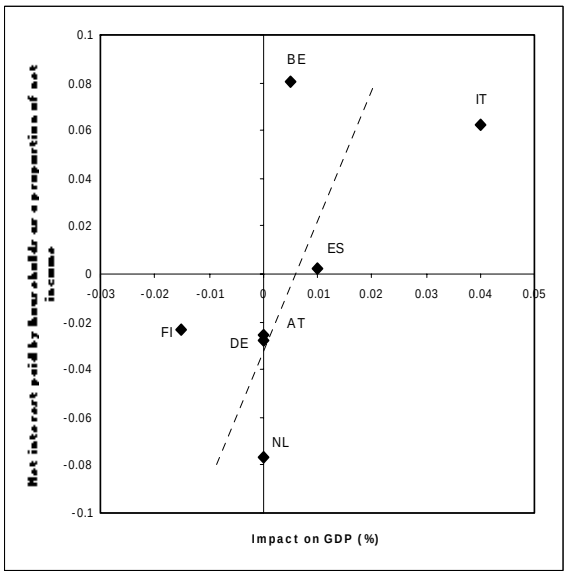


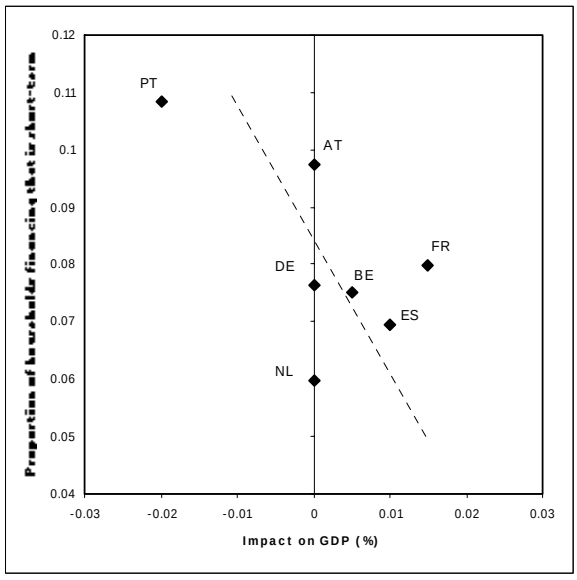
Figure 18 The income channel and the agents' financial position

(a) Net interest receipts as a proportion of net income and the output effects of the income channel



Spearman Rank Correlation = 0.47

(b) Proportion of household financing that is short-term and the output effects of the income channel



Spearman Rank Correlation = -0.49

(a) Net interest paid by households as a percentage of the net disposable income (2000), Eurostat. (b) Households' short term bank loans over total bank loans (2000), Eurostat.

Figure 19 Magnitude of the wealth channel

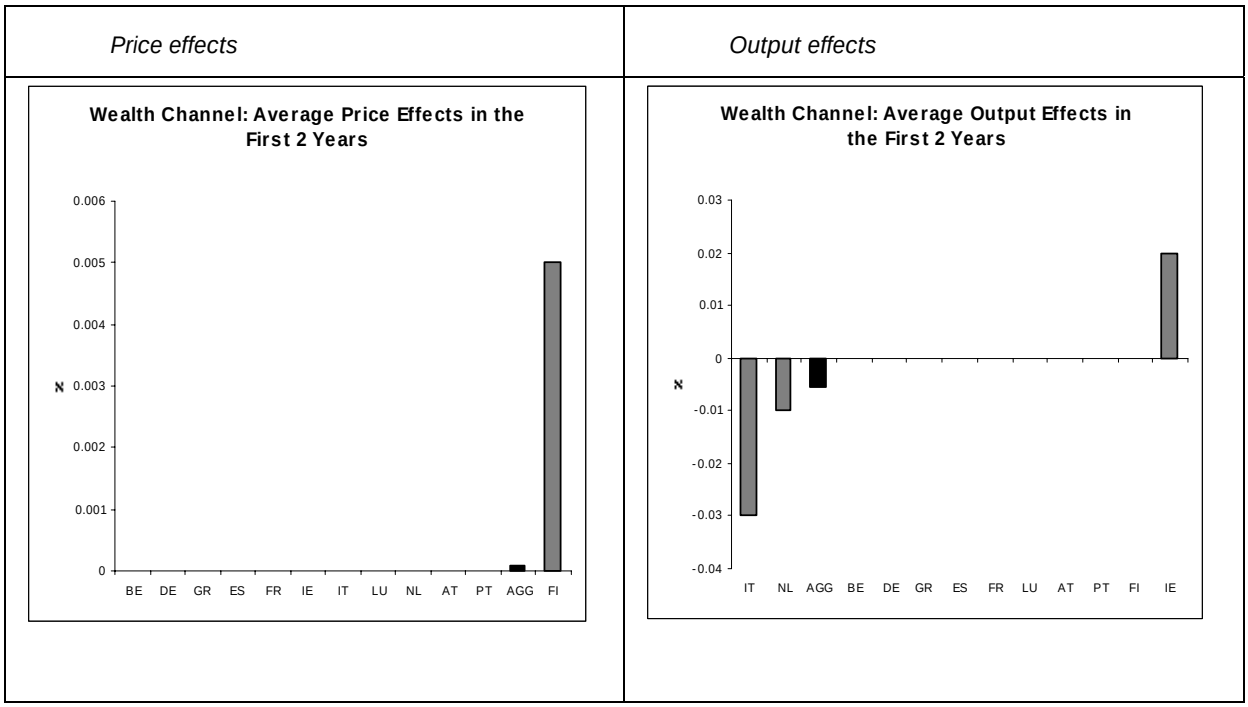


Figure 20 Market capitalisation and the output effects of the wealth channel

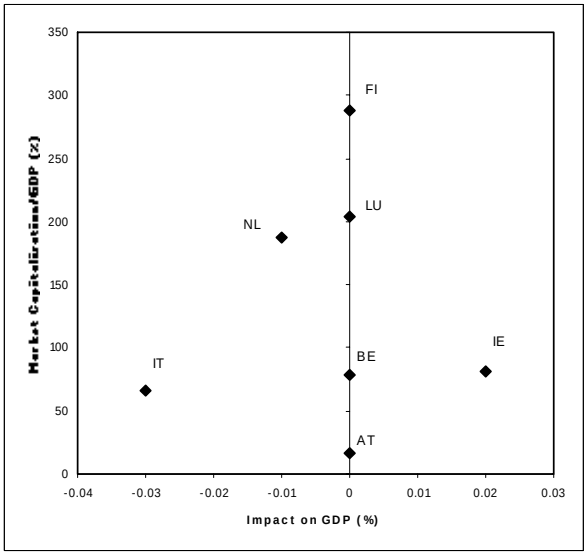
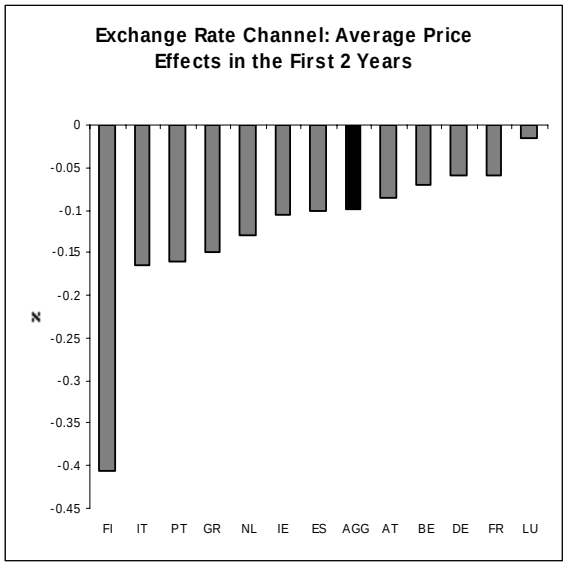


Figure 21 Magnitude of the exchange rate channel

Price effects



Output effects

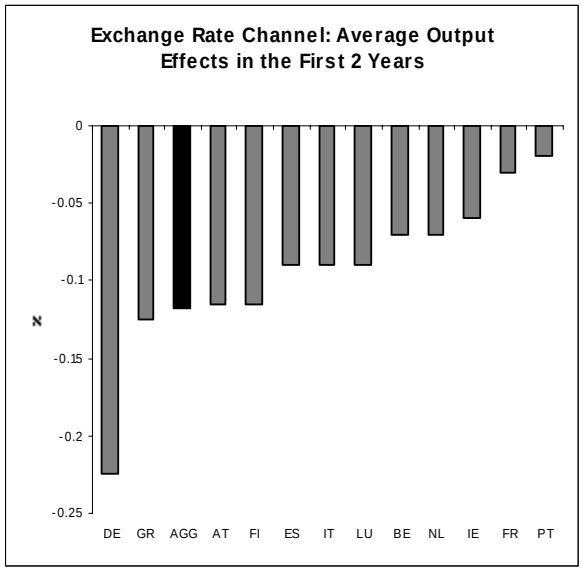
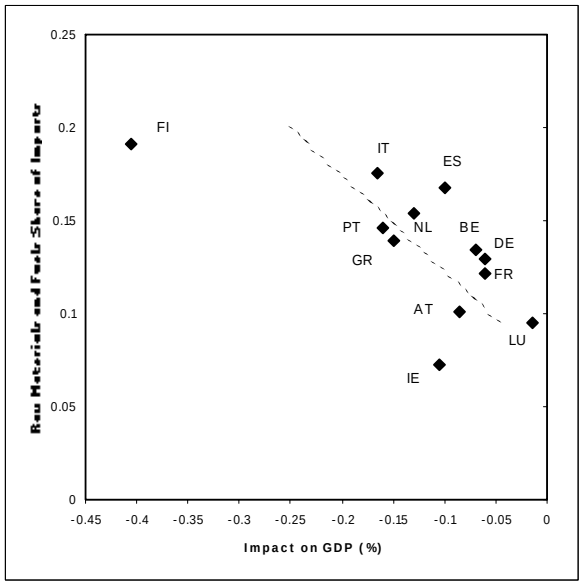


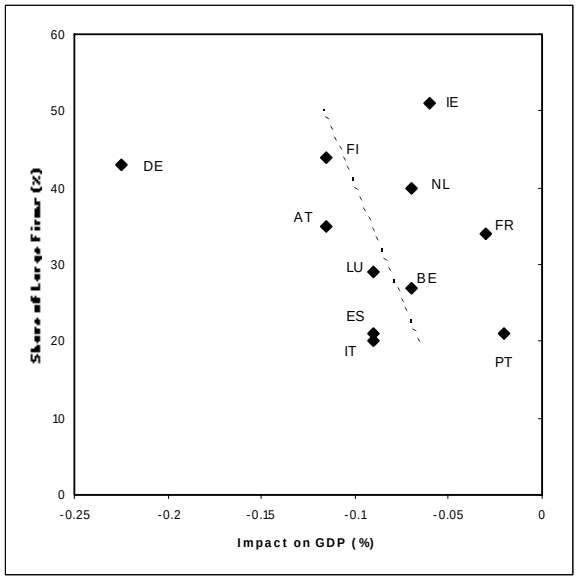
Figure 22 The exchange rate channel and the openness and sectoral composition

(a) Share of raw materials and fuel in imports and price effects of the exchange rate channel



Spearman Rank Correlation = -0.10

(b) Share of large firms and output effects of the exchange rate channel

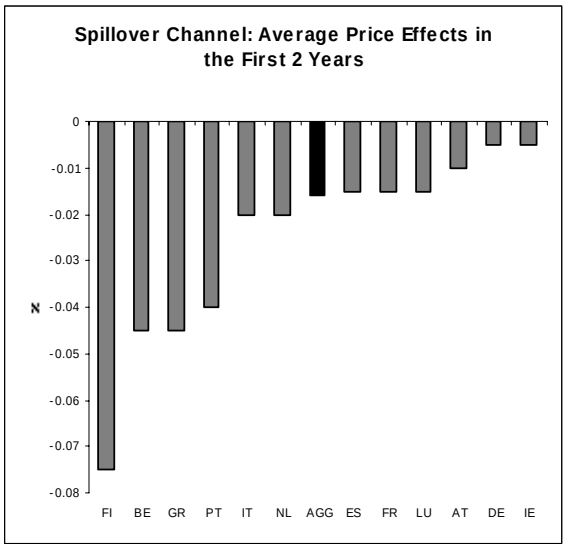


Spearman Rank Correlation = -0.31

(a) Eurostat, (b) Employment in firms with over 250 employees as per cent of private sector employment, (1996), European survey on small and medium enterprises.

Figure 23 Magnitude of the spillover channel

Price effects



Output effects

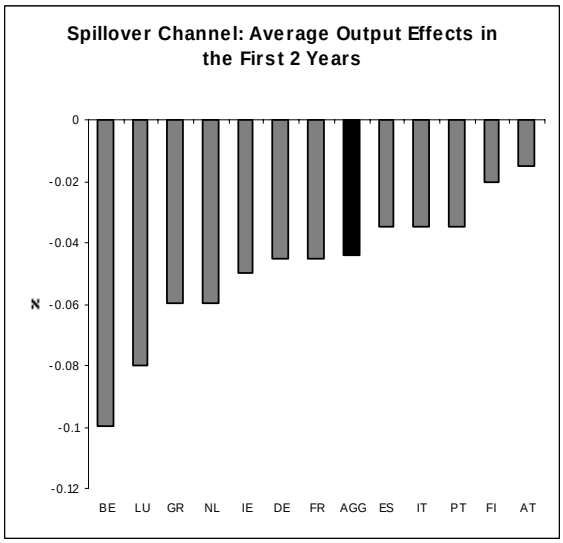
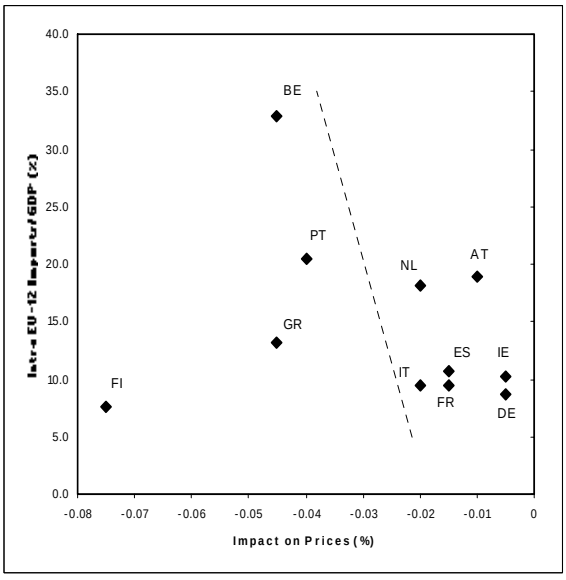


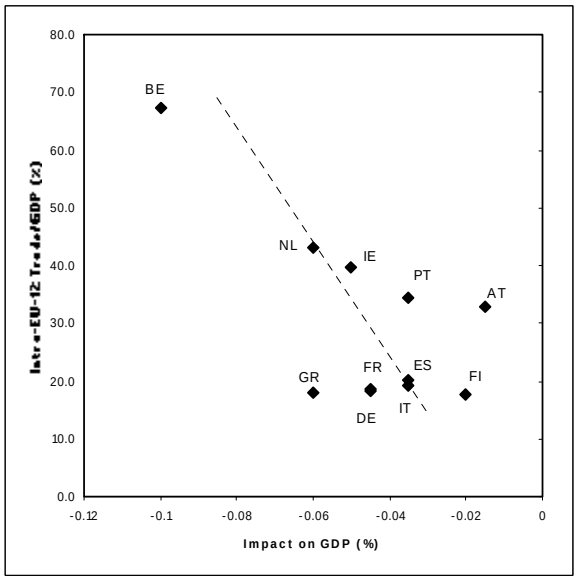
Figure 24 The spìllover channel and the trade structure

(a) Intra-EU 12 imports and price effects of the spillover channel



Spearman Rank Correlation = -0.22

(b) Intra-EU 12 total trade and output effects of the spillover channel

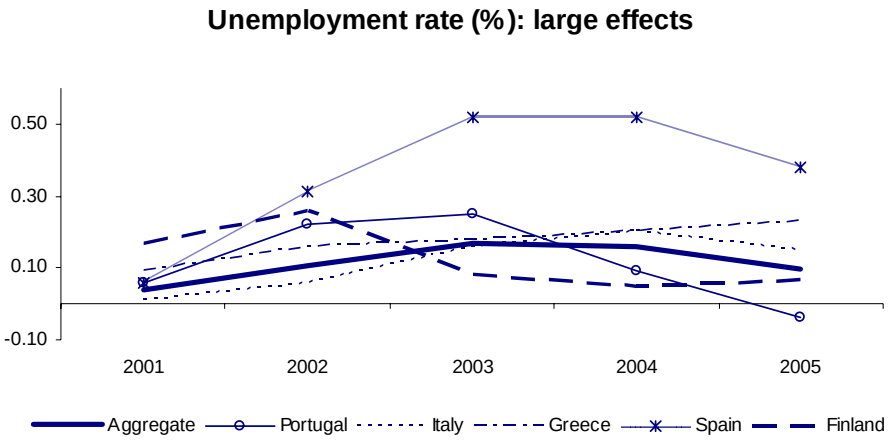


Spearman Rank Correlation = -0.41

Source: Eurostat

Figure 25 The spìllover channel and the trade structure

Labour market variables and monetary policy simulation:



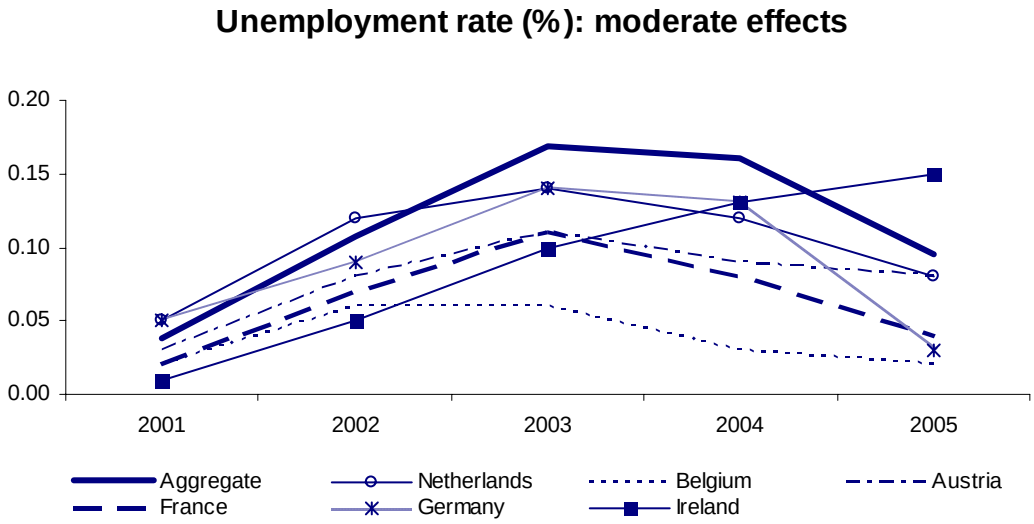
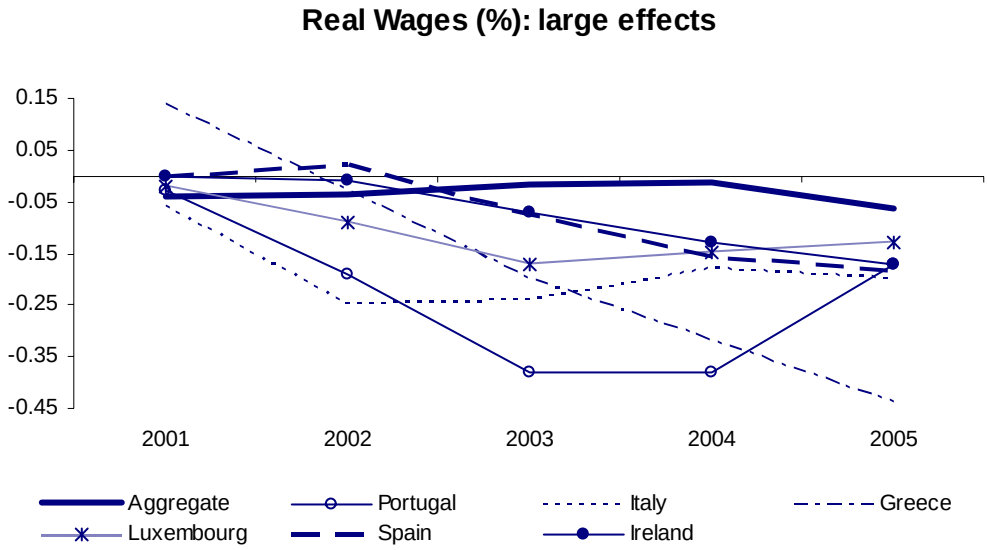


Figure 26

Labour market variables and monetary policy simulation:



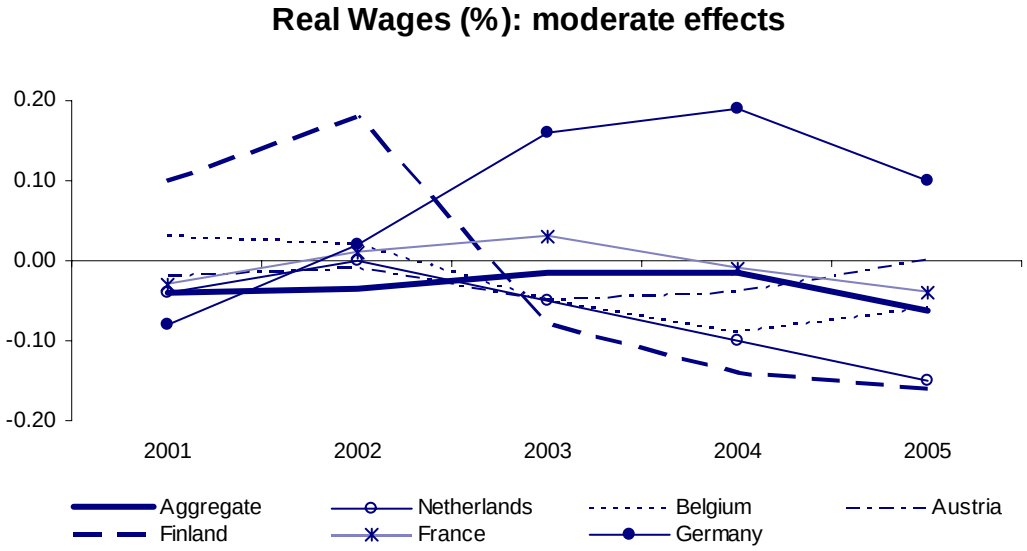
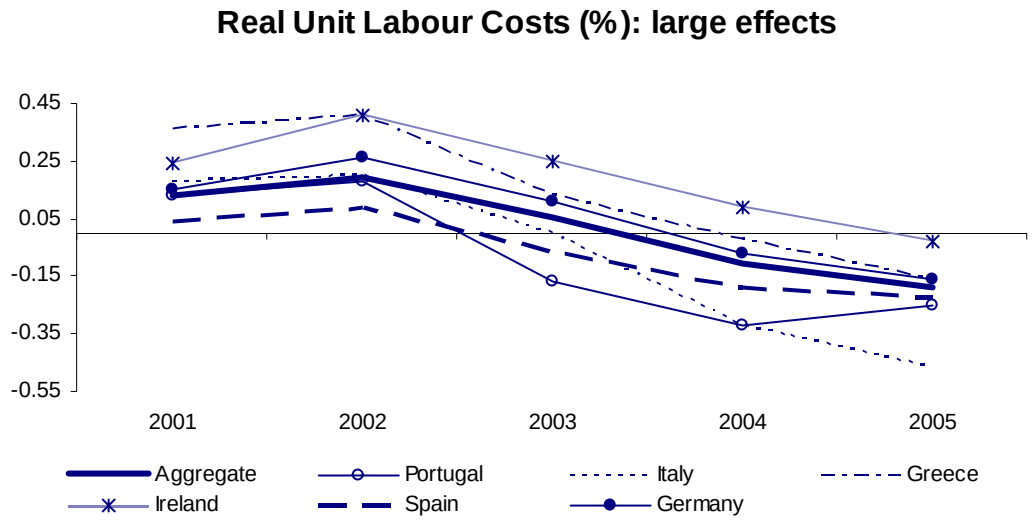
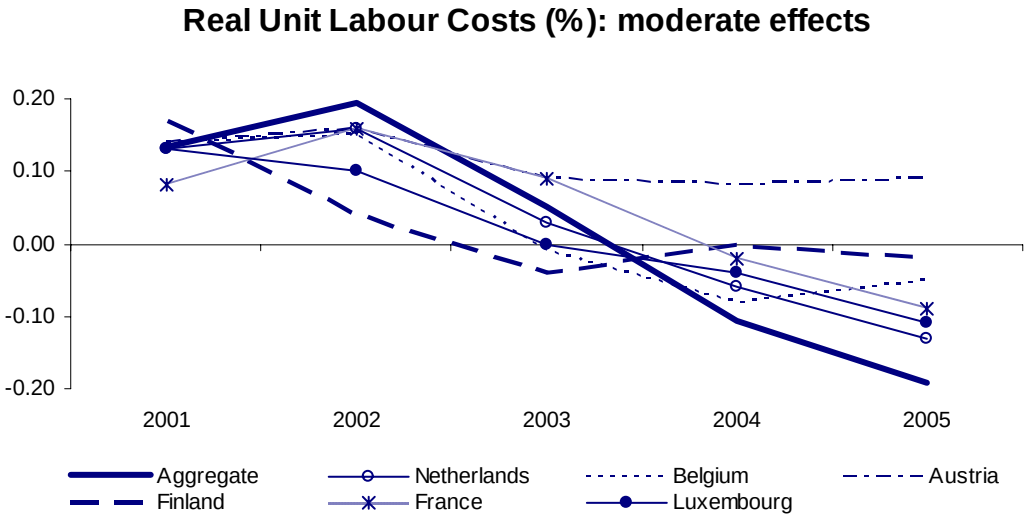


Figure 27

Labour market variables and monetary policy simulation:





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