Monetary transmission and equity markets in the EU

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SOM theme E: Financial markets and institutions

Abstract

We assess the role of equity markets in the transmission of monetary policy in the EU. We use a structural VAR model based upon the models of Kim and Roubini [2000] and Brischetto and Voss [1999] and we find that there are differences in monetary policy transmission across our sample of countries. The largest output losses following a monetary shock are seen in a core of euro area countries: Austria, Belgium, Finland, France, and Germany. Germany also displays the largest response of prices and is followed by Austria and Finland. Variance decompositions also suggest that the bank based core euro area countries are different from market based countries. As regards the channels of transmission we find no evidence to suggest an equity wealth effect channel in the euro area and only circumstantial evidence for the UK. We do, however, find that those countries that use equity finance (the UK and the Netherlands) suffer smaller output losses following a monetary shock indicating that a bank lending channel is less likely to be present in these countries.

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1. INTRODUCTION

The deepening economic and political integration in Europe has spawned a large body of literature and a lively debate on how the European Central Bank should govern monetary policy. As Guiso, Kashyap, Panetta and Terlizzese [1999] pointed out, there are three conditions that have to be met to effectively run a common monetary policy: 1) agreement on ultimate goals, 2) similar business cycles, and 3) the transmission mechanism must operate in a similar way across countries. The Maastricht Treaty covers the first condition, but the other two are still open for discussion.

The modern credit view of monetary policy transmission stresses that financial structure differences may lead to differing transmission mechanisms because different financial structures allow firms different access to external financing of projects. Various authors have argued that these differences lead to substantial differences in monetary policy transmission across EMU countries. In what is probably one of the best-known studies in this area, Cecchetti [1999] argues that:

> "Most economists believe that the monetary transmission mechanism will vary systematically across countries with differences in the size, concentration, and health of the banking system, and with differences in the availability of primary capital market financing. The countries of the EU differ quite dramatically in all of these dimensions that would seem to matter, leading to the prediction that the impact of interest rates on output and prices will not be consistent across countries. While the estimates of the impact of interest rate changes on output and inflation tend to be quite imprecise, they do differ, and in the way that is predicted by the state of the countries' financial systems." (Cecchetti [1999], p. 22). [1]

[1] In contrast, summarising a large project on differences in monetary transmission across euro area countries, the ECB concludes in its Monthly Bulletin of October 2002 that the empirical evidence does not suggest that there are systematic differences between countries in policy transmission that are robust across different studies and methodologies. See Mojon and Peersman [2001] and Angeloni, Kashyap, Mojon and Terlizzese [2001] for further details. For a discussion of the results

The extent to which monetary transmission works differently across the EU is critical for the ability of the ECB to run a single policy; hence most literature has focussed on heterogeneity among markets in the EU. A Bank for International Settlements [1995] study first focused on differences in financial structure within the EU and found marked differences in transmission with the UK suffering the largest output loss after a monetary contraction and Spain the smallest. Kashyap and Stein [1997] examine the role of banks in European monetary policy and find that banks play an important role in transmission in Italy and Germany, whilst credit markets are more important in the Netherlands. Clements, Kontolemis and Levy [2001] focus on differences in transmission and claim that the textbook interest rate channel accounts for the majority of the differences in transmission. [2] There is still no general consensus in the literature, however.

In this paper we investigate differences arising from the role of equity markets in transmission: higher asset prices can boost spending; hence, equity is a suitable candidate for propagating monetary policy to target variables (see Mishkin [2001]). We focus on two main questions: Firstly, are there differences in transmission? Secondly, if there are differences, what causes them?

The following section will review the literature focussing on the role of equity in the transmission of monetary policy and the impact it has on growth and inflation. Section 2 also reviews features of the institutions of the EU countries of relevance to the transmission mechanism. Banks tend to dominate the financial system in Europe, though there are substantial differences between countries. Section 3 gives a description of the data. Section 4 details our structural vector autoregression (SVAR) modelling strategy, and section 5 our main testing results. We concern ourselves with several questions.

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of simulations with econometric models of national central banks, see Van Els, Locarno, Morgan and Villetelle [2001].

Firstly, do we find differences in the monetary transmission in the countries? Secondly, can we link these differences in transmission with the heterogeneity of the financial systems? Finally, is there evidence of an equity channel? Before summarizing and concluding, section 6 looks at the implications of our results.

2. MONETARY TRANSMISSION: THE ROLE OF EQUITY

The equity channel

We need to separate two broad aspects of the literature on monetary policy and financial markets to discuss the equity channel. First, the impact of monetary policy on asset prices and secondly, how asset prices affect the central bank's target variables: output and prices. There is a broad consensus on the way monetary policy affects asset prices, especially equity: lower interest rates generally improves the prospects for equity and results in a higher price level. The affect of equity prices on output and inflation are less clear.

For the impact of asset prices on output, most researchers have focussed on investment and consumption. In the case of investment, rising equity prices lower the cost of new capital relative to existing capital. Following Tobin's [1969] Q theory of investment this spurs investment. The theoretical foundation of the lending view of Bernanke, Gertler and Gilchrist [1999] focuses on the intermediation role of banks and capital market imperfections. [3] Deflationary monetary policy may decrease a firm's net worth and in turn affect the firm's ability to raise external finance. The lower the firm's net worth the more severe the adverse selection and moral hazard problems are in lending

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[2] This is calculated as the residual from a regression after the exchange rate and credit channels have been accounted for.

[3] Empirical evidence suggests that financial imbalances drive changes in investment (see Fazzari, Hubbard and Petersen [1988]). Kashyap and Stein [1995] show that bank lending is important for the US. Similar conclusions can be drawn for the UK (see Dale and Haldane [1995]) and the Netherlands (see Garretsen and Swank [1998]).

to this firm, thus restricting external finance and investment. For consumption, Ludvigson and Steindel [1999] have found the household wealth effect is strong in the US. But this wealth effect view is controversial because housing wealth is greater for most than equity market wealth. House prices are, therefore, considered to be more important than equity for consumption (see Makin and Palumbo [2001]). Recent evidence from the IMF [2002] shows the robustness of wealth effects in other markets with the equity wealth effect in market based financial systems larger than in bank based systems. Secondly, higher equity prices signal financial markets expectations of faster output growth in the future; individuals' expectations of wage income, and therefore their willingness to spend, should follow. Thirdly, liquidity effects in household balance sheets and a lower probability of financial distress will result in increased consumer spending.

In contrast to the effects on economic growth, the effect of asset prices on inflation is less well researched. Rapidly rising equity and housing prices in the late 1990s have heightened concerns that inflationary pressures are building even though there has been only modest growth in conventional price indicators. Studying the major industrialised countries (G7), Stock and Watson [2003] find that asset prices are less predictive as a leading indicator for inflation than for output. For the same set of countries Goodhart and Hofmann [2001] find positive impulse responses for growth, but puzzling responses of inflation to equity prices and suggest that the forward looking behaviour of equity prices is to blame. As inflationary pressures arise via excess aggregate demand, one would expect more evidence on the leading indicator properties of asset prices. Bryan, Cecchetti and O'Sullivan [2002] support the view that the impact of asset prices on inflation is limited, but claim that the failure to include asset prices in the aggregate price statistic for the US has introduced a downward bias.

A major obstacle for this line of research is the forward-looking nature of equity: do higher equity prices boost investment and consumption or are they merely indicating that future output and consumption, and hence profits, are going to be higher?

European financial structure

Rajan and Zingales [2003] (Tables A1 and A2 in the Appendix) provide an indication of differences in financial development between countries in Europe and contrast it with the US and UK data. Not surprisingly, in 1980 bank deposits were more important in Continental Europe than in the Anglo-American countries: bank deposits relative to GDP were 60% larger. The reverse was true for equity markets. Market capitalisation to GDP was one fifth of that of the US and the UK. A similar picture arises from the amount of equity raised and the number of publicly traded companies (after correcting for Luxembourg). Differences between the 1980 and 2000 data are striking. Spectacular returns on equity over the last two decades of the previous century have raised market capitalisation to GDP in the market-oriented US by a factor 3. The growth in Continental Europe was even more pronounced: the ratio went up more than 13 times. Equity issuance also rose substantially. The gap between the Anglo-American markets and Continental Europe still exists: European firms are more reliant on bank loans than those of the US, but it is clearly reduced.

The composition of external finance (Table A3) corroborates the bank dominance in Europe. It also shows that while equity finance has matured, corporate bond markets are still in a juvenile stage when compared to the US.

3. DESCRIPTION OF DATA

Variables

We use eight variables to look at the transmission mechanism: prices, output, a short term domestic interest rate, a short term foreign (US) interest rate, the money supply, the level of the equity market, the nominal exchange rate, and commodity prices. [4] The first four

[4] In our empirical studies we also ran models using the German interest rates as the foreign interest rate. Only for a few smaller markets was there any meaningful difference. We argue that this is

variables are standard in the type of VAR research conducted. Inclusion of nominal exchange rate captures the differences in trade channels between countries. Moreover, it stems from the observation that in the early 1990s, there was still considerable speculation whether or not some countries would join the monetary union (e.g. in September of 1992, the pound sterling was under speculative attack and, after defending the pound by raising interest rates, the UK was eventually forced out). We would argue that at least part of monetary policy was externally focussed at the time. Commodity prices are included to control for the price puzzle in the VAR studies.

In our study we evaluate eight countries for which the ECB currently conducts monetary policy: Austria, Belgium, Finland, France, Germany, Italy, the Netherlands, and Spain. As Sweden and the UK are potential candidates for entry, we add these countries to our set. For a broader sample we also include the US.

Data

Our sample period begins in January 1980 until December 2002. [5] Not all countries have all data available at all times; Sweden starts in February 1982. Economic data are all from the International Financial Statistics database at the IMF. The money market rate is the monetary variable included for short-term interest rates that are controlled by the central bank. Money supply is narrow money, M1 or broad money, M3. As proxy for economic activity we have taken Industrial Production. CPI is the relevant price index. Equity market data are Datastream total return indices. In case the total return series in Datastream were unavailable or had a short sample period, the equity price series from

because our models include equity markets where the US interest rates tends to be the dominant factor.

[5] In order to take the realignment of the ERM into account, which occurred between 1980 and 1982, we tested for robustness by changing the sample period in the empirical study. Dropping the first years in the study did not change the results.

IFS were used (Finland and Spain). Commodity prices are the Commodity Research Bureau spot price index.

Statistical analysis of data

Before our empirical analysis, we test for stationarity and seasonality of the series. We take logarithms for prices, output, equity, nominal exchange rates and commodity prices. A battery of Augmented Dickey Fuller tests reveals that most series are integrated of order one. These results are confirmed by KPSS (of Kwiatkowski, Phillips, Schmidt and Shin [1992]) statistics for unit roots. We also conducted HEGY (of Hylleberg, Engle, Granger, and Yoo [1992]) tests for stochastic seasonality to guide us in our choice of specification. The conclusions drawn from results for Johansen's test for cointegration (see Johansen [1995]) is that there are at least 3 cointegrating relationships for each country. We therefore rely on the result of Sims, Stock, and Watson [1990] that sufficient cointegrating relationships makes estimation of the time series in levels a valid approach. [6] They show that mistakenly estimating in levels will lead to a loss of efficiency whilst mistakenly imposing long run conditions is a misspecification; differencing discards any long run information that may be there. We believe that risking at most an efficiency loss is the best option.

4. MODELLING STRATEGY

The standard VAR models as proposed by Sims [1980] were an alternative to large scale macroeconometric models and do not rely on "incredible" identifying assumptions. The main critique of VAR models centres on the fact that the model fit the data at the expense of theoretical consistency, both from a short and long run perspective. The original atheoretical VARs use a Choleski decomposition to get impulse responses; a Choleski decomposition implies a causal ordering that may itself be incredible if the researcher wishes to look at the effects of more than just monetary shocks. Structural VAR (SVAR) models explicitly provide an economic or informational rationale behind the restrictions necessary to identify monetary and other shocks (see Bernanke [1986], Sims [1986] and Blanchard and Quah [1989]). Within a SVAR framework we examine the effects of a 100 basis points shock to the money market interest rate and also the effects of a one percent shock to equity prices. [7]

Our structure is based upon that of Kim and Roubini [2000] and Brischetto and Voss [1999]. We amend the model slightly to include equity. To understand the model it will be useful to summarize the VAR modelling process. Our aim is to be able to say what effect changes in one variable have on the other variables. This requires that we identify the structural form of the model wherein each element in the error term is contemporaneously uncorrelated with the others, in other words one must orthogonalise the error term (equation 1).

$$e_t = B_0 u_t \tag{1}$$

$$B(L) y_t = e_t \tag{2}$$

Where e_t is the vector of structural shocks and u_t is the vector of reduced form errors. Equation 2 shows the structural form of the model in moving average form with *B(L)* an infinite order lag polynomial. In VAR modelling, though, one first estimates the reduced form as an autoregression as in equation 3.

$$y_t = A(L) y_t + u_t \tag{3}$$

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[6] Exact test statistics for all tests mentioned are available on request.

Here, *A(L)* is a finite order lag polynomial. The following three equations illustrate the link between the reduced form and the structural form.

$$B(L) = B_0 + B^0(L) \tag{4}$$

$$A(L) = -B_0^{-1}B^0(L) \tag{5}$$

$$\Sigma = B_0^{-1}\Lambda B_0^{-1} \tag{6}$$

Equation 4 splits the infinite order lag polynomial from the structural form into the contemporaneous correlations, B_0, and the lagged correlations. Equation 5 maps each reduced form coefficient matrix onto its structural form counterpart. This can be done simply if the researcher knows the B_0 matrix of contemporaneous correlations. B_0 is identified through the unrestricted covariance matrix of the reduced form, Σ, and the diagonal covariance matrix of the structural form, Λ, as in equation 6. This, unfortunately, does not uniquely identify B_0; there are many matrices that satisfy equation 6. In order to identify the structural form of the model the researcher must place additional restrictions somewhere in the model: we use contemporaneous restrictions on the B_0 matrix to identify the shocks as in equation 7.

[7] A shock to equity prices is just a movement in equity prices that is not predicted by the autoregressive system we have estimated. It may come from new information regarding future profitability or it may be noise in the series.

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\begin{bmatrix} e_{Com} \\ e_{FFR} \\ e_{IP} \\ e_{CPI} \\ e_{MD} \\ e_{MS} \\ e_{ER} \\ e_{S} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{21}^{0} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{31}^{0} & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ b_{41}^{0} & 0 & b_{43}^{0} & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{53}^{0} & b_{54}^{0} & 1 & b_{56}^{0} & 0 & 0 \\ b_{61}^{0} & b_{62}^{0} & 0 & 0 & b_{65}^{0} & 1 & b_{67}^{0} & 0 \\ b_{71}^{0} & b_{72}^{0} & b_{73}^{0} & b_{74}^{0} & b_{75}^{0} & b_{76}^{0} & 1 & 0 \\ b_{81}^{0} & b_{82}^{0} & b_{83}^{0} & b_{84}^{0} & b_{85}^{0} & b_{86}^{0} & b_{87}^{0} & 1 \end{bmatrix} \begin{bmatrix} u_{Com} \\ u_{FFR} \\ u_{IP} \\ u_{CPI} \\ u_{M} \\ u_{R} \\ u_{ER} \\ u_{S} \end{bmatrix} \tag{7}
$$

Kim and Roubini base their identification strategy upon a model of the macro-economy based upon optimising agents developed by Sims and Zha [1995]; so do we. Hence, it will be instructive for us to explain the salient features of the identification strategy.

The structural model is composed of several blocks. Firstly there are two equations describing the money market equilibrium. Money demand is shown in row 5 and money supply in row 6 of the B_0 matrix. Following the discussion in Sims and Zha, we assume that monetary policy does not respond contemporaneously to output or prices simply because the data isn't available contemporaneously. Whilst the central bank can have a forecast of current output and prices, so does our model. In our model, the interest rate equation includes lagged values of all variables, which can be viewed as containing an implicit forecast of the current period output and prices. Whilst it is also true that a central bank has many more sources of data to base these forecasts upon than we could possibly hope to include in a VAR, the most important variables in constructing this forecast are likely to be the lagged values of output and prices themselves. These are in the information set of the central bank in our model. We allow the central bank to respond contemporaneously to the variables that are available contemporaneously: commodity prices, money, and the exchange rate. The exceptions to this information rule are the short term foreign interest rate (the Fed funds rate) and equity prices. We follow Kim and Roubini by arguing that the "monetary authority cares more about unexpected changes in exchange rate against the US rather than unexpected changes in US interest rate per se." We also assume that the central bank does not respond contemporaneously to equity market movements. Again, whilst the central bank can react to the general level and speed of change of the equity market through the lagged values, we don't believe that the central bank responds contemporaneously; responding actively to equity prices would imply that the central bank thought that equity was either over or undervalued. Our money demand equation is standard in that it assumes money demand depends contemporaneously on real income and the opportunity cost of holding money. Contemporaneous portfolio adjustments from money to equity are assumed to be negligible and are treated as zero. [8]

Rows 3 and 4 comprise the domestic goods market equilibrium and the large number of zero restrictions in these rows is consistent with a model exhibiting nominal rigidities. Commodity prices do, however, enter this block and the rationale behind this follows from a cost markup rule for prices as is common in the theoretical literature.

Rows 1 and 2 are our measure of the external pressures on the economy. As Kim and Roubini also explain, "By including the oil price, we control for current systematic responses to (negative) supply shocks and inflationary pressure." We use a broad commodity price index instead of the oil price for this. We also include the Fed funds rate as a foreign exchange rate in our model. We chose this over a German rate because, as Grilli and Roubini [1995] propose, for the G7 countries the US acts as "leader" and the other countries are "followers". Whilst in a European context Germany has been the "leader" and the others "followers", in a global context, those countries that follow

[8] We have also estimated the model allowing for a contemporaneous response of money demand to equity prices but the estimated responses of money to equity market shocks were unsatisfactorily large.

Germany also follow the US if Germany does. Without controlling for US rates, open economy VARs often suffer from both the price puzzle and the exchange rate puzzle. [9] As Grilli and Roubini explain: "Interest rate innovations in the non-US G7 countries occur as an endogenous policy reaction to inflationary shocks that cause exchange rate depreciation." Furthermore, we include the Fed funds rate as an endogenous variable for all countries even though movements in individual European countries are unlikely to have any significant impact on US monetary policy. The alternative would be to treat the Fed funds rate as exogenous and allow no impact of Austrian prices on US rates for example. Whilst this may look appealing, we are estimating a model for each country individually in order to gauge the effects of shocks without saying how correlated these shocks are across countries. By treating the Fed funds rate endogenously we allow a shock to Austrian prices to be a largely composed of a European shock that would affect US policy. In order to be able to isolate solely Austrian price level shocks we would conceivably have to control for the movements of many other European variables; this would be beyond the scope of a VAR analysis. Furthermore, in the current institutional setting (and the one addressed specifically in this paper), it is the response to these European level shocks that are of the greatest interest to the asymmetric transmission literature.

The final two rows in our model are the exchange rate and equity prices. The exchange rate serves two purposes: allowing the monetary authorities to take into account "the effects of a depreciation of their currencies on their inflation rates" and "controlling for the components of interest rate movements that are systematic responses to a depreciation of the domestic currency, we are more likely to identify the interest rate

[9] The price puzzle is the term given to an estimated increase in prices (or inflation) following a positive interest rate shock and is a common finding of VAR studies. The exchange rate puzzle is the corollary finding for the exchange rate: a fall following a positive interest rate shock.

innovations that are true exogenous contractions”. We allow equities to react to all information currently available.

Our choice of the Kim and Roubini model is also driven by the result that, as Grilli and Roubini [1996] put it, “the structural VAR approach appears to be quite successful in explaining all the puzzles that plagued the recent literature on the effects of monetary policy in closed and open economies.”

Following Kim and Roubini we estimate all models with 6 lags in order that the any differences found are not due to modelling differences. [10] This follows from the Akaike Information Criterion and Hannan-Quinn tests. The chosen lag length of 6 is greater than suggested for most countries but the desire to have a similar model for all countries meant we chose the lag length that encompassed all suggested lag lengths. We also include dummies in our estimation to take care of seasonal effects. Since the restrictions are short run in nature we will focus mainly upon the short run (up to 30 months) effects of shocks to the variables of interest.

5. EMPIRICAL RESULTS

Table A4 contains maximum likelihood tests for the validity of our overidentifying restrictions. They are not rejected at the 10% level for any of the countries in our sample and some p-values are very high: for example Sweden has a p-value of 0.9899. We therefore, proceed with our analysis based upon the models estimated.

Impulse responses

Impulse responses of output, prices and equity resulting from a 100 basis points increase in interest rates are in the Appendix in combination with the impulse responses for output

[10] As a crosscheck we ran the models with different lag lengths for each country and note that this did not impact the results materially.

and prices resulting from a positive 1% equity market shock. [11] In order not to show 200 impulse responses, Tables 1 and 2 provide a summary of the main effects resulting from a domestic interest rate and equity market shock. The Appendix provides the summary results of a foreign interest rate and commodity price shock (Tables A5 and A6).

Output responses to a domestic interest rate shock

The interest rate shock has a negative effect on output for all countries, although the responses are not significant at the 90% level for Austria, Finland, and the UK. With the exception of France and Sweden where long run negative effects on output can be observed, the responses are hump-shaped as is commonly found in VAR analyses. The magnitude of the responses are varied, ranging from a peak effect of just -0.11% in the Netherlands to –1.28% in Germany. Interestingly, if one looks at our statistic for output loss, the core countries of the euro, except the Netherlands, suffer a similar loss. [12]

Table 1: Indicators to compare difference in SVARs to an interest rate shock. The first two columns of this table displays the peak effect on output within the first 48 months and lag at which this occurs. The third column gives the total output lost in the first 30 months. The final columns show the peak effect within the first 48 months and lag at which this occurs.

	Peak effect on output	Lag	Output loss	Peak effect on prices	Lag	Peak effect on equity prices	Lag
Austria	-1.15	3	-10.30	-0.41	2	-12.91	18
Belgium	-0.73	5	-12.04	-0.26	19	-3.43	1
Finland	-0.76	20	-15.96	-0.34	42	-6.78	16
France	-0.68	43	-13.81	-0.16	48	-4.05	2
Germany	-1.28	6	-13.08	-1.13	38	-2.00	1
Italy	-0.38	19	-7.62	0	0	-3.96	14
Netherlands	-0.11	19	-1.79	-0.12	48	-0.83	9
Spain	-0.32	27	-6.93	-0.01	48	-1.34	27

[11] Impulse responses for all other possible shocks are available on request.
[12] The output loss is calculated as a simple sum of the effect at each point in time over the first 30 months. The average fall in output is therefore one thirtieth of our statistic.

Sweden	-0.16	48	-3.11	-0.04	2	-0.99	11
UK	-0.16	4	-1.67	-0.09	35	-0.80	5
US	-1.32	15	-21.32	-0.20	22	-6.55	9

Response of prices to a domestic interest rate shock

After a delay, most countries display a fall in their price levels following the shock. For Spain and Sweden the effects are very small and insignificant at the 90% level whilst the UK and US responses are larger but still insignificant. Italy displays a price puzzle. For the other countries, the responses are largely negative, if in the cases of Finland and the Netherlands after a lag, and significantly so for a time. As with the response of output, we find that there is a wide variety of magnitudes with Germany the largest and the UK one of the smallest.

Response of equity prices to a domestic interest rate shock

For all countries except Germany, there is a significantly negative response of equity prices to the domestic interest rate shock. Once again, the magnitude of the shock varies considerably across the countries. Those countries that display the largest falls in their equity markets, as measured by the peak fall, are also those that have the largest output losses. This is in line with theory that equity markets reflect future output performance.

Table 2: Indicators to compare difference in SVARs to a equity price shock. The first two columns of this table display the peak effect on output within the first 48 months and lag at which this occurs. The third column gives the cumulative effect on output over the first 30 months. The final columns show the peak effect within the first 48 months and lag at which this occurs.

	Peak effect on output	Lag	Cumulative output effect
Austria	0.07	8	1.09
Belgium	0.05	5	0.35
Finland	0.07	13	1.05
France	0.02	18	0.31
Germany	0.06	32	1.42
Italy	0.06	1	0.45

Netherlands	0.07	4	1.04
Spain	0.08	22	1.89
Sweden	0.08	9	0.81
UK	0.11	21	2.54
US	0.16	13	3.38

The effects of equity price shocks

In all countries a positive equity market shock is followed by an increase in output; most euro are countries display a peak increase of around 0.06%. The effects in the UK are somewhat larger. The positive response is significant at the 90% level for all countries except Belgium and France. The effect on prices is more ambiguous and the patterns are dissimilar. Apart from Finland, the euro area countries experience falling price levels after the equity price shock. Finland, Sweden, the UK, the US, and Japan all experience rising price levels.

Our interpretation

If equity markets really cause inflationary bubbles through excessive spending (an increase in aggregate demand), we would have expected to see positive responses of prices to equity market innovations; for the euro area we do not. We interpret the fall in prices as evidence of lower costs of external finance, if evidence of anything at all. With integrated financial markets around the world it would seem that our 1% equity market shock is a response to an expected increase in future output with a peak of around 0.06 – 0.07% with a similar discount rate across the countries. The exception is the UK where not only is there an increase in prices following the equity price shock, but also a larger increase in output. This evidence is more consistent with a balance sheet effect.

Responses to external shocks

For most countries the effect of a positive shock to the Fed funds rate is either minimal or a fall in output. This, again, varies across the countries in our sample. Prices fall following the Fed funds shock whilst equity prices generally mimic the output responses. Commodity price shocks increase price levels across the board and also lower equity markets; both sets of responses have reasonably similar orders of magnitude.

Variance decompositions

In general output remains dominant in the variance decomposition of output. In Spain, the UK and the US the proportion of the forecast error attributable to the equity market increases through time, especially in the UK. We interpret this as further evidence that equity markets drive output in the UK. In euro area money and/or the exchange rate become more important. The forecast error variances for prices tell a similar story. There is some minor evidence of an effect of equity on inflation for Belgium, Finland, Italy and Sweden, but only after 30 months. Interestingly, the price decomposition for Germany really shows how successful the Bundesbank policy of controlling monetary growth has been over the sample period with money and interest rates accounting for the majority of price variations at long horizons. This is less so for the other euro area countries and especially so for the US. This calls into question the first pillar of the ECB policy strategy of focusing on monetary growth, whilst this is important for Germany it is not so for the rest of the euro area.

Decomposing the variance in interest rates makes clear that changes in interest rates themselves and in money supply are the dominant factors. Barring Austria and Belgium, equity markets hardly play a role. And even in these markets, the effects occur with very long lags. This strongly suggests that monetary policy does not respond to equity market volatility. Finally we note that large equity markets (UK, US and Germany) are driven by their own dynamics according to our variance decompositions. In the other markets the importance of other variables increases, notably money in Belgium and France.

6. IMPLICATIONS

Since we find asymmetric responses to the monetary shocks it is of interest to ask why? Using the main results from the impulse responses (Tables 1 and 2) and the financial development indicators from Rajan and Zingales [2003] for the year ending 2000 we looked for relationships between financial structure and the size of the responses. We do so by calculating the Spearman's non-parametric correlations. These correlations are displayed in Tables 3 and 4.

Using a 5% significance level, we find three key relationships for interest rate shocks and one relation for equity market shocks. Firstly, a relation between the peak effect on output and equity issuance. The less developed the equity market, the larger the peak effect. Secondly, a relation between the lag at which the peak effect of output occurs and the bank loans and deposits ratio. The larger the size of the banking system, the sooner the dip in output occurs. Thirdly, we find a positive relationship between market capitalisation with the lag at which inflation dips. This suggests that inflation peaks sooner if the banking system is less important. We do not put much emphasis on this as we note that the relation between timing and bank loans is borderline significant. Finally, there is a clear relation between the peak effect on output and the market capitalisation and number of companies. The larger and deeper the equity markets, the smaller the peak effect of an equity market shock.

Table 3: Interest rate shocks and financial structure. The table presents Spearman's correlation coefficients between impulse response statistics to interest rate shocks and financial structure statistics from Rajan and Zingales [2003]. Asterixes in parenthesis denote significance at a 5% (*) or 1% (**) level.

	Bank loans	Deposits	Market capitalisation	Equity issues	Number of companies
Peak output	0.127	0.118	0.391	0.527 (*)	0.436
Timing	-0.624 (*)	-0.729 (**)	0.105	0.497	0.346
Output loss	0.073	0.036	0.318	0.291	0.382
Peak price level	-0.383	-0.433	0.073	0.255	0.260
Timing	0.510	0.409	0.161	0.579 (*)	0.055
Peak equity market	0.364	0.464	0.136	0.445	0.418

Timing	-0.237	-0.433	0.246	0.278	0.100

Table 4: Equity market shocks and financial structure. The table presents Spearman's correlation coefficients between impulse response statistics to equity shocks and financial structure statistics from Rajan and Zingales [2003]. Asterixes in parenthesis denote significance at a 5% (*) or 1% (**) level.

	Bank loans	Deposits	Market capitalisation	Equity issues	Number of companies
Peak output	-0.115	-0.189	0.581$^{(*)}$	0.512	0.677 $^{(*)}$
Timing	0.196	0.128	-0.032	0.237	0.223
Output gain	0.200	0.082	0.309	0.273	0.309

These findings are straightforward; countries where the private sector borrows a larger amount at interest are affected sooner by changes in interest rates. The relative availability of alternate finance sources is important in cushioning the effects interest rate shocks. This is compatible with the existence of a credit channel whereby the availability of equity finance reduces the special nature of bank lending. All in all, our findings suggest that financial structure is important for the transmission of monetary policy shocks and that the split is between those countries traditionally thought to have bank based financial systems and those that have market based systems. Within the euro area this also means that there is a difference in transmission between the core countries and the rest.

7. SUMMARY

We have estimated an eight variable structural vector autoregression in order to investigate the role played by equity markets in the monetary transmission mechanism. Our model largely avoids the oft-found price puzzle. Across the euro area countries we find that positive equity market shocks have a similar positive effect on output, but do not have a positive effect on prices. We interpret this as evidence against an equity wealth effect. The only country where this pattern breaks down is the UK, displaying a positive response of prices to equity market shocks and larger output responses. Variance decompositions also suggest that the shocks driving the series studied are different among the euro area group and the UK and the US.

The responses to interest rate shocks are asymmetric across the countries in our sample. Within the EU, the smallest output loss occurs in the UK and the Netherlands, with the largest occurring in Finland. French and German output losses are close to those of Finland. The responses of output are smaller in those countries that have a large equity issuance suggesting that the availability of differing sources of external finance is important in the transmission mechanism. The responses of prices and output to the monetary shock are related to the volume of bank lending to the private sector which is intuitively appealing: interest rate changes have bigger effects where more funds are borrowed at interest.

In terms of the channels of monetary transmission we find no evidence of an equity channel in the euro area. In the Euro area, central banks do not take explicit account of equity markets when setting monetary policy. Nor should do, as equity markets do not seem to interfere with the objective of price stability. We do, however, find some evidence across our sample to suggest that equity markets can play a role by providing substitute sources of external finance to bank loans, thus diminishing the effect of any possible bank lending channel.

BIBLIOGRAPHY

Angeloni, I., A. Kashyap, B. Mojon and D. Terlizzese, 2001, “Monetary transmission in the Euro area: Where do we stand?”, ECB *Working Paper No. 114*.

Bernanke, B., 1986, “Alternative explanations of the money-income correlation”, *Carnegie-Rochester Conference Series on Public Policy*, 25, 49-99.

Bernanke, B., M. Gertler and S. Gilchrist, 1999, "The financial accelerator in a quantitative business cycle framework", in: Taylor, J. and M. Woodford, *Handbook of Macroeconomics*, North-Holland, Amsterdam, 1341-1393.

Bank of International Settlements, 1995, "Financial structure and the monetary transmission mechanism", *C.B. 394*, Basle.

Blanchard, O. and D. Quah, 1989, "The dynamic effects of aggregate demand and supply disturbances", *American Economic Review*, 79, 655-673.

Borio, C. and P. Lowe, "Asset prices, financial and monetary stability: Exploring the nexus", BIS *Working Paper No. 114*.

Brischetto, A. and G. Voss, 1999, "A structural vector autoregression model of monetary policy in Australia", Reserve Bank of Australia *Research Discussion Paper*.

Bryan, M., S. Cecchetti and R. O'Sullivan, "Asset prices in the measurement of inflation", NBER *Working Paper No. 8700*.

Cecchetti, S., 1999, "Legal structure, financial structure and the monetary policy transmission mechanism", Federal Reserve Bank of New York *Economic Policy Review*, 9-28.

Clements, B., Z. Kontolemis and J. Levy, 2001, "Monetary policy under EMU: Differences in transmission mechanism?", IMF *Working Paper*.

Dale, S. and A. Haldane, 1995, "Interest rates and the channels of monetary transmission: Some sectoral estimates", *European Economic Review*, 39, 1611-1626.

European Central Bank, 2003, *Report of financial structures*.

Fazzari, S., R. Hubbard and B. Petersen, 1988, "Financing constraints and corporate investment, *Brookings Papers on Economic Activity*, 141-195.

Garretsen, H. and J. Swank, 1998, "The transmission of interest changes and the role of bank balance sheets", *Journal of Macroeconomics*, 20, 325-339.

Goodhart, C. and B. Hofmann, 2001, "Asset prices, financial conditions, and the transmission of monetary policy", Paper presented at conference on "Asset prices, exchange rates, and monetary policy", Stanford University.

Grilli, V. and N. Roubini, 1995, "Liquidity and exchange rates: Puzzling evidence from the G-7 countries", New York University *Working Paper*.

Grilli, V. and N. Roubini, 1996, "Liquidity models in the open economy: Theory and empirical evidence", *European Economic Review*, 40, 847-859.

Guiso, L., A. Kashyap, F. Panetta and D. Terlizzese, 1999, "Will a common European monetary policy have asymmetric effects?", Federal Reserve Bank of Chicago *Economic Perspectives*, 23, 56-75.

Hylleberg, S., R. Engle, C. Granger and B. Yoo, 1992, "Seasonal integration and cointegration", *Journal of Econometrics*, 44, 215-238.

IMF, 2002, *World Economic Outlook*, Washington, Spring.

Johansen, S., 1995, *Likelihood-based Inference in Cointegrated VAR models*, Oxford: Oxford University Press.

Kashyap, A. and J. Stein, 1995, "The impact of monetary policy on bank balance sheets", *Carnegie-Rochester Conference Series on Public Policy*, 42, 151-195.

Kashyap, A. and J. Stein, 1997, "The role of banks in monetary transmission: A survey with implications for the European monetary union", Federal Reserve Bank of Chicago *Economic Perspectives*, 21, 2-18.

Kim, S. and N. Roubini, 2000, "Exchange rate anomalies in the industrial countries: A solution with a structural VAR approach", *Journal of Monetary Economics*, 45, 561-586.

Kwiatkowski, D., P. Phillips, P. Schmidt and Y. Shin, 1992, "Stationarity against the alternative of a unit root", *Journal of Econometrics*, 54, 159-178.

Ludvigson, S. and C. Steindel, 1999, "How important is the stock market effect on consumption?", Federal Reserve Bank of New York *Economic Policy Review*, 5, 29-52.

Makin, D. and M. Palumbo, 2001, "Disentangling the wealth effect: A cohort analysis of household saving in the 1990s", Federal Reserve Board of Governors *Working Paper*.

Mishkin, F., 2001, "The transmission mechanism and the role of asset prices in monetary policy", NBER *Working Paper No. 8617*.

Mojon, B. and G. Peersman, 2002, "A VAR description of the effects of monetary policy in the countries of the Euro area", ECB *Working Paper No. 93*.

Rajan, R. and L. Zingales, 2003, "Banks and markets: The changing character of European finance", University of Chicago *Working Paper*.

Sims, C., 1980, "Macroeconomics and reality", *Econometrica*, 48, 1-48.

Sims, C., 1986, "Are forecasting models usable for policy analysis?", Federal Reserve Bank of Minneapolis *Quarterly Review*, , 10, 2-16.

Sims, C., J. Stock, and M. Watson, 1990, "Inference in linear time series models with some unit roots", *Econometrica*, 58, 113-144.

Sims, C. and T. Zha, 1995, "Does monetary policy generate recessions?", Yale University *Working Paper*.

Stock, J. and M. Watson, 2003, "Forecasting output and inflation: The role of asset prices", *Journal of Economic Literature*, 41, 788-829.

Tobin, J., 1969, "A general equilibrium approach to monetary theory", *Journal of Money, Credit and Banking*, 1, 15-29.

Van Els, P., A. Locarno, J. Morgan and J. Villetelle, 2001, "Monetary policy transmission in the Euro area: What do aggregate and national structural models tell us?", ECB *Working Paper No. 95*.

APPENDIX

Table A 1: Indicators of financial development. The second to fourth column or this table show bank loans to the private sector, deposits and equity market capitalisation as ratio to GDP. Market capitalisation is the aggregate market value of equity of domestic companies. Equity issues are the ratio of funds raised through public equity offerings (both initial public offerings and seasoned equity issues) to gross fixed capital formation. Number of companies is the ratio of number of domestic companies whose equity is publicly traded in a domestic equity market and the countries population is millions. Data is displayed for the year ending 1980.

	Bank loans to private sector	Deposits	Equity market capitalisation	Equity issues	Number of companies
Austria	0.724	0.682	0.030	0.000	8.740
Belgium	0.272	0.299	0.090	0.030	22.850
Denmark	0.244	0.276	0.090	0.010	42.540
Finland	0.462	0.391	n.a.	0.012	n.a.
France	0.731	0.679	0.090	0.060	13.990
Germany	0.864	0.564	0.090	0.010	7.460
Greece	0.520	0.507	0.085	n.a.	n.a.
Ireland	0.315	0.577	n.a.	n.a.	n.a.
Italy	0.555	0.676	0.070	0.040	2.360
Luxembourg	1.210	1.626	0.001	0.016	205.556
Netherlands	0.632	0.602	0.190	0.10.	15.120
Portugal	0.855	0.946	0.006	n.a.	n.a.
Spain	n.a.	0.723	0.087	0.028	13.213
Sweden	0.415	0.510	0.110	0.000	12.390
Average	0.601	0.647	0.078	0.020	34.422
UK	0.276	0.280	0.380	0.040	47.220
US	0.354	0.540	0.460	0.040	23.110

Source: Rajan and Zingales [2003].

Table A 2: Indicators of financial development. The second to fourth column or this table show bank loans to the private sector, deposits and equity market capitalisation as ratio to GDP. Market capitalisation is the aggregate market value of equity of domestic companies. Equity issues are the ratio of a three-year average (1999 – 2001) of funds raised through public equity offerings (both initial public offerings and seasoned equity issues) to gross fixed capital formation. Number of companies is the ratio of number of domestic companies whose equity is publicly traded in a domestic equity market and the countries population in millions. Data is displayed for the year ending 2000.

	Bank loans to private sector	Deposits	Equity market capitalisation	Equity issues	Number of companies
Austria	1.040	0.819	1.156	0.051	11.975
Belgium	0.792	0.837	0.783	0.138	15.707
Finland	0.534	0.464	2.383	0.497	29.730
France	0.864	0.636	1.087	0.145	13.720
Germany	1.207	0.925	0.668	0.065	9.071
Greece	0.526	0.566	0.942	0.430	30.869
Ireland	1.069	0.793	0.843	0.172	20.053
Italy	0.770	0.514	0.703	0.041	5.058
Luxembourg	1.099	3.367	1.771	0.494	122.727
Netherlands	1.398	0.937	1.701	0.629	14.754
Portugal	1.408	0.997	0.567	0.502	10.889
Spain	1.012	0.816	0.882	0.866	25.817
Sweden	0.457	0.391	1.476	0.289	32.920
Average	0.937	0.930	1.046	0.322	27.530
UK	1.320	1.069	1.840	0.149	32.370
US	0.493	0.379	1.549	0.207	25.847
Average	0.907	0.724	1.694	0.178	29.109

Source: Rajan and Zingales [2003].

Table A 3: Composition of external funding. The table shows the percentage share of loans, bonds, equity and other forms of external funding for the non-financial corporate sector. Other includes trade credit and advances and other liabilities. The final column displays the total external funding as percentage of GDP. Data is displayed for the year ending 2000.

	Loans	Bonds	Equity	Other	Total external funding to GDP
Austria	69.3	7.0	21.3	2.4	24.7
Belgium	21.1	2.6	73.8	2.5	221.6
Finland	18.7	2.3	74.5	4.5	379.5
France	10.4	3.6	57.0	7.9	278.5
Germany	37.6	1.5	48.6	12.3	81.9
Italy	29.7	1.1	54.5	14.8	103.3
Netherlands	32.0	3.9	53.0	11.1	162.7
Portugal	33.1	4.0	42.0	20.9	107.7
Spain	21.4	1.2	54.6	22.8	155.8
US	19.0	14.0	67.0	n.a.	210.0

Source: European Central Bank [2003]: Report on financial structures (Table 5.1) and US Federal Flow of Funds.

Table A 4: Tests for the validity of overidentifying restrictions. Likelihood ratio tests for the validity of overidentifying restrictions with p-values from a χ^2 distribution with 5 degrees of freedom (4 for Italy).

	Test statistic	P-Value
Austria	4.1888	0.5226
Belgium	5.6664	0.3400
Finland	2.3694	0.7960
France	1.4042	0.9239
Germany	6.2458	0.2830
Italy	7.2016	0.1256
Netherlands	3.0801	0.6876
Spain	7.9595	0.1585
Sweden	0.5561	0.9899
UK	3.7739	0.5824
US	1.9388	0.8576

Figure A 1: SVAR Impulse response of output to a 100 basis points interest rate shock. The horizontal axis gives the number of months after the shock. The vertical axis gives the responses in percentage changes. Confidence intervals are bootstrapped 90% intervals generated using Hall's method.

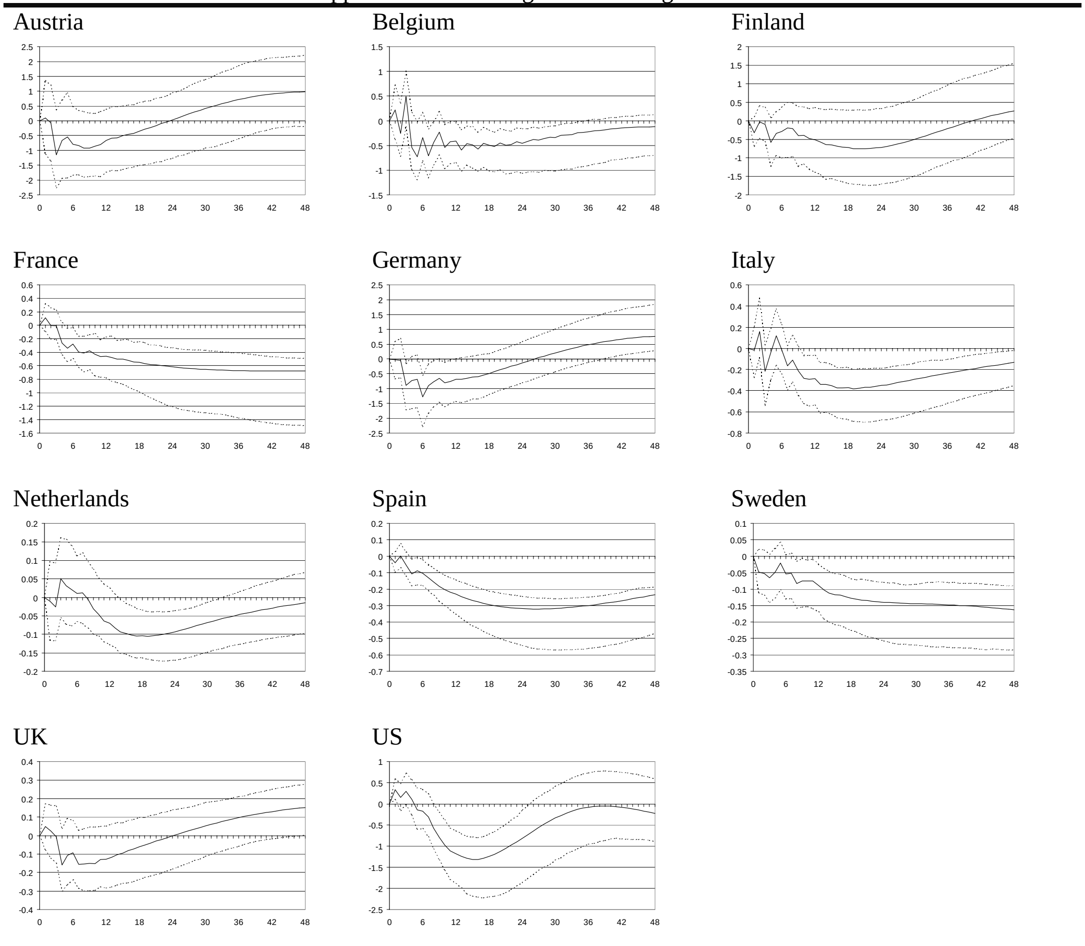

Figure A 2: SVAR Impulse response of the price level to a 100 basis points interest rate shock. The horizontal axis gives the number of months after the shock. The vertical axis gives the responses in percentage changes. Confidence intervals are bootstrapped 90% intervals generated using Hall’s method.

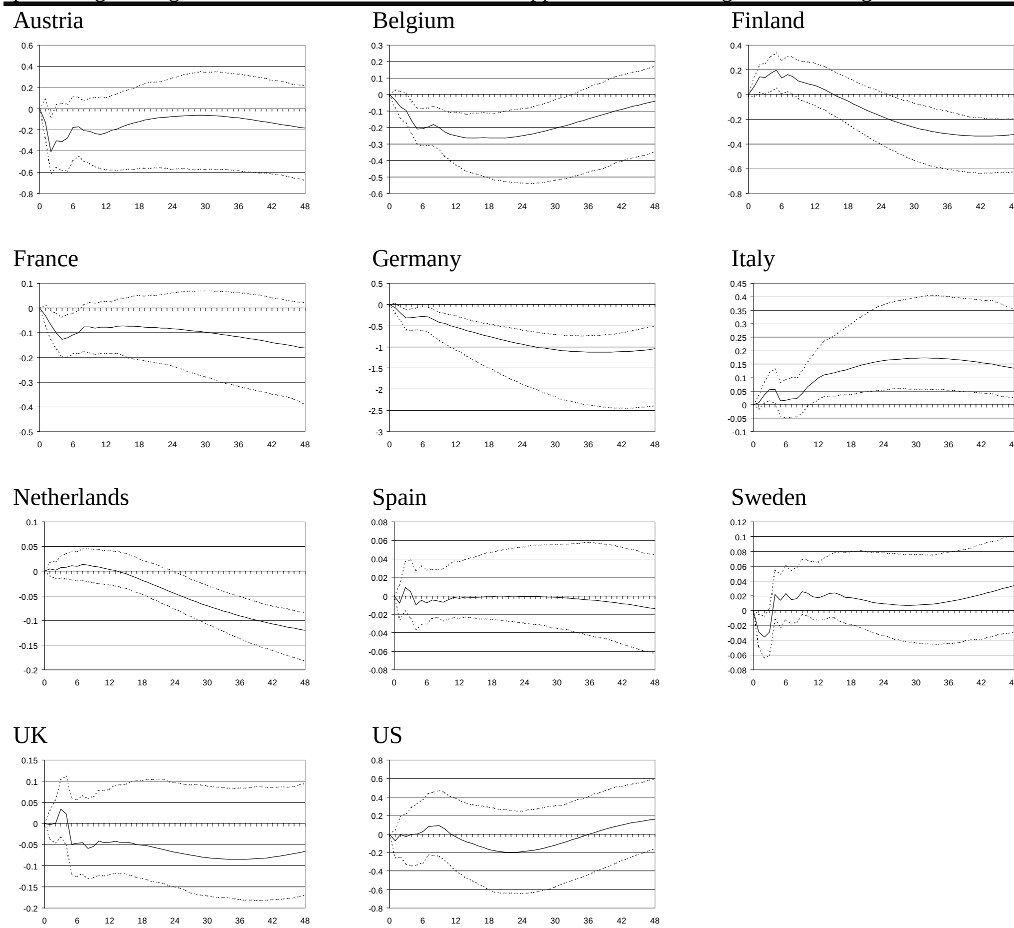

Figure A 3: SVAR Impulse response of equity prices to a 100 basis points interest rate shock. The horizontal axis gives the number of months after the shock. The vertical axis gives the responses in percentage changes. Confidence intervals are bootstrapped 90% intervals generated using Hall's method.

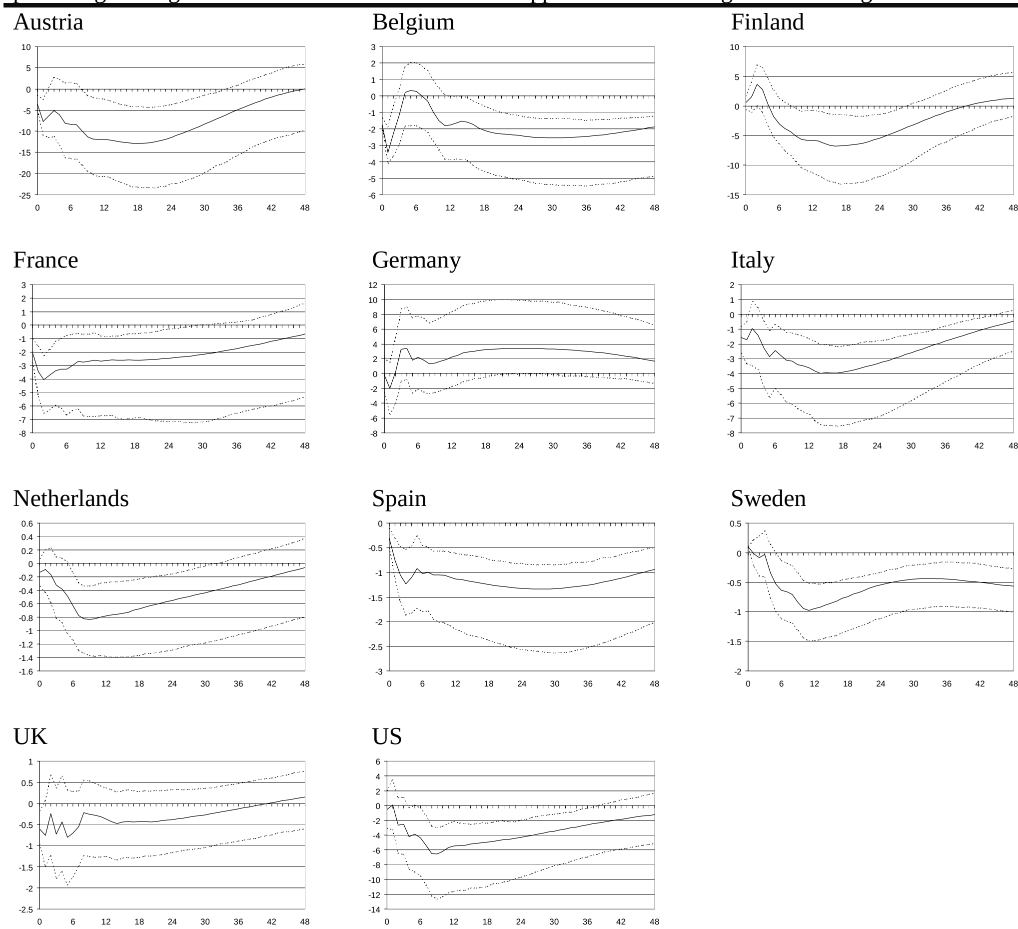

Figure A 4: SVAR Impulse response of output to a 1 percent equity market shock. The horizontal axis gives the number of months after the shock. The vertical axis gives the responses in percentage changes. Confidence intervals are bootstrapped 90% intervals generated using Hall's method.

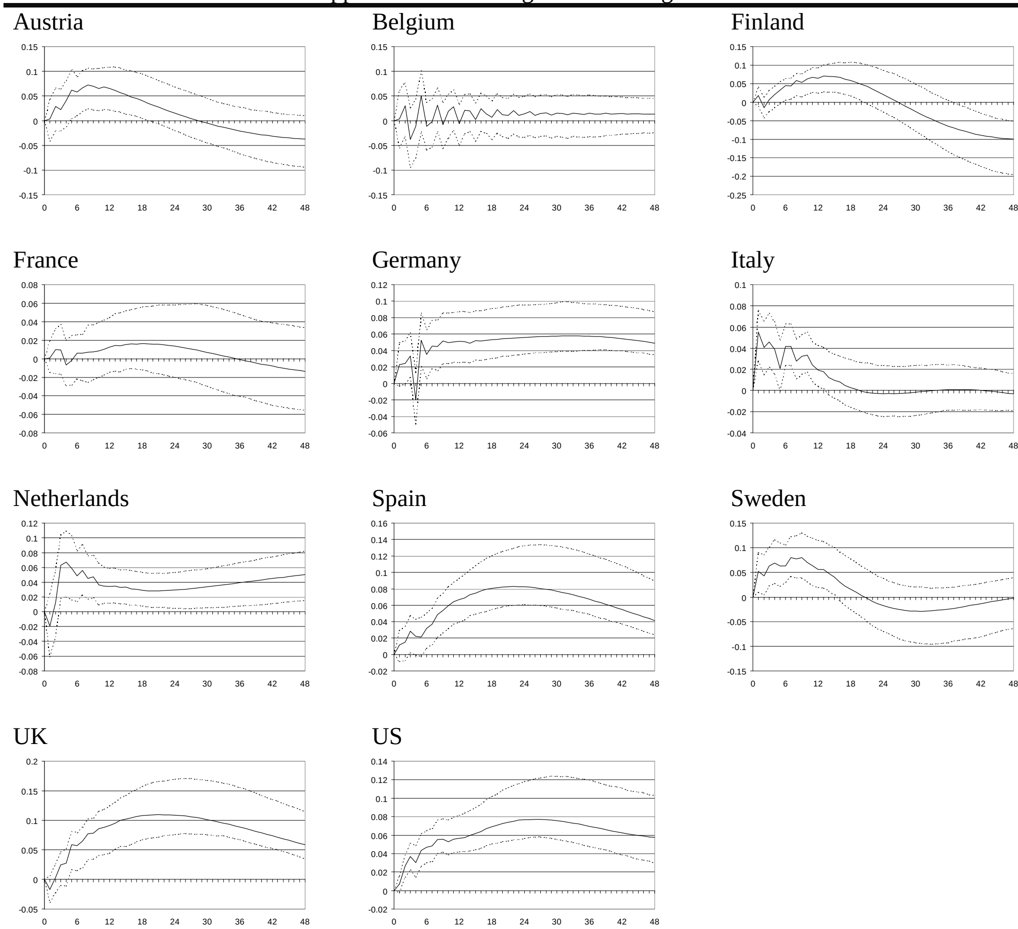

Figure A 5: SVAR Impulse response of the price level to a 1 percent equity market shock. The horizontal axis gives the number of months after the shock. The vertical axis gives the responses in percentage changes. Confidence intervals are bootstrapped 90% intervals generated using Hall's method.

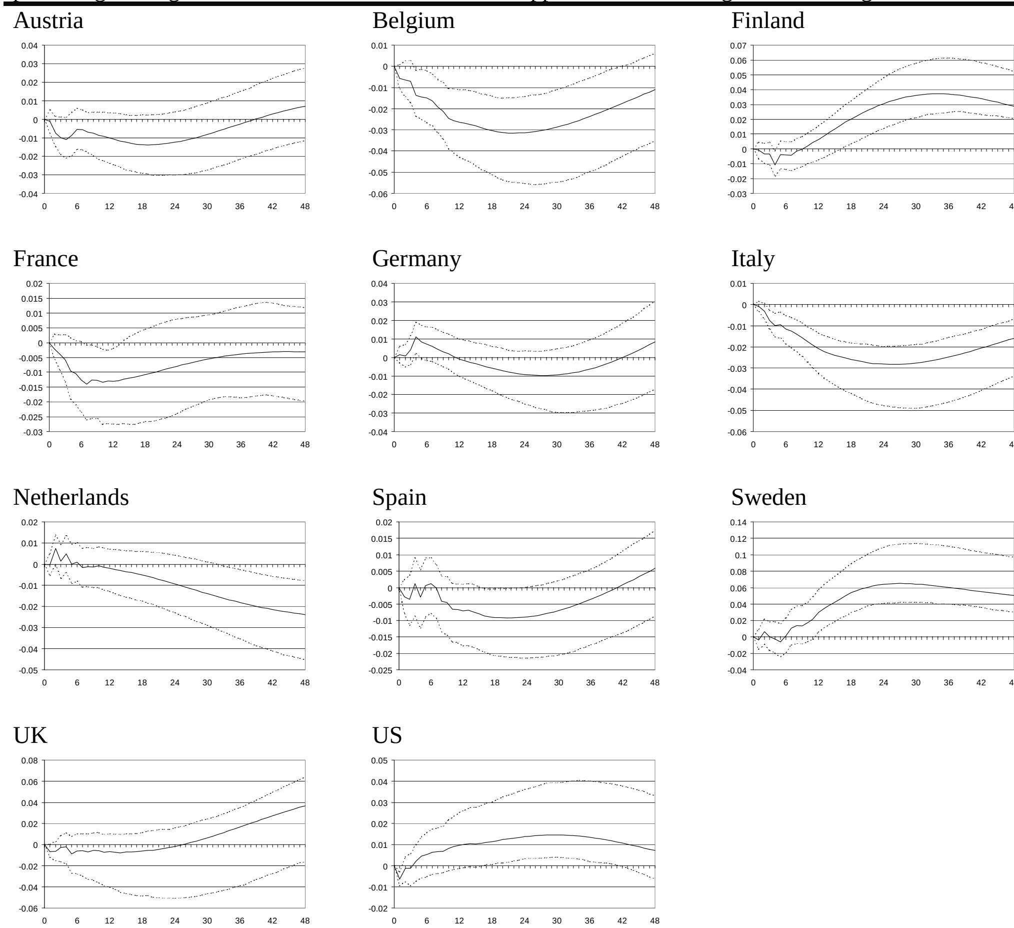

Table A 5: Indicators to compare difference in SVARs to a foreign interest rate shock. The first two columns of this table displays the peak effect on output within the first 48 months and lag at which this occurs. The third column gives the total output lost in the first 30 months. The final columns show the peak effect within the first 48 months and lag at which this occurs.

	Peak effect on Output	Lag	Output loss	Peak effect on Prices	Lag	Peak effect on Equity Prices	Lag
Austria	-0.23	17	-4.60	-0.15	48	-2.09	29
Belgium	-0.11	1	1.51	-0.04	7	-0.63	6
Finland	-0.47	48	-4.95	0.00	0	-1.14	48
France	-0.01	48	0.31	-0.01	7	0.07	48
Germany	-0.01	14	0.73	-0.06	47	0.27	48
Italy	-0.35	22	-5.17	-0.01	2	-1.06	13
Netherlands	-0.30	35	-6.24	-0.02	3	-1.52	43
Spain	-0.21	30	-5.10	-0.03	1	-1.22	23
Sweden	-0.72	26	-6.78	-0.03	6	-1.86	20
UK	-0.03	1	1.06	-0.09	48	-0.35	3
US	-0.78	24	-13.68	-0.12	48	-1.09	38

Table A 6: Indicators to compare difference in SVARs to a commodity price shock. The first two columns of this table display the peak effect on prices within the first 48 months and lag at which this occurs. The third and final column show the peak effect on equity prices within the first 48 months and lag at which this occurs.

	Peak effect on Prices	Lag	Peak effect on Equity Prices	Lag
Austria	0.06	8	-0.19	5
Belgium	0.03	6	-0.39	5
Finland	0.01	2	-1.86	13
France	0.04	29	-0.59	11
Germany	0.06	32	-1.09	5
Italy	0.06	24	-1.45	10
Netherlands	0.05	30	-0.61	8
Spain	0.04	6	-0.76	2
Sweden	0.05	1	-0.31	5
UK	0.11	22	-0.65	5
US	0.05	21	-1.16	8

Figure A 6: Variance decompositions. This figure displays the percentage of the forecast error for the main variables output, prices, interest rates and equity prices. Forecasts errors due to equity prices are shown for three different horizons (6, 18 and 30 months) per country.