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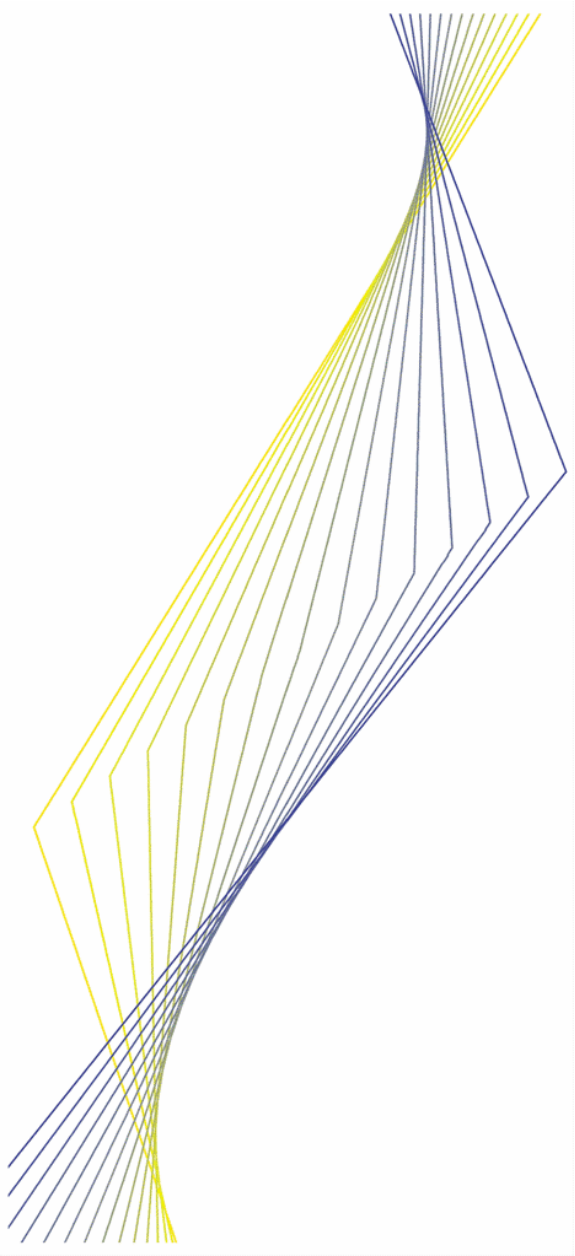

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MONETARY TRANSMISSION IN THE EURO AREA: WHERE DO WE STAND?

BY IGNAZIO ANGELONI[1], ANIL KASHYAP[2], BENOÎT MOJON[1], DANIELE TERLIZZESE[3]

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The Eurosystem Monetary Transmission Network

This issue of the ECB Working Paper Series contains research presented at a conference on "Monetary Policy Transmission in the Euro Area" held at the European Central Bank on 18 and 19 December 2001. This research was conducted within the Monetary Transmission Network, a group of economists affiliated with the ECB and the National Central Banks of the Eurosystem chaired by Ignazio Angeloni. Anil Kashyap (University of Chicago) acted as external consultant and Benoît Mojon as secretary to the Network.

The papers presented at the conference examine the euro area monetary transmission process using different data and methodologies: structural and VAR macro-models for the euro area and the national economies, panel micro data analyses of the investment behaviour of non-financial firms and panel micro data analyses of the behaviour of commercial banks.

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Contents

Abstract

Drawing on recent Eurosystem research that uses a range of econometric techniques and a number of new data sets, we propose a comprehensive description of how monetary policy affects the euro area economy. We focus mainly on three questions: (1) what are the stylised facts concerning the transmission of monetary policy for the area as a whole and for individual countries? (2) can the "classic" interest rate channel (IRC) alone, without capital market imperfections, explain these facts? (3) if not, is the bank lending channel a likely candidate to complete the story? We find plausible euro-area wide monetary policy responses for prices and output that are similar to those generally reported for the US. However, investment (relative to consumption) seems to play a larger role in euro area monetary policy transmission than in the US. We cannot reject the hypothesis that the IRC completely characterises transmission in a few countries, and estimate it to be substantial in almost all. Where the IRC is not dominant, there is normally some direct evidence supporting the presence of a bank lending channel (or other financial transmission channel). The cases where financial effects appear important can be further split according to whether they primarily relate to consumption or investment.

Key words: Monetary policy; transmission mechanism; euro area; bank lending.

JEL classification: E52, E58, E44

Non-technical Summary

Based on the results of research conducted within the Eurosystem, and drawing also on previous literature, this paper puts together a comprehensive picture of how monetary policy affects the euro area economy. The empirical evidence draws on a variety of techniques (structural models, VARs, panel estimates) and data (area-wide and national aggregates, individual data on bank and non-financial firm balance sheets). The discussion is organised around three questions: (1) what are the stylised facts concerning the transmission of monetary policy to the area as a whole and to the individual countries? (2) can the "classic" interest rate channel (IRC) alone, without financial frictions or credit constraints, explain these facts? (3) if not, is specifically the bank lending channel a plausible candidate to complete the story?

On the *first question*, our central result in short is that an unexpected increase in the short-term interest rate temporarily reduces output, with the peak effects occurring after roughly one year. Prices respond more slowly, with inflation hardly moving during the first year and then falling gradually over the next few years. Structural econometric models and VARs, though not strictly comparable, provide a picture with similar qualitative features. Despite the synthetic and somewhat artificial nature of historical data for the area as a whole, these findings are theoretically sensible and broadly consistent with a large body of empirical literature analysing the other large currency area in the world, namely the US. Moreover, the delayed response of prices relative to that of output suggests that studying the transmission of policy to spending and output is a logical step, even if the aim of monetary policy is defined primarily or exclusively in terms of prices.

A further aspect of the assessment based on aggregate data at the area level is that both the VARs and the structural models highlight the importance of investment in driving output changes in the wake of a monetary policy tightening. This feature distinguishes the transmission mechanism in the euro area from that in the US, where much of the output adjustment appears to be due to changes in consumption.

On the *second question*, we find that the IRC works remarkably well as a null hypothesis, though it does not explain all. While not dominant on the whole, the IRC is a very prominent channel in the transmission. In a group of countries, accounting for about 15 % of the euro area GDP, the IRC is unambiguously the dominant channel. In all other countries for which we have the evidence (covering, another 75 % of the euro area GDP) interest rate effects are always a sizeable, and sometimes the virtually unique, source of

investment movements. It is interesting that there generally seems to be a significant effect of the user cost of capital on investment. This finding, based on micro-data analysis, is somewhat in contrast with the often more ambiguous results coming from aggregate data. On the whole our results, while certainly not supporting the idea of an exclusive role of the IRC, are in conflict with presumption of a strong and widespread lending channel based on the overarching role of banks as providers of finance in the euro area.

Concerning the *third question*, the paper shows that in the transmission of monetary policy the IRC is complemented by financial factors in more than one way. Indeed, the cases where the IRC dominance can be rejected do not point to a single, prevalent alternative. In some of the countries it looks like the role of banks in supplying business credit to finance investment may be important. But this does not appear to hold everywhere, as there are cases in which if loan supply matters it is not likely to be true for investment. Thus, in terms of monitoring bank lending it is probably necessary to track both household and business lending. Moreover, there are also cases in which financial factors are important but banks are not likely to be an important ingredient in the picture.

Overall the role of banks in the transmission mechanism is somewhat different, and perhaps smaller, than what might have been expected based on prior work. The bank lending channel is found to operate significantly in Germany and Italy. But there are also countries where bank lending appears irrelevant for transmission. In some, we suspect that government guarantees to support banks, the propensity of banks to operate in networks, and strong borrower-lender relationships may mitigate the strength of any loan supply effects.

In assessing the role that the banks do play in the transmission, the relevant characteristics that appear to affect the potency of the lending channel are not always those that we (and probably others too, based on our reading of the past literature) would have guessed. Bank size and bank capital seems not to play much of role in shaping loan supply responses to monetary policy. But this means that the vast heterogeneity in terms of size both across and within countries is probably not very important. In contrast, bank liquidity positions seem to be important in virtually all the countries where loan supply effects appear to be present.

Taken together this means that even though the banks dominate the supply of credit in all euro area countries, they do not appear to be uniformly important.

1. Introduction

The transmission mechanism of monetary policy in the euro area is a subject of obvious, considerable interest, both from a policy and an academic viewpoint. Yet, the relevant empirical knowledge is far from satisfactory.

The European Central Bank (ECB), which started conducting monetary policy in 1999, aims at maintaining price stability for the area as a whole, using all relevant information at its disposal[1]. For this purpose, ideally all one would need is a good quantitative assessment of the dynamic consequences of a change in the policy controlled interest rate on the main area-wide macroeconomic variables. Armed with these estimates one could then gauge the overall impact of policy and attempt to disentangle the channels through which it takes place.

However, at this time addressing these issues directly and only at the area-wide level is fraught with several difficulties. First, there is the problem of the short life of the currency union. Historical empirical relationships established among area-wide time series prior to the birth of the new European currency in 1999 might not be robust to the change in the monetary policy regime. The problem is only partly mitigated by the fact that, during the preparatory phases of monetary union, significant cross-country convergence in policies and structures is likely to have taken place[2]. Moreover, structural differences among the economies of the euro area countries are still non-negligible – so the area-wide economy may still be in flux. Finally, at the area-wide level there are many economic variables that cannot easily be measured. For instance, to date it has not been possible to assemble reliable data on inventories or durable consumption, variables that are likely to be important for monetary transmission.

These considerations suggest that it might be best to complement the area-wide evidence with an assessment of the area-wide conditions built up from the country level. Statistical analysis by Marcellino, Stock and Watson (2001) confirms the advantages of this strategy[3]. Unfortunately taking this route requires a large amount of country-specific expertise to competently deal with institutional and other differences between countries[4]. An indirect signal of this difficulty is provided by the huge disparity of the results one finds when surveying the literature comparing monetary transmission across the euro area countries[5]. Besides reaching different conclusions about the potency and the principal channels of policy, the results are often not comparable across countries. Thus, it is often hard to know if any

[1] The ECB strategy is discussed in Issing et al. (2001).
[2] See Angeloni and Dedola (1999).
[3] Their conclusion is that "… there typically are gains from forecasting time series at the country level, then pooling the forecasts, relative to forecasting at the aggregate level".
[4] See for instance the Bank for International Settlements (1995).
[5] See the for example reviews in Guiso, Kashyap, Panetta, and Terlizzese (1999).

differences that are or are not uncovered reflect the methodologies used or the actual economic workings of the various countries. [6]

Undoubtedly, this situation partly reflects the inherent difficulty in identifying the effects of monetary policy. There is a clear simultaneity problem that arises because policy actions are taken in response to the state of the economy. This problem is no easier to tackle at the country level than at the area-wide level.

To deal with these problems, a possibility is to take advantage of the rich wealth of information that is available at the microeconomic level. As identification using micro data is often achieved through cross-sectional variability, the problem of simultaneity is probably less acute[7]. Moreover, the large sample size allows relatively precise estimates even if the time span is relatively short, thus minimising the estimation problems posed by regime changes. A further advantage of the micro data is that they make it possible to control for agents' characteristics, which sometimes provides a more powerful test of certain aspects of the transmission mechanism (see for example, Chatelain et al. (2001) and Ehrmann et al. (2001)). Finally, drawing on micro data allows the possibility of separating differences due to behaviour (similar agents acting differently) from differences due to composition (similar agents acting similarly, but having different weights in the aggregate). This distinction may be helpful in gauging which relationships might prove less affected by the regime shift.

As with the other approaches mentioned, though, resorting to micro data is not a cure for all ills. In particular, it makes it very difficult to provide a direct answer to the key question of what are the aggregate effects of monetary policy on the relevant economy (the area as a whole).

Given all of these difficulties, there is no single approach that can be relied upon to describe and analyse the transmission mechanism of monetary policy in the euro area. The most reasonable and effective strategy for investigation seems to us to collect evidence from all available sources (area-wide aggregate time series, country level time series, microeconomic panels), hoping that these complement each other and provide informative cross-checks. This is the route followed by the teams of Eurosystem[8] economists that have collaborated to study the transmission mechanism[9].

Our aim in this paper is to bring together and interpret this evidence. We will not provide an exhaustive summary of all these findings, because other papers presented in this conference

[6] See the discussion of this point in Mojon and Peersman (2001).
[7] See the discussion in Chatelain et al. (2001).
[8] The Eurosystem includes the European Central Bank and the National Central Banks of the European Union member states that have adopted the euro.

are devoted to precisely this task and because the sheer amount of information produced makes it very hard to provide a complete description. The reader interested in more details should consult the set of accompanying papers[10].

We will rather try and frame the main results coming from different sources and models in a coherent overall interpretation of the transmission process. Our null hypothesis is that the euro area monetary transmission mechanism can be characterised as taking place through the classical interest rate channel (IRC). We characterise the IRC as the response of aggregate demand components, GDP and prices to the change in the policy controlled interest rate that would take place if there were no capital market imperfections[11]. With this definition, the IRC includes all "classical" inter-temporal substitution effects. In the case of investment, it includes the effects engendered through the user cost of capital as well as any demand effects attributable to inter-temporal reallocations prompted by interest rate changes. In the case of non-durable consumption, we assume that the inter-temporal reallocations strictly due to changes in the interest rate are negligible.

We take this as our null hypothesis for several reasons. First, since the IRC is the conventional way in which monetary policy is presumed to operate in a large, fairly closed economy, it is logical to ask whether it can explain the working of monetary policy in the euro area, before looking for alternative channels. Second, much of the concern that has been voiced about the potentially asymmetric effects of the single monetary policy appears to be grounded in observed asymmetries in the financial structure of firms, as well as in their vulnerability to informational problems. These features would be clearly of little relevance if the IRC were to account for the bulk of the transmission mechanism. Third, taking the IRC dominance as the null hypothesis provides a disciplined way to look for alternative explanations. Highlighting the places where the interest rate effects do not appear to be the whole story helps identify where other channels (such as balance sheet, liquidity constraints, bank credit supply, and the like) may be important. This in turn can help guide the measurement and monitoring of the most relevant information for policymakers.

It should be stressed that, while historically the exchange rate channel has been important for each of the constituent countries, we expect monetary policy to influence the euro area

[9] A group of Eurosystem economists has specialised, within the Monetary Transmission Network, in analyses based on VAR and panel data. Another one (Working Group on Econometric Modelling) has undertaken studies based on structural econometric models.

[10] See ECB Working Paper Series, n. 91 to 112.

[11] The IRC would be the only channel through which monetary policy would affect aggregate spending in a closed economy where: (1) the central bank was able to influence the term structure of market real interest rates, and (2) all agents were able to borrow and lend at those rates. In this world, no agent's expenditure would be affected by his/her availability of liquidity or collateral. According to this definition, we obviously do not include in our notion of capital market imperfections the institutional features of the payment system needed to justify the existence of money demand.

economy (which is much more closed to international trade than the average of the constituent countries) mainly through domestic channels of transmission. These will therefore be the main focus of our analysis.

The remainder of the paper is organised into six parts. In section 2 we briefly explain the logic underlying our analysis, focusing in particular on how we intend to bring the various pieces of empirical evidence to bear on the issue.

Section 3 presents and interprets the evidence for the euro area as a whole. This section draws upon evidence from both Vector Autoregressive (VAR) models and structural euro area models and also includes some comparisons between the euro area and the U.S. There are surprising similarities between the two, but also important differences.

The macro country-level evidence is summarised in section 4, including both results from VARs and from structural econometric models. We first present our basic results concerning the potency of monetary policy across countries. We then check whether the interest sensitive components of GDP – those components of aggregate demand that are most subject to inter-temporal substitution effects – appear to be the ones that respond the most to changes in monetary policy, and are able to account for the bulk of the GDP response. It is important to keep in mind that even if this were the case, it would not establish the dominance of the IRC, as the movements in those components might be due to factors different from those included in the IRC. Conversely, this step of the analysis could be sufficient to reject, for some country, the IRC dominance, provided that movements of the non-interest sensitive spending components are not merely driven by changes of the interest sensitive ones[12].

Section 5 introduces the microeconomic evidence on non-financial firms' behaviour. These data are used to determine whether countries where macroeconomic data suggest a strong IRC are also countries where the cost of capital is a particularly important driver of investment.

Section 6 looks for evidence on banks' lending that would be consistent with non-interest channels of monetary transmission, to complete the assessment so far reached concerning the IRC dominance.

Section 7 contains our summary of the analysis. Here, we first, summarise our understanding of how policy effects appear to be transmitted in each euro area country. Next, we offer some tentative judgements regarding the overall, area-wide effects of monetary policy. We close

[12] The most obvious objection to this proviso is the possibility of multiplier effects on non-durable consumption. However, in an IRC-dominated world, consumption would be determined not by the keynesian multiplier, but by expected lifetime resources and future real interest rates. In such world we would expect a change in the nominal interest rate to have only minor effects on consumption, as it does not change the long-run value of potential output and affects only temporarily the real term structure. Even if expected real rates were significantly changed, the effect on non-durable consumption would likely be small, as we argue later in this paper.

with a brief mention of two areas where future work is most needed to refine these assessments.

2. Assessing the Importance of the Interest Rate Channel (IRC)

Ideally, we would like to "test" for the dominance of the IRC in a fully explicit and rigorous way. Unfortunately, as we rely on bringing together rather disparate pieces of evidence, this often makes it impossible to formally pool the findings and to conduct sharp statistical tests. Hence, some judgement is required in deciding what can be concluded from the presented evidence[13]. As a consequence, the end result of our testing strategy yields a "suggested interpretation" of the empirical results. Alternative interpretations may be possible, and we will flag them when appropriate.

Our reasoning has two starting points. First, if the IRC is the dominant channel of monetary transmission, then interest sensitive spending ought to account for the bulk of the spending changes that occur after a shift in monetary policy. Secondly, there ought to be evidence that these spending shifts appear to be due *directly* to changes in interest rates and not just *indirectly*, i.e. because other determinants of such spending categories are affected by policy. To take an example, merely showing that investment swings are the driving force behind output shifts is not enough to conclude in favour of IRC dominance. Rather, one must also find that investment is moving *because* of changes in interest rates, not due to other reasons.

This reasoning suggests that there are three critical parameters that must be measured in order to determine whether the IRC dominance can be rejected. The first is the elasticity of output with respect to monetary policy. Loosely speaking, this tells us the overall effect of a monetary shock on activity. Next, we need to determine the elasticity of interest sensitive spending categories with respect to the monetary shock. For reasons explained below, we will, in many cases, be forced to use investment as a proxy for all interest sensitive components of GDP. Comparing the investment and output elasticities allows us to assess (given the share of investment in GDP) whether interest sensitive items move enough to account for the output response. This would be a necessary condition for the IRC to hold[14].

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[13] Whenever possible we attempt to offset the importance of the judgement by making assumptions that are favourable to the IRC. Of these, probably the most important is couching the IRC dominance as the default explanation. Since it starts out as the null hypothesis, in cases where the evidence about its importance is ambiguous, we will conclude in its favour. However, it should be always kept in mind that failing to reject the IRC is not the same as accepting it.

[14] More specifically, our key parameter here is the "contribution" of the interest sensitive spending items to changes in output. The contribution is equal to the ratio of the two elasticities multiplied by share of the interest sensitive components in GDP. Obviously, the contribution might be close to unity

The third ingredient in our calculation is the elasticity of investment with respect to the interest rate, calculated excluding the monetary policy related effects that could operate through non-interest channels. A second necessary condition for IRC dominance to hold is that the interest rate elasticity is big enough to account for the overall elasticity of investment with respect to monetary policy.

2.1 – Overview of our testing strategy

Our testing strategy will work sequentially. *First*, we ask whether the available empirical evidence suggests that the response of interest sensitive components of spending cannot account for the observed changes in output. *Second*, for those cases where the response of the interest sensitive components of spending seems sufficient to explain GDP changes, we check whether such response can be explained, to a sufficiently large extent, by the direct effect of interest rate changes on these components. If the outcome of *both* steps above is positive, we can plausibly conclude that our null hypothesis cannot be rejected. *Third*, in all other cases, i.e. when the IRC does not seem to provide an adequate explanation of GDP changes for either reason, we look for evidence of financial factors.

In building our positive case for financial effects, we look first for direct evidence of cash-flow or liquidity effects on investment[15]. We then look for independent evidence regarding banks' behaviour following changes in monetary policy. There are several reasons for looking in this direction, explained in detail by Ehrmann et al (2001). The short justification is that a sizeable body of work shows that these factors matter in the U.S., and they should a fortiori be presumed to apply to the euro area as well, given its less advanced financial market structures and the greater role of banks in the financial system. Importantly, however, our testing strategy does not necessarily assume that all financial effects are bank-related.

2.2 - A classification scheme

Using this strategy for combining the macroeconomic and microeconomic evidence, we sort countries into four categories (plus a fifth one, which includes cases where our evidence is

even if the IRC dominance were to fail, as those components might move (also) as a result of financial factors being at play. However, if the contribution were small, the IRC dominance could be rejected.

[15] The financial factor effects on investment are proxied by a cash flow or a liquidity variable in the investment equation. Clearly, to the extent that this variable does not fully capture financial factors, and in particular the role of collateral, our estimate would overstate the role of the IRC. While we did not investigate the effects of collateral on investment, Mojon, Smets and Vermeulen (2001) provide evidence that in France, Germany, Italy and Spain, the effects of changes in interest rate on the external finance premium of firms, which appear to depend on firms' collateral, is not larger for small firms than for large firms. This indicates that even though collateral has an impact on the cost of external finance, this cost does not adjust disproportionately for smaller firms, for which the access to external funding is more

inconclusive). See the chart 1 for a simple representation of how our testing strategy leads to each of these categories.

The first set comprises cases where the IRC appears dominant. For these countries two conditions hold; namely, that the contribution of the interest sensitive spending components appears to account for large part of the changes in GDP and the imputed elasticity of investment with respect to the user cost of capital is consistent with a large investment response. The countries in this group obviously need not have the same overall output response to monetary policy. For all of them, we do not expect a large role of financial factors.

It might happen, however, that the contribution of the interest sensitive spending is large, but the response of investment is not accounted for solely (or predominantly) by interest rate effects. These cases fall into our second category. For them, we expect financial factors to be important for investment.

Then there are countries where the IRC dominance could be rejected because the contribution of interest sensitive components to the total movement in GDP is not large. For those, the non-interest rate effects are presumably operating (also) through other expenditure items (particularly, consumption). Among those countries, our third category comprises those where the response of investment is largely explained by interest rate effects. We therefore expect, for these countries, to find financial factors affecting consumption.

Our fourth category comprises countries where, instead, investment movements cannot be accounted for exclusively by interest rate effects. For these, we expect financial factors to show both for consumption and for investment.

Finally, there are a few countries where the evidence is either insufficient or ambiguous, so that we cannot draw any firm conclusions. The difficulty in classifying these countries could come from either of two problems. One possibility is that we could be unable to determine with sufficient confidence the size of the response of either investment or output to monetary policy. This could happen because the VARs and the econometric models give strongly conflicting estimates, or because neither the models nor the VARs give a precise estimate. A second possibility is that, lacking micro estimates of the user cost elasticity, we are unable to go beyond the (inconclusive) statement that the IRC *could* be the dominant transmission channel.

difficult, to changes in the interest rate. Given that the effects of interest rate changes on investment through collateral are not more important for small firms than for large ones, we expect the "collateral channel" to be small for all firms.

The final step in our testing strategy, having identified these five categories, is to check whether we find additional or independent evidence corroborating or completing the predictions formulated for each group.

A first kind of check amounts to verifying, in the countries where we (provisionally) concluded that financial factors should be at work, whether any subsets of firms where one might think liquidity problems should be more acute show stronger sensitivities of investment to liquidity. A second kind of checks relies on evidence on the behaviour of banks. This kind of evidence, besides helping us to cross check previous conclusions, also allow, in some cases, to specify in more detail our assessment.

One specific channel of monetary transmission (the so-called bank lending channel) places a special emphasis on the role of monetary policy in affecting the provision of bank credit. Therefore we look at whether the countries where non-interest rate factors seem to matter for investment are also countries where bank lending is particularly sensitive to monetary policy.

As long recognised in the literature, assessing the responsiveness of loan supply to monetary policy is tricky because bank lending may be highly sensitive since it reflects changes in loan demand rather than loan supply. Here again we turn to micro data.[16] The micro data can be used if one can find ways to define bank characteristics that are related to the likely sensitivity of their loan supply to changes in monetary policy. We describe our procedure for doing this in section 6.

2.3 - Difficulties in implementing our testing strategy

There are a number of conceptual and practical difficulties in implementing our testing strategy. They consist in the definition and measurement of appropriate spending categories (an issue ultimately connected with the availability of data), in the related identification of the transmission channels and in the mix of econometric methodologies (VAR; structural models; panel data) used in our investigation.

A first problem we face is that theory suggests that interest rates should influence a host of spending categories besides business investment, notably durable consumption and inventory investment. Unfortunately, the unavailability of homogeneous data for many euro area countries prevents a fully satisfactory statistical measurement of these categories. In short, we

[16] This is because separating supply from demand using aggregate data is difficult. Previous tests of this type generally require comparing movements in loans with movements in bank loan substitutes following a demand shock. However, in the euro area there are not many substitutes for loans, so such tests are not easily performed.

used all the information at our disposal, wherever available, to scale-up our investment data in order to take into account the presence of these other interest sensitive demand components.[17]

Second, there is the question of how to treat non-durable consumption, which is the largest component of GDP in all countries. Non-durable consumption can in principle exhibit some degree of interest sensitivity, due to inter-temporal income-substitution effects or to wealth effects. Here we appeal to the large empirical literature suggesting that non-durable consumption is insensitive to interest rates[18]. The case of weak wealth effects seems to be particularly plausible in the euro area, in light of the short duration of financial wealth and of the limited weight of stock market wealth in private portfolios.

Separate considerations need to be made concerning the possible existence of a broader balance sheet channel, in place (or on top) of a narrower bank lending one. Our tests and our data have admittedly limited power in discriminating between the two. Here we place our bets mainly on the evidence, that we study carefully, concerning the existence of cash-flow or liquidity effects on non-financial firms spending. Our presumption is that the existence of balance sheet effects can be revealed, at least partly, by the evidence on whether firms are subject to liquidity or cash constraints.

A seemingly more important issue is what to do about movements generated via the exchange rate. In principle these effects could be sizeable over our pre-euro sample period, for at least the most open among the euro area economies. However, besides the difficulty of dealing with the many exchange rate regime shifts that have occurred in the two last decades in Europe, it is a fact that the evidence on the response of the exchange rate to monetary policy (in all countries we know of) is far from systematic. The empirical support for the uncovered interest parity relationship is notoriously poor[19]. Such relationship is often assumed in econometric work[20]. But monetary transmission results based on this assumption must be

[17] Durable consumption and inventory investment at the aggregate level are either poor or simply not available. More specifically, durable consumption is measured separately only in France and Finland. Likewise, in all countries but France and the Netherlands inventory investment is computed as a residual in the national income and product accounts. Thus, there is little one can do to systematically study how interest rate changes influence these variables. For the two countries where durable consumption is available, VARs analysis suggests that it is about equally responsive to interest rates as is investment. Thus, as a first approximation, we assume that our findings for investment carry over to durable consumption and add the share of spending on durable consumption to the spending share on investment to get an overall percentage of GDP that is interest sensitive. The share of spending on consumer durables is estimated using all available information. We do not do any adjustment to account for inventory investment. Data limitations prevented the Eurosystem groups from exploring the response of inventories to monetary policy in a systematic way at this stage.

[18] The very comprehensive review by A. Deaton (1992) concludes "…my own view of the empirical evidence is that saving is not much influenced by interest rates. Given the theoretical ambiguities, I do not find it surprising that clear results have not emerged from the analysis of the data…".

[19] Clarida et. al. (2001) suggest that forward exchange rates (i.e. indirectly the interest rate differentials) allow, in non-linear models, to beat the random walk hypothesis. However, the results of this literature are still tentative.

[20] See e.g. van Els et al. (2001).

seen as highly uncertain, at best. Conversely, VAR estimates – e.g. by Mojon and Peersman (2001) – that do not impose this condition, do not find a systematic exchange rate channel.

On the whole, we try to take a middle ground position that allows us to essentially side-step these problems. Our approach is to recognise that after a shift in monetary policy, the exchange rate channel of monetary transmission and the influence on non-durable consumption both could account for some of the changes in GDP. For all the reasons outlined above, we do not attempt to offer a precise country by country estimate of these effects. Instead, we only ask whether monetary-induced movements in investment (scaled up to account for durable consumption) account for the bulk (say, 2/3 or more) of the output response.

In posing the question this way, and allowing for a very generous estimate of the response of the non-interest sensitive demand components, we believe we are tilting the exercise in favour of IRC dominance [21].

A final issue that deserves mention is that of the measurement of the monetary policy shocks. No original contribution to this issue is offered either by this paper or by any of the accompanying ones. Two standard methods are followed. The first is to examine the effects of unsystematic, VAR-identified shocks. The second is to focus on simple changes of short term interest rates, presumably controlled by the central banks through standard monetary policy instruments. We express no preference between these two methods, but rather look for results that are robust across them.

3. Monetary Transmission to the Aggregate Euro Area

In this section, we show some summary results on the effects of monetary policy on the euro area, based on synthetic data for the main area wide macroeconomic variables. We use this as a first step towards the more detailed analysis of the transmission channels performed country-by-country in the following sections [22].

[21] One important caveat relates to possible downward biases in the estimation of the elasticity of investment to the cost of capital. The survey by Caballero (1999) is very explicit on this point. If this bias was systematic, our procedure would tend to *under*estimate the contribution of investment to output changes and to *over*estimate the role of financial factors. Our – admittedly partial – insurance against this risk is to emphasise cross-country differences in the relevance of IRC (since we have no reason to suspect why irreversibility problems should differ across countries). We are grateful to Vitor Gaspar for calling our attention to this problem.

[22] The area-wide data are reconstructed by aggregating the national data of the 11 national countries originally adopting the euro. For the sources of data and some description of the aggregation method, see Fagan, Henry and Mestre (2001). Greece (which adopted the euro in 2001 and is covered in the analysis of the forthcoming sections) is not included in these aggregates. We have chosen to use these data, which are already documented and analysed, rather than new aggregates. We believe that this is unlikely to affect the stylised facts described here.

The main data used in the analysis are plotted in charts 2a and 2b. The time period under consideration spans three decades (1971-2000) covering three complete economic cycles, with corresponding recessions (1974, 1981 and 1993) and recoveries.

Inflation is on a downward trend for most of the period, with a major decline in the first half of the 1980s (corresponding to the first successes of the EMS), and eventually converges to an inflation rate of around 2 percent or less in the late 1990s. The synthetic euro exchange rate displays two cycles, with peaks (strong euro) in 1980 and 1992, and trough around 1985.

3.1 – Stylised facts on the euro area business cycle

Some descriptive statistics regarding the serial properties of the euro area data are reported in Table 1. We briefly report these results because they provide useful background for what follows; the interested reader should look for details in Agresti and Mojon (2001). Corresponding results for the US are also reported for comparison[23]. The comparison with the US is relevant for at least two reasons. First, the euro area economy shares certain broad structural features with the US (particularly: size; degree of openness; composition of output by sector), which make the comparison natural particularly from the viewpoint of the transmission mechanism[24]. Second, the business cycle characteristics and the transmission of monetary policy in the US are relatively well documented: thus highlighting common features may identify cases where existing research results might carryover.

A few findings emerge from Table 1 (reproduced from Agresti and Mojon, 2001). The *absolute level* of the volatility of GDP in the euro area (obtained from series filtered using the technique proposed by Baxter and King (1999)), is somewhat lower than in the U.S.[25] However, if measured *relatively* to GDP the volatility of the main domestic demand components appear to be broadly similar in the two economies. An exception is inflation, whose volatility appears to be much lower in the euro area (both absolutely and relative to GDP).

The right-hand part of Table 1 shows dynamic cross-correlation between the main macro variables (at the quarterly frequency) and GDP (where all data are filtered). The autocorrelation for prices are also shown separately. The degree of persistence of the GDP and price series and the lead-lag patterns across GDP components, interest rates and credit with respect to GDP are remarkably similar between the two currency areas. However there are also a few differences between the US and the euro area. In particular, the cross-

[23] Corresponding results for the UK are provided by Bean et al. (2001).
[24] For a discussion of the similarities and differences between the structures of the euro area and the US economy, with reference to the transmission mechanism, see Issing et al. (2001) chapter 3.

correlation between inflation and GDP differs. The correlation between lagged GDP and current inflation tends to be lower in the euro area, and the sign of the correlation between current inflation and future GDP growth becomes negative after 2 quarters in the US, unlike in the euro area. Moreover, stock prices appear to be strongly positively correlated with future output in the US, contrary to what is found for the euro area. Finally, M1 seems a better leading indicator of output in the euro area than in the US. These findings can be given intuitive interpretation[26], and would deserve further analysis that go beyond the scope of this paper.

3.2 - VAR estimates of the effects of monetary policy

As a first description of the transmission mechanism we report the results of the VAR model for the euro area estimated by Peersman and Smets (2001). In their model, the reconstructed short-term interest rate for the euro area is assumed to be a good proxy of the average stance of monetary policy over the period. The impulse response functions described below cover the evolution of inflation and output growth following a standard unexpected short-term interest rate shock, whose size is estimated to be around 30 basis points. For the euro area, we report the results of two models: the second differs from the first simply for the inclusion of M3 as an endogenous variable (see details in Peersman and Smets, 2001). For comparison we also report similar statistics for a VAR for the US economy. The US model uses a specification that is close to the first of the two VAR models of the euro area, and is also qualitatively similar to Christiano, Eichenbaum and Evans (1999)[27]. For the US impulse responses the size of the standard shock to the federal funds rate over this period is estimated to be around 70 basis points.[28]

Comparing the first column of chart 3 (euro area) with the last (US), we see that in both economies the interest rate increase induces output to fall for a few quarters and to start recovering within roughly one and a half years. Both in the US and in the euro area inflation slowly falls after a monetary tightening and the decline is not significant in either region for

[25] It is however worth noting that the volatility of the business cycle has declined in the US in the 1990's while it has increased in the euro area (Agresti and Mojon, 2001).
[26] Given the lower stock market capitalisation in Europe, it is not surprising that stock prices are a poorer prediction of output.
[27] The benchmark VAR presented in their paper actually obtains a response of GDP to interest rate shocks that is about 50% larger than the one obtained by Peersman and Smets (2001) for the euro area and for the US. This larger response is however obtained in a different sample period, from 1965 to 1995 instead of 1980 to 1998 for the results of Peersman and Smets.
[28] In fact, the size of the US shocks turns out to be fairly sensitive to the choice of the sample period. The size of the shock decreases to 0.45 if the sample period does not include the October 1979 change in the operating procedures. Here we have included them in the sample as seems appropriate to do since the ensuing cyclical slowdown is also included and to be closer to the sample period chosen for the euro area, which starts with the beginning of the EMS in October 1979.

several quarters. The magnitudes of both the inflation and output movements are larger in the US; however, this seems attributable to the size of the interest rate shocks (the differences are roughly proportional to the differences in the size of the shocks).

The similarity between the euro area and the US response profiles is strengthened if focus is placed on the results of the central column of the chart (model with M3) rather than the first (without M3). The latter model may be more appropriate for the euro area over our sample period, in light of the prominence assigned to monetary aggregates by a number of central banks.

3.3 - Evidence from structural econometric models

Alternative estimates of the impact of shocks to the short-term interest rate based on central banks structural econometric models are presented in Table 2. First, we compare the VAR (using the specification with M3) with the Area-Wide Model (AWM) of Fagan, Henry and Mestre (2001), a medium-size model estimated on synthetic euro area data[29]. This comparison is made by simulating the AWM using the path for the policy rate and the exchange rate that the VAR generates after a policy shock[30]. Second, we compare the AWM to the area wide response that emerges from the aggregation of the individual country models described in van Els et al (2001). In both cases, the short-term interest rate is raised by 100 basis points for two years (and brought back to baseline from year three), while the long-term interest rate is consistent with term structure relationships and the exchange rate is consistent with UIP in every country of the euro area. We label the country-aggregated forecasts EMM (for Eurosystem's Macro Models).

The simulations are obviously not comparable, but within each pair (VAR vs. AWM in the first case, EMM vs. AWM in the second), we can compare the results obtained with the two methodologies. We can also compare the changes of key demand components relative to output (so called "contributions" to output changes). Such contributions will play an important role in the analysis of the following sections.

We focus first on the results for *investment, consumption and GDP*, then on those for *prices*. The response of GDP and investment to the policy change looks fairly similar in the VAR and AWM. Since investment spending is about one fifth of GDP for the euro area, the estimates suggest that in the first year following the interest rate shock the change in investment

[29] Some of the properties of this model under monetary policy shocks are discussed in McAdam and Morgan (2001).
[30] We are grateful to Alistair Dieppe for providing us the AWM simulations reported in Table 2 and 3.

accounts for about a half to three quarters of that in output.[31] At longer horizons the contribution of investment is slightly higher.

Comparing the EMM and AWM, the AWM tends to produce systematically stronger responses, particularly at longer horizons. Again, however, the models are in agreement in suggesting that the contributions of investment are sizeable already in the short run and growing with the horizon. Overall, hence, although there are differences in the four simulations, the results seem to point clearly at a large role of investment in driving GDP changes after a monetary policy change.

The models paint relatively different pictures about how *prices* respond to policy shocks. The AWM consistently produces strong responses, this time also relative to VAR. The slow response in the VAR (including a price puzzle, whereby estimated prices are actually higher after 1 year) sharply contrasts with the rapid decline in inflation that occurs in the AWM for the first type of simulation. The AWM suggests that prices' deviation from baseline remains constant after 3 years, while in the VAR it steadily falls after the first year. The difference between the price dynamics implied by the EMM and AWM is more muted, but again the AWM shows stronger responses.

Table 3 introduces the comparison between the euro area and the US. The euro area results are shown both for the AWM and the EMM. For the US, the Federal Reserve Board model (FRB-US) was used[32]. We present these data because they are interesting and because they provide some useful insights to our subsequent argument. However, the design of the experiments at this stage of our research is still tentative, for a number of reasons. Most notably, the long-term rate is treated differently in the various simulations, which therefore are not strictly comparable[33]. Hence, the results should be treated with care. In this context, we believe that the results concerning the contributions of individual demand components to the total change in output *within each simulation* are more reliable than the cross-simulation comparison of the absolute values.

Table 3 shows the multipliers (in semi-elasticity form) following a permanent exogenous change in the short-term rate (by 50 basis points) and the nominal effective exchange rate (by 5 percent). For the interest rate simulations the exchange rate is assumed fixed and vice versa.

[31] In contrast to the statistics reported in the next section here we are not accounting for durable consumption, since the data are missing for too many countries. If we did impute a 6% share as is sometimes done in the next section, the contributions would be 30% higher, further demonstrating the responsiveness of interest sensitive spending.

[32] We are grateful to Flint Brayton for providing us with these simulations and to Libero Monteforte for computing, from the results of van Els et al. (2001), the results labelled EMM.

[33] Specifically, in the AWM and EMM, the long-term rate is endogenised using term structure relations. In the FRB-US simulations, the long-term rate is left exogenous. However, the endogenous changes in the long-term rate in the European models are rather small and short-lived, a first and rough comparison between these results seems possible.

The results point to rather similar effects of the short-term rate on GDP in the euro area (based on EMM) and the US. In contrast, the exchange rate seems to produce a markedly different effect in the short run (stronger in the euro area). Price responses to short rate changes at first glance appear weaker in the euro area. However, considering the different effects of exchange rates on prices, a shock that raised the interest rate and appreciated the exchange rate could give rise to similar results on prices.

Further interesting results emerge concerning the breakdown between investment and consumption. In the FRB-US model, consumption is responsible for the bulk of the GDP adjustment, whereas in the AWM and EMM investment is the key driver; in other words, it seems that a relatively greater role is played by consumption in the transmission of monetary policy in the US, and a correspondingly greater role by investment in the euro area. This could be due to the strength of wealth effects on consumer behaviour in the US.

3.4 - Overall summary of the euro aggregate evidence

We read the evidence in this section as suggesting three broad conclusions. First, consumption, investment and GDP in the euro area display broadly similar time series characteristics over the business cycle as the corresponding series for the US. The dynamic cross-correlation among key demand components is remarkably similar. However, we have also pointed at some specific differences that call for further interpretation.

Second, VAR and structural model analyses for the euro area confirm sizeable and plausible monetary policy effects on output and prices. In the VARs, an unexpected increase in the short-term interest rate temporarily reduces output, with the peak effects occurring after roughly one year. Prices respond more slowly, hardly moving during the first year and then falling gradually over the next few years. Again, these VAR properties are similar to those reported for the US. The structural models of the US and the euro area broadly confirm this picture.

However, the compositional effects on consumption and investment appear to be quite different between the two areas. In the US, much of the output adjustment appears to be due to changes in consumption, whereas in the euro area, investment changes are more important. Both the VARs and the structural models confirm the importance of investment in driving output changes in the wake of a monetary policy tightening in the euro area.

4. Macroeconomic Evidence on Monetary Transmission in Individual Euro Area Countries

While the evidence assessed in the previous section, based on area-wide data, is not inconsistent with our null hypothesis of IRC dominance, we take seriously the concerns associated with the use of synthetic data. Accordingly we explore the importance of the IRC also using country level data. We proceed by first reviewing the VAR results and the structural model results. After recording some general observations about these finding we explore their implications regarding the importance of the IRC.

4.1 – Estimates of links between monetary policy, inflation, investment and output

The estimates based on the work by Mojon and Peersman (2001) and van Els et al (2001) regarding the responses of prices (as measured by the CPI in the VAR and the consumption deflator in the structural models), GDP, and investment to a monetary policy change are reported in Table 4. The underlying shocks are different. On the one hand, the VARs summarise the responses of the different variables to an unexpected, one-time change in the policy rate. As Christiano, Eichenbaum and Evans (1999) explain, this experiment provides a clean way to identify *unsystematic* policy effects. However, it is not designed to quantify the *full* impact of policy shifts. Furthermore, the implicit path for interest rates and exchange rates that accompany the GDP, inflation and investment responses in the VAR are neither the same across countries nor necessarily easily described. So it may be misleading to compare magnitudes across countries. On the other hand, once one accepts the strong identifying restrictions in the structural models, these can be used to describe any type of interest rate path that one chooses.

In what follows, we consider the effect of a 100 basis point increase in the short-term interest rate sustained for 3 years[34], coupled with a reaction of the long-term rate consistent with the expectation hypothesis, and with a shift in the effective exchange rate that is consistent with the uncovered interest parity condition (the bilateral exchange rates of each country with other countries in the area are left unchanged). Even though the size of policy change is identical for all countries, one must still be cautious in making cross-country comparisons since, prior to 1999, a given change in interest rate in different countries may have had different effects depending on the level and volatility of interest rates.

The different nature of the two experiments makes most comparisons of the quantitative results across techniques unfeasible. Fortunately, however, some qualitative conclusions can

[34] The substantive conclusions would be unaffected if we chose to report instead the findings from exactly the experiment discussed in van Els et al (2001) where the interest rate rises for two years and then returns to its baseline. However, the responses to rate reversal sometimes complicates descriptions so we focus instead on a sustained shock.

still be drawn and, as we will argue in the next sub-section, a quantitative comparison of the investment contribution to GDP movements – which is the focus of our interest – remains broadly feasible.

A serious concern is the uncertainty attached to the point estimates. Mojon and Peersman (2001) report confidence intervals for the impulse responses and as is typical with VARs these intervals are often quite large. To keep the tables readable we opt not to report standard errors for all the estimates. Instead we only highlight patterns where the estimation error is unlikely to be important. In what follows we concentrate on the point estimates at only three horizons: four, eight and twelve quarters after the policy shift. Very little is lost by omitting the intervening quarters, and in all the countries the peak response for output happens within 3 years.

Table 4 suggests four observations. First, both econometric techniques suggest that a monetary tightening leads to a reduction in output and inflation in virtually all countries and in the euro area as a whole. While this is not terribly surprising, since this prediction was undoubtedly one of the things that the model builders considered in settling on their preferred specifications, it is nevertheless reassuring to observe that this presumption is confirmed by the data. A second observation, probably more informative, is that for essentially all the estimates the peak response of inflation comes after the peak response in output.

A third observation is that a close examination of the VARs reveals a few counter-intuitive results. The VAR estimates for Ireland and the Netherlands suggest that a monetary tightening is expected to raise output at some point in the first three years. Similarly, in Austria, Greece, the Netherlands and the US, an increase in interest rates is estimated, at some point, to raise investment for these four countries. Moreover, once uncertainty is accounted for, often the estimates, including though the counter intuitive results just described, are not significantly different from zero. None of these anomalies are present in the structural models for these countries. As a result, we will put more weight on the latter in assessing the importance of the IRC for these five countries.

Finally, drawing on results that are not reported in the table we were able to compare the VAR estimates of durable consumption expenditure to investment expenditure in Finland, France and Italy. In each of these countries the shape of the impulse responses for these two variables were fairly similar, with peaks occurring at essentially the same time. The levels differed somewhat, with durables responding more than investment in Italy, about the same in Finland and less in France. Based on these findings we assume, in what follows, that the investment responses to monetary shocks can also be used to infer the likely response of durables.

4.2 – The contribution of interest sensitive spending to monetary policy induced GDP movements

We now see what these estimates can tell us about the possible dominance of the IRC. To make this assessment, we transform the data presented in Table 4 to show how much of the GDP response following a monetary tightening is attributable to interest sensitive spending shifts. This amounts to simply taking the ratio of the investment response to the GDP response[35] and multiplying it by the share of investment (plus durable consumption) in GDP.

One preliminary tricky question is how to handle timing. We do not see the IRC making a sharp prediction about the exact timing of when the effects should be most relevant. Moreover, in some of the structural models, long run properties are imposed to guarantee that certain features hold (e.g. unitary elasticity of investment with respect to the cost of capital). So we want to focus on horizons where the findings were not imposed from the outset. The results we report can be interpreted as the proportion of output changes following a sustained policy shift that can be attributed to changes in investment and durable consumption. These provide a concise, intuitive, and relatively robust way to summarise to role of interest sensitive spending. We show results three years after the shift because the bulk of the output adjustments have occurred in all the euro area countries by this time. We also show the average contributions over the first three years; this indicator could give a different picture if the importance of the interest sensitive components was fluctuating substantially or trending. It turns out that the inferences we draw from these two indicators are always in agreement. This similarity reflects the more general tendency for these contributions to be fairly stable across a variety of ways of computing them. So we are relatively confident in the conclusions that follow.

This transformation of the data also alleviates many of the problems that prevented comparisons in the previous table. In particular, for the VARs within each country the investment and output responses are both calculated for the same policy shock, so that when their ratio is taken the size of the shock is irrelevant. Thus, the VAR results across countries can sensibly be compared even though the shocks are not the same across countries. By the same argument, the fact that the paths of the shocks in the VAR and structural models are very different is much less of a problem. So it also seems reasonable to contrast the VAR and structural model estimates.

The results are shown in Table 5. There is a remarkable degree of correspondence between the estimates coming from the VARs and those coming from structural models. Ignoring the countries where the VARs produced the previously mentioned counter-intuitive results, there

are six countries (Belgium, Germany, Finland, France, Italy, and Spain) where meaningful comparisons can be made. These countries account for over 85% of euro area GDP. In each of these countries (except France) the VARs and structural models yield broadly similar conclusions about the IRC.

The five clear-cut cases separate into two groups. Belgium stands out as the country where output appears to be responding by much more than would be expected based on the investment movements. Thus, there is a *prima facie* case for looking for non-IRC effects (in particular financial effects) there. Germany also appears to be in this camp. Underlying these judgements is the belief that neither allowing for a generous exchange rate channel – say 20 per cent of the overall GDP response at year 3 – nor correcting for a modest response by non-durable consumption is going to be sufficient to fully account for the gaps between the output and investment responses.[36]

The other three countries, Finland, Italy and Spain, are cases where the output shifts do appear to be fully explainable simply on the basis of the investment (and consumer durables) responses. (As described earlier this is also true in the synthetic euro area data.) The Finnish findings are the most straightforward to interpret. Allowing for only small adjustments of either non-durable consumption or net exports we can explain the output changes.

The conclusions for Spain and Italy are tempered slightly because one of the two estimates (either that obtained from the VAR or from the structural model) looks very high. According to the Spanish VAR, investment seems to move by much more than would be expected given the output shift. This is due to the fact that this VAR predicts a very sharp drop in imports, so that net exports are forecast to grow following the monetary tightening. The Spanish econometric model does not have this property, but it also points to a powerful role for investment. Accordingly we identify Spain as country where the IRC dominance cannot, on the basis of the evidence so far produced, be rejected at this stage of the analysis.

Italy looks like the reverse of Spain, with the model giving investment more than full credit for the output movement. This again is caused by a relatively strong response of imports, falling due to both the initial appreciation of the exchange rate and the contraction in absorption. While this feature is not captured by the VAR, that shows an "exchange rate

[35] In the case of VAR simulations, the contribution is based on the cumulated responses of GDP and investment because the interest rate shocks are temporary.

[36] Since Belgium openess with respect to non euro area countries is large, this may seem like an insufficient allowance for the exchange rate channel. However, the Belgium national central bank model does not imply especially large contributions from the exchange rate moves after the second year of a policy shift. Indeed, the exchange rate channel that they compute by year 3 looks to be similar to the one implied for most euro area countries. As for Germany, the structural model would indeed imply a substantially bigger contribution of the exchange rate channel. While this would provide an alternative interpretation of the German results, the large difference between the relative size of the exchange rate

puzzle" (the exchange rate depreciates after the monetary policy tightening), the VAR-based contribution is on the high side as well and we conclude that, also for Italy, the IRC dominance cannot so far be rejected.

For France the structural model suggests a very low investment contribution, while the VAR suggests a high contribution. We do not see any clear basis that can be used to decide which assessment is more reliable. Thus, at this point we leave open the possibility that the IRC could be dominant in France.

We categorise the remaining countries, where we identified problems in the VARs, using the contributions from the structural models. Austria, Ireland, the Netherlands, Portugal and Luxembourg are all cases where the investment movements are sufficiently large to suggest a dominant role for the IRC. Of these the figures for Ireland and Luxembourg are at first sight somewhat puzzling, with the estimated investment contribution far exceeding 100%. In both cases, given the very open nature of the respective economies, the main compensating contribution comes from net exports.

The Greek structural model imputes a very small role for investment. We are unaware of any independent evidence on this point for Greece. Putting all the evidence together we conclude that the IRC stands a reasonable chance to be the dominant channel of transmission of monetary policy in 9 of the 12 EA countries (accounting for roughly 2/3 of euro area GDP). According to our sequential testing strategy, for these countries the key question becomes whether the strong observed investment responses are attributable to interest rates or are reflecting transmission via balance sheet, bank lending or other channels. We will address this question in section 5.

For the remaining countries, Belgium, Germany, and Greece, the evidence on investment already tells us that the IRC alone is not adequate for explaining affects of monetary policy on output. For these countries it appears that an important component of monetary transmission is operating through consumption. To explore further these cases, we will check whether there is more direct evidence of this in the final section of the analysis and, in the next section, whether the low investment responses are mainly due to a low elasticity with respect to interest rates.

5. Firm level estimates of the effect of interest rates on investment

The aim of this section is to link the movements in investment to changes in interest rates – the direct test of the critical link in the IRC. In principle, one could use aggregate time series

channel identified for Germany and that identified for all other Euro countries might simply result from different modelling choices. For the time being, we maintain the interpretation provided in the text.

data. But there are several reasons why this would be difficult. First, there is the usual simultaneity problem that has plagued the literature: that the central bank might be raising interest rates precisely at a time when investment demand shifts. Second, the combination of the sharp drop in interest rates that accompanied the convergence prior to the start of monetary union and the large shocks in the early 1990s with the break up of the ERM may make estimation particularly difficult in the recent period. Finally, for most countries we do not have aggregate data going back much before the mid-1970s. Consequently, while we view the macro data as being informative as to the total elasticity of investment with respect to the change in monetary policy, we are not confident in the ability of the macro data to sort out the part of this change operating through the IRC.

We therefore resorted to panel data estimates at the level of individual non-financial firms. The micro data have several advantages. Most importantly, the identification is achieved through cross-sectional variation. Much of this variation is driven by tax laws (through the interaction with depreciation schedules) so that the simultaneity problem is less severe. By drawing on a large cross-section of firms we are able to estimate the interest sensitivity using fairly short panels, mostly with data from the 1990s. At the micro level, we can construct data about investment and its determinants that are closer proxies of the theoretically appropriate ones. Another side benefit of exploring the firm-level data is that the results can be used to shed light also on the question of asymmetries *within* individual countries; we take advantage of this to compare different types of firms to more reliably identify the presence of specific factors influencing the transmission of policy. Moreover, the comparison of similar types of firms across countries might make it possible to assess the importance of country-specific behavioural effects. In this way, one could shed light on the question of whether any differences observed in monetary transmission to investment across countries depend more on the mix of firms present in those country, or to genuine differences in the way similar firms respond the same policy.[37]

The evidence discussed in this section draws on Chatelain et al. (2001), that provides a summary of the results for the four largest countries, and on the papers by Butzen et al. (2001), Lünemann and Mathä (2001) and Valderrama (2001), that provide results for Belgium, Luxembourg and Austria respectively. Next, we extend our results by drawing on the papers by Chatelain and Tiomo (2001), Gaiotti and Generale (2001) and von Kalckreuth (2001), concerning France, Italy and Germany respectively.

While there might be econometric reasons for suspecting some biases in these estimates (see also the thorough discussion in Chatelain et al. 2001), we do not have any a priori reasons to

[37] The implication of sectoral mixes for monetary transmission are examined by Dedola and Lippi (2001) and by Peersman and Smets (2001).

suspect that these would differ much across countries. However, there are some countries where liquidity and cash-flow effects appear to be very important and others where they appear hardly to matter. It is these differences, rather than the exact size of any coefficient estimates, that drive our assessment.

Moreover, we also attempt to cross-validate and to further qualify the conclusions that emerge from this analysis in the next section. For instance, for the countries where our calculations suggest the rejection of the IRC dominance, we check whether there is evidence of non-negligible monetary policy effects on loan supply. If there appears to be robust evidence of monetary induced loan supply effects, this reinforces our confidence in the importance of financial factors in the transmission mechanism.

Moreover, to further corroborate the use of estimates based on micro-data to break down the overall response of investment observed in the macro-data, we attempted to compare the elasticities that are implied by the structural macroeconomic models described in the last section and by the equations that we describe below. Given the differences in data coverage, sample period, specification, and econometric methodologies one might expect large differences between the two sets of estimates. Indeed, there are differences. In particular, the elasticities based on structural macro models are invariably smaller than those based on micro data. This is expected, given the differences in sample composition (overall investment for the macro data versus, only manufacturing investment in the micro) and to the arguably better way of handling the simultaneity bias in the micro estimates. But the differences are on average not much bigger than those found across countries or across studies.

5.1 - Linking the policy rate to the determinants of investment

In order to identify the full effects of IRC on investment, it is necessary to account for the interconnections between the instrument controlled by the monetary authority and the determinants of investment. The investment equations that we rely upon, described in detail in Chatelain et al (2001), are specified so that firms' investment rate is determined by current and lagged values of sales growth, the growth of the user cost of capital, and the ratio of cash-flow to capital.[38] Thus, our assessment depends on a set of estimates that relate the policy interest rate to sales, the user cost of capital, and cash-flow.

There are several ways to establish the linkages between the policy rate and these variables. In the paper by Chatelain et al (2001) an "analytic" approach is taken, in the paper by Gaiotti and Generale (2001) use is made of estimates from a structural econometric model for Italy.

[38] The estimated equations also include lags of the dependent variable but these are unimportant for the purposes of explaining our procedure. It should also be noted that, while the equations presented in

However, the analytic approach has some drawbacks (it neglects the intrinsic dynamics of the linkages as well as indirect effects), while the approach taken by Gaiotti and Generale was not easily replicable for all the countries. Based on aggregate data for the three variables of interest computed in a similar way for each country, we experimented with simple, single equation econometric estimates and with VAR estimates obtained appending those variables to the VARs described in Section 4. Fortunately, the three main conclusions presented below are relatively robust to these different approaches.

We focus in the following on the single equations estimates, that have the advantage of embodying some sensible long-run restrictions for these linkages (see below). We constructed aggregate data on sales, cash-flow, capital and the user cost of capital for France, Germany, Italy and Spain. In doing so we matched as closely as possible the definitions used in each country for the cost of capital. Sales growth and cash-flow are defined identically everywhere and represent a rough aggregate proxy of the firm-level data used by Chatelain et al (2001). The data on capital stocks were constructed using a perpetual inventory calculation (assuming a depreciation rate of 8 percent).

We then estimated regression equations relating sales, cash-flow, the long-term interest rate, and the user cost of capital to the policy rate[39]. The long-term rate is relevant since it appears in the definition of the user cost and therefore the policy impact on the cost of capital is governed by its effect on the long rate. In the estimates, some long-run constraints are tested and imposed; in particular, the effect of the (nominal) policy rate on the (real) user cost is zero and the cash-flow remains in a constant proportion to the capital stock.[40]

The elasticities of user cost, sales and cash-flow to the policy interest rate at years 1, 2 and 3 implied by these estimates are presented in Table 6; these elasticities are used to combine the elasticity of investment to the user cost, to sales and to cash-flow, estimated on micro data, to get the overall elasticity of investment to the policy rate presented in Table 7.

Chatelain et al. (2001) have the same specification, those drawn from the other papers might differ slightly, most notably on whether the stock of cash or cash-flow is used as a financial variable.

[39] These equations are specified as follows:

$$uc_t = A_1(L)(uc_{t-1}) + A_2(L)\Delta \log r_t + \varepsilon_t$$

$$\log(cf_t) = A_1(L)\log(cf_{t-1}) + A_2(L)\log(K_{t-1}) + A_3(L)\log(r_t) + \varepsilon_t,$$

$$y_t = A_1(L)y_{t-1} + A_2(L)\log(r_t) + \varepsilon_t$$

In the first equation, *uc* denotes the user cost of capital; in the second, *cf* denotes firm specific cash flow and *K* the capital stock; in the third one, *y* denotes firm specific sales. In all equations, *r* denotes the policy controlled interest rate. The following long-run restrictions were imposed in the estimation. In the first equation, the effect of the interest rate on the user cost is zero. In the second, cash flow is constant as a ratio of the capital stock and the interest rate has no effect (the latter restriction is not accepted in Germany).

[40] However, since we do not have long consistent time series for all of the series for each of the countries, to economise on degrees of freedom, we adopted the most parsimonious equations that delivered sensible properties.

Three main patterns emerged from these regressions (that we subsequently refer to as linkage equations). First, the user cost was most strongly affected by the policy rate in Spain. Its influence was fairly similar in the other three countries (being however highest in Italy, middle range in France and lowest in Germany). The "analytic" approach in Chatelain et al. (2001) yields a slightly different ranking, with Italy and Spain having approximately the same, highest response, then France and finally Germany.[41] Second, sales seemed to be well described as a near random walk in each of the countries and there was a weak connection between the policy rate and sales. We view this conclusion as clearly unsatisfactory, most likely driven by the simultaneity between sales and interest rates, prominent in the aggregate data. However, while this might bias towards zero the measure of the overall interest rate elasticity of investment, it is unlikely to significantly affect our assessment of the relative role of cash-flow, which is our main focus of interest. Finally, the policy rate was more strongly related to cash-flow in Italy[42] and to a lesser extent in France than in Spain or Germany. The results in Chatelain et al. (2001) confirm the strongest interest elasticity of cash-flow in Italy, but point to a relatively strong link also in Spain and to smaller values for Germany and France. Changing the details of the regression specifications never changed the general properties of the linkages that we estimated.[43]

For the other countries for which we have micro estimates of the investment equations (Belgium, Luxembourg, Austria and Finland), we do not have all the detailed macroeconomic data that we need to estimate these linkage equations. For these countries, we use the average values estimated for the other four countries, but also cross check the results with the other estimates of the linkages.[44]

To get the total effect of the policy rate on investment, we then simulate the micro economic regression equations together with the linkage equations. In doing this we assume that the economies start in a steady state (that is consistent with the sample properties of the micro data sets) and are hit by an increase in the policy interest rate. We then compute the elasticity

[41] The size of the interest elasticity of the user cost is broadly comparable in the two approaches. Keep in mind that the results in Chatelain et al. should be scaled by the elasticity of the long-term interest rate to the policy rate, which can be very roughly put at about 0.5 in the horizon considered. Also note that the elasticity computed with the Banca d'Italia macroeconometric model, used by Gaiotti and Generale, is almost identical to what we found for Italy in our estimates.

[42] The interest elasticity of cash-flow estimated on the basis of the Banca d'Italia macroeconometric model, used by Gaiotti and Generale (2001), is considerably smaller (about 0.2 on average over the first 3 years, against an average of 0.5 in the results reported in table). Note however that the VAR based estimate for Italy would be, on average, 0.6.

[43] Interest elasticities based on VARs (averaged over the first 3 years), while systematically bigger, yield broadly similar rankings of the various countries. The main difference with the results reported in the table is that the interest elasticity of the user cost is highest in Italy.

[44] In the case of Austria and Luxembourg the specifications (see Valderrama (2001) and Lünnemann and Mathä (2001), respectively) use the stock of liquid assets rather than the cash-flow. As the interest elasticity of the former can be very different from that of the latter, we calibrated the linkage equation

of investment that is implied by the combination of the linkage equations and the regression equations.

Our assessment of the IRC dominance turns on the importance of cash-flow in the estimated investment elasticities. In particular, we compare the full estimate of the elasticity when all the linkages between the policy rate and the determinants of investment are permitted and the elasticity when the cash-flow effects are suppressed. If the cash-flow effects are important in explaining the overall elasticity then we argue that the IRC is not fully responsible for our findings.

Importantly, for cash-flow effects to matter two conditions must hold. First, the cash-flow coefficients in the investment equation must be substantial. Second, the link between the policy rate and cash-flow must be significant. If either of these conditions fail then liquidity effects cannot play an important role in how monetary policy influences investment.

5.2 - Parsing the interest rate effects

The elasticities of investment with respect to the policy rate (with and without cash-flow effects) are shown in Table 7. Since we have micro estimates for only 8 of the 12 countries we cannot do a full evaluation for all countries – although recall that for one of the others (Greece) the prior evidence already rejects IRC dominance.

In Finland and Spain the pair of investment elasticities (overall and with cash-flow effects blocked out) are virtually identical.[45] Also in Luxembourg, the role of the liquidity variable appears rather limited (and would disappear altogether if the OLS estimates were used). This leads us to conclude that interest rate effects alone are responsible for the influence of the policy rate. Combined with our prior evidence, these countries appear to be cases where the IRC is sufficient to explain monetary transmission.

Germany and Belgium are cases, along with Greece, where the investment contributions to GDP responses were sufficiently low to conclude that the IRC is clearly not sufficient. The data in Table 7 show that in Germany the cash-flow effects are minimal. Similar conclusions

for the liquidity stock by assuming that its duration be equal to 4 months (1/3 of a year), and therefore we imposed (without dynamics) an interest elasticity equal to 0.33.

[45] For Finland, this is basically the consequence of relatively small coefficients of cash-flow in the investment equations, since the finding holds even if we use in the linkage equations the coefficients estimated for Italy, which embody a particularly strong reaction of cash-flow to the short-term interest rate. For Spain, the negligible contribution of cash-flow to the overall interest elasticity of investment results mainly from our estimate of a weak link between cash-flow and interest rate. It should however be noted that the results reported in Chatelain et al. (2001), obtained assuming an interest elasticity of cash-flow in Spain considerably bigger than our estimate, yield basically the same conclusion about the role of cash-flow. Indeed, while they report that the size of the interest elasticity of investment attributable to cash-flow is non-negligible, its relative contribution to the full interest elasticity of investment is rather small.

are reached by von Kalckreuth (2001). While he finds that firms with a low credit score (as assigned by the Bundesbank) have a relatively high investment sensitivity to cash-flow, his calibrations suggest that these effects are not quantitatively large.

In Belgium a sizeable part of the policy rate elasticity appears to operate through cash-flow effects. In the case of Belgium, where the linkage equations were arbitrarily set equal to the average of the four main countries, we cross-checked this conclusion picking different sets of linkage coefficients. The result appears to be somewhat sensitive to the selection of the linkage equation, and in particular the role of cash-flow appears substantially diminished assuming that the links are those estimated for Germany or Spain (the two countries where the interest rate elasticity of cash-flow is estimated to be the smallest).

While this casts some doubts about the role of financial factors in Belgium, the paper by Butzen et al. (2001) finds some evidence of a stronger effect of monetary policy on small firms, a finding usually interpreted as supportive of financial factors being at work in the transmission mechanism.

Overall, we conclude that for the purposes of modelling investment in Germany, the IRC is a satisfactory characterisation, but that some non-interest channels must be operating on other components of spending. Conversely, in Belgium, financial factors seem to matter for both investment and other components of GDP. We will look for confirmation of these conjectures, and hopefully for a solution of the remaining ambiguity, in the banking data. In particular, we will see whether bank lending to households is more importantly affected by monetary policy in these countries than elsewhere. We will also look at whether loan supply shifts are generally believed to occur.

In France, the aggregate evidence previously examined was ambiguous and gave us no confidence in assessing whether the IRC dominance could or could not be rejected. Table 7 however shows that the cash-flow effects are large, accounting for roughly half of the total investment response. Indeed, Chatelain and Tiomo (2001) find that adding cash-flow to their equation eliminates the statistical significance of the user cost for their full sample of firms. These cash-flow effects, however, are not uniformly strong across all firms, with equipment producers showing the highest sensitivity. Collectively these findings suggest that a pure IRC channel is unlikely in France. However, the prior ambiguity means that we cannot say whether any financial effects should be expected for only investment or for both investment and consumption.

Finally, Austria and Italy are cases where the IRC dominance could not be ruled out based on the previous evidence but appears doubtful in light of the data in Table 7. In both these

countries the cash-flow effects appear to be relatively large, possibly more important than the interest rate effects[46].

As with Belgium, the results for Austria were cross-checked using alternative choices for the linkage equations.[47] The relative importance of the liquidity measure remains sizeable even when picking the links estimated for Italy or Spain (where the interest elasticity of user cost is highest). In addition, Valderrama (2001) finds for Austria stronger effects of monetary policy on small and young firms, and smaller effects for firms that have a tighter credit relationship with a bank (hausbank). Both findings seem supportive of the role of financial factors in shaping the transmission of monetary policy. A similar supportive evidence for the role of financial factors is reported for Italy by Gaiotti and Generale (2001): they find that the effect of cash-flow on investment is stronger for small firms and for firms with a larger share of intangible assets. Overall, we provisionally conclude that financial factors, by influencing investment, appear to play, both in Italy and in Austria, a noticeable role in monetary transmission, and we will look for more evidence supporting this conclusion in the next section.

6. The role of banks in the transmission of monetary policy

To complete our assessment, we now examine the evidence on banks. While we have identified in a number of countries a role for financial factors, this does not necessarily imply a role for banks. Balance sheet or broad credit channel effects could be quite important. These balance sheet effects could operate *in addition* to any effects attributable to banks, or even *in absence* of effects generated by bank loan supply. Nevertheless, checking whether the role of financial factors in the transmission takes the form of a bank lending channel is natural given the overwhelming role of banks in the euro area financial system.

6.1 - Nature of the evidence

Our first source of empirical information is given by VAR models. This evidence is shown in Table 8[48]. The first row in the table shows the cumulative change (at the fourth quarter) in the

[46] The result for Italy is qualitatively in line, if quantitatively stronger, with the conclusions reached by Gaiotti and Generale (2001).

[47] The cross-check was made only for the linkage equations relative to user cost and sales, since in the Austrian specification the stock of cash rather than cash-flow is included. As for Luxembourg, the elasticity of the stock of cash with respect to the interest rate is assumed to be 0.33, which is consistent with an assumed duration of 4 months.

[48] The results reported in the table are obtained appending each of the variables (deposits, interest rates, and loans) to the baseline VARs from Mojon and Peersman (2001). As in the earlier VAR experiments, the size of the shocks (and the subsequent interest rate paths) differ across countries so that the levels of the responses are not directly comparable.

policy rate that is implied by the VAR for each country. The next two rows in the table show the response of a pair of monetary aggregates, M1 and M3-M1.[49]

A monetary shock can affect the overall stock of broad money, its composition, or both, or neither[50], depending on the elasticity of the money demand functions and on the endogenous adjustment in the returns on the different components of deposits. The third row of the table provides direct evidence on this issue by showing the change in the interest rate on time deposits – which broadly corresponds to the rate of interest on M3-M1. The remainder of the table contains information on loan prices and quantities. Whenever possible we show the responses of business and consumer loans separately, but these data unfortunately are only available for a few countries.

However, the VARs can give only a partial guidance about whether monetary policy reduces banks access to deposits or why it alters the volume of loans. While a pattern of falling deposits accompanied by falling loans could reflect a shift in the *supply* of loans, it could also reflect a change in loan *demand*. Within the context of the VARs there is no simple way to resolve this identification problem, so we treat this evidence as merely suggestive.

Our second piece of evidence comes from the country-specific, individual bank level analyses[51]. These are designed to identify shifts in loan supply from shifts in loan demand. Their maintained assumption is that certain bank characteristics (bank size, the level of bank capital, or the amount of liquid assets held on the balance sheet) should determine the degree to which banks respond to changes in policy.

Any differences among banks (measured by these characteristics) in the response of loans to a monetary policy shock can be legitimately labelled as supply driven, provided that the characteristics are not standing in for differences in the customers of the banks[52]. The testing procedure in these papers is designed to detect the presence of a loan supply shift, but not

[49] Added together, these aggregates cover much of the liability side of most banking systems (excluding capital). For the definition of these aggregates see Agresti and Mojon (2001).

[50] M3 and M1 are used here as proxies of the relevant components in the balance sheets of the banking system. The approximation is made here for simplicity, and does not affect the results in any significant way. The underlying assumption is that the difference between the monetary aggregates and the bank deposit aggregates (mainly constituted by paper currency in the hands of households and firms) does not react significantly to monetary policy over the relevant time horizon.

[51] See Brissimis et al. (2001); De Haan (2001); Ehrmann et al. (2001); Farinha and Robalo (2001); Gambacorta (2001); Hernando and Martínez-Pagés (2001); Kaufmann (2001); Loupias et al. (2001); Topi and Vilmunen (2001); Worms (2001).

[52] As noted by Ehrmann et al. (2001), the main characteristic that seems to shape bank responses is the level of liquidity held by banks. While this could indeed reflect the endogenous choice in the composition of assets by banks differing in risk tolerance, the evidence shows that less liquid banks tend to be more sensitive to interest rate changes but not, more generally, to changes in GDP growth (except perhaps in Germany). If the risk tolerance hypothesis were correct this should not be the case. Moreover, as we explain below, the German analysis already contains a reliable bank specific control for demand conditions. Thus, we take the liquidity findings as indicative of the susceptibility of banks loan supply to changes in monetary conditions in our discussion below.

really set up to easily quantify the size of any shifts.[53] Accordingly, in Table 9, we summarise this information verbally.

As our third piece of evidence, we consider institutional features of the euro area national banking systems that might affect the strength of the bank lending channel. In particular, four aspects could matter for monetary transmission: the importance of state influences in determining credit flows, the prevalence of relationship lending, the size of deposit insurance guarantees, and the extent of bank networks. We would expect that each of these features would reduce the sensitivity of bank lending to changes in monetary policy. In addition, we assemble in Table 10 four types of statistics: proxies for banks' size, capital, liquidity and the concentration of the industry (implicitly shown by the comparison between statistics for all banks and the largest banks).

6.2 - The last step in our testing strategy

We now use the evidence on the role of banks to cross check, complement and qualify the role of financial factors in the transmission. To do so, we review this evidence in turn for the groups identified in Section 5.

The countries for which we could not reject the hypothesis of IRC dominance were Finland, Luxembourg and Spain. The papers by Topi and Vilmunen (2001) and Hernando and Martínez-Pagés (2001) do not find clear evidence of loan supply effects on the monetary transmission.[54] In the Spanish case this finding is reinforced by an interesting observation about the impact of the phenomenal growth of mutual funds in Spain. The deposit outflows that accompanied the growth were uneven across banks, but the lending changes that followed did not track the deposit shifts. This is unlikely to be due to any loan demand differences and is instead most naturally interpreted as showing that loan supply and deposits in Spain are not tightly linked.

In Finland, Topi and Vilmunen (2001) find that the main bank characteristics that might be expected to influence loan supply (size, capitalisation and liquidity) do not lead to any significant differences.[55] A limited role of bank supply in the transmission appears broadly consistent with the presence, in Finland, of an important network for the many co-operative

[53] The main problem in quantifying the size of the shifts is in building a set of linkage equations analogous to the ones we used with the micro investment regressions. In this case the control variables include GDP and inflation, which significantly complicates this task.
[54] For Luxembourg we do not have estimates based on bank-level data.
[55] We read the literature review in Topi and Vilmunen (2001) as implying that while several papers suggest that financial factors might matter for investment, they often do not address the identification problems and rarely discuss a role for banks. Indeed, Vihriala (1997) study on panel data finds little role for banks in constraining spending.

banks. For Spain, however, the structure of the banking system shows none of the institutional factors that might insulate lending decisions from monetary policy.

In Italy and Austria the prior evidence identified financial factors as playing a role in explaining firms' responses to monetary policy.

In Italy, the VAR evidence shows that both M1 and M3-M1 fall after a monetary tightening, suggesting that the Italian banks find it difficult to raise financing during periods of tight monetary policy. More importantly, the bank level analysis presented in Gambacorta (2001) indicates that monetary policy does alter loan supply. Specifically, he finds that the amount of liquidity on individual banks' balance sheets significantly influences the degree to which they change loans after a monetary shock: the lower the level of liquidity the stronger the loan supply response. Overall, these findings are consistent with previous results. Gambacorta (2001; Table 2) reports that there is near unanimity in the past literature that a broad credit channel exits[56].

The Austrian evidence is more ambiguous. From the VAR we observe decreases in M1 balances and loans after a monetary tightening. However, Kaufmann (2001) finds that when she uses the same benchmark type of regression used in Ehrmann et al. (2001), bank characteristics do not appear to influence the size of lending adjustment. Shifting to a time-varying specification she finds that bank liquidity sometimes matters. In particular, during recessions the lending from banks with more liquid assets is significantly less affected than that from otherwise comparable banks. But the strength of this finding depends on how the recession periods are selected and also sometimes is accompanied by other anomalous findings (e.g. higher policy rates leading to higher lending).

As described in detail by Kaufmann (2001), and Ehrmann et al. (2001) from a cross-country perspective, one possible explanation for the relatively weaker role of Austrian banks in the transmission process could be the importance of networks and relationship lending between firms and their banks.

Germany is the only country where our preliminary classification suggested that a role for financial factors could be relevant for consumption decisions, while limited for the investment of firms. Logically this would suggest investigating whether loan-supply effects (or other financial factors) are particularly important for households. We have no direct evidence on this question, but there are some suggestive pieces of information. First, the VARs shows that household borrowing falls much more quickly after a monetary tightening than does business borrowing. Actually, business borrowing is estimated to rise in the first year. Second, the bank level analysis of Worms (2001) shows significant loan supply effects that are related to

the liquidity position of the banks[57]. A relevant aspect of this paper is that it uses data on the customer mix of each bank to build a variable that reflects the average income of each bank's borrowers. As this income proxy should reliably control for loan demand, we expect lending changes to genuinely reflect supply shifts. At any rate, similar results are obtained when the controls for demand conditions are constructed as in Ehrmann et al. (2001). The general picture also seems to fit with certain structural features of Germany's banking system. On the one hand, the level of concentration is relatively low and banks are not particularly well capitalised. On the other hand, banks tend to belong to networks and the hausbank lending relations are often very strong. The latter feature could explain why corporate borrowers are insulated from credit restrictions, while households remain exposed[58].

In our preliminary classification Belgium was the country where not only did the IRC incompletely account for GDP movements, but also cash-flow seemed important for observed investment responses. This suggests that liquidity effects would be expected to matter for both business investment and household expenditure. The VAR evidence, as in Germany, points to household borrowing responding much more quickly to a policy shift than business borrowing. As estimates based on bank level data are not available, we cannot reliably identify loan supply, and the econometric evidence alone cannot determine whether banks contribute to policy transmission in Belgium. Unfortunately, the broad features of the banking system do not provide clear-cut indications as to whether bank loan supply might be expected to be strongly sensitive to monetary policy. Certain institutional features of the Belgian banking system -- regarding relationship lending, government guarantees, deposit insurance and bank networks -- do not suggest mechanisms that would cushion bank lending from monetary policy. However, Belgium's banking industry is dominated by 12 institutions, and banks in Belgium hold a very small proportion of assets in loans (see Table 10). On balance, the presence of a strong lending channel seems to us unlikely.

Based on the macro evidence and the micro evidence on firms in France, financial factors appear to play an important role in driving investment responses to monetary policy. However, it was not possible to determine whether interest sensitive spending exhausted the response of GDP, and therefore financial factors could also matter for consumption. The VAR suggests that the declines in loans are due to drops in business lending only, as household lending is actually estimated to rise. This suggests that if banks in France are playing a role in explaining the transmission, they are probably doing it by influencing investment rather than consumption. The French evidence on micro-bank data suggests that loan supply does shift

[56] The only paper expressing a different view is Favero et al. (2001), based on a case study of the Italian foreign exchange crisis of 1992.

[57] Worms (2001) shows that one component of liquidity, the amount of inter-bank deposits, is particularly important in determining which banks respond most strongly to policy changes.

when monetary policy changes. Loupias et al. (2001) show that less liquid French banks are more responsive to monetary policy, but they do not explore whether this effect is equally strong for firms and individuals. Previous studies using microeconomic data do not rule out a role for banks – see Rosenwald (1998) and the literature review by Loupias et al. (2001). This is perhaps a bit surprising since the French banking system is fairly concentrated and characterised by relatively high holdings of liquid assets. Moreover, small firms often forge relationships with their banks.

Finally, we are left with the four countries (Ireland, Greece, the Netherlands, and Portugal) where, absent firm-level evidence, our testing of the IRC dominance hypothesis was only partially, if at all, implementable.

Among these, Greece stands out because the small share of GDP movements accounted by interest sensitive components already allows us to reject IRC dominance. This suggests looking for evidence of financial factors having a role (on consumption and possibly on investment). Brissimis et al. (2001) find that both smaller banks and banks with lower levels of liquidity are more responsive to monetary policy.[59] Smaller banks, with less liquid assets are estimated to be especially sensitive to policy changes. However, we do not have enough information to tell whether these loan supply shifts are more relevant for households or businesses. Other evidence seems supportive of a non-negligible role of banks. In spite of being somewhat concentrated (see Table 10), the Greek banking system is also characterised by banks holding relatively low levels of capital and liquid assets. Moreover neither networks nor relationship lending are believed to be significant. Finally, Brissimis and Kastrissianakis (1997) conclude that the bank lending channel appears to exist in Greece, although it may it have weakened in the 1990s.

In the other three countries the aggregate evidence was not able to reject the hypothesis of IRC dominance. In Ireland, bank networks are prominent, with most banks belonging to one, and there is a lot of relationship lending.[60] But, the largest banks control a relatively small share of the total market, the share of loans in banks assets is very high, and banks do not seem to carry high levels of liquidity or capital. These offsetting considerations do not help to draw a firm conclusion.

In Portugal and the Netherlands it appears that loan supply is affected by monetary policy changes. For Portugal, Farinha and Robalo (2001) conclude that bank capital plays an important role in shaping banks responses to monetary policy, with less capitalised banks

[58] This judgement is consistent with the view expressed by Cecchetti (2000).
[59] Given the instability of the VAR estimated for Greece, the Greek results reported in Table 8 should be discounted.
[60] Unfortunately, bank level estimates are not available for Ireland.

being more sensitive.[61] This is consistent with the institutional characteristics of the banking sector in Portugal, whereby networks are unimportant and relationship lending is not typical, thus supporting the operation of a lending channel.

For the Netherlands, De Haan (2001) finds that unsecured bank lending is responsive to monetary policy. These effects are larger for small banks, banks with low liquidity and banks with low capital – although the interactions between these characteristics do not appear to be important. In contrast, secured lending seems to be unaffected by policy changes. Finally, household lending is little affected by policy changes, and this reinforces the view that monetary policy operates primarily by affecting investment. This relatively clear-cut evidence however contrasts with priors based on the fact that in the Dutch banking system liquidity, concentration and capital levels are relatively high and relationship lending is prevalent.

7. Overall evaluation of the evidence

We sum up, in this final section, our overall reading of all the evidence discussed in this paper. For expository convenience, we start by discussing the individual euro area countries, focusing first on the importance of the interest rate channel and secondly on any evidence regarding the bank lending channel. To facilitate reading, we do so in the form of a short overall judgement for each country. Further comments on the euro area as a whole are given in the next subsection.

7.1 - Summary by country

The logic of our testing strategy led us first to identify five groups of countries: those in which the IRC dominance hypothesis could not be rejected; those in which it could be rejected, and financial factors seemed to play a role either for investment, or for consumption, or for both; those for which the evidence was inconclusive. We then complemented this classification by looking whether, in each case, the evidence on the response of loan supply to monetary policy shifts was or was not present (and possibly stronger for firms or households). All together, this leads to the two-way classification presented in Table 11. In what follows, we quickly review, for each country, the evidence that led us to assign that country to the specific cell in Table 11.

[61] However, as Farinha and Robalo (2001) nicely explain, both the banking market and macro economy have undergone a sequence of changes that make econometric work challenging.

Austria

Austria is a country where interest sensitive components of GDP seem to account for a large part of the movements of GDP in the wake of a monetary shock. While this is consistent with our null hypothesis that the IRC is the dominant transmission channel, firm-panel results show that there is a non-negligible role for liquidity variables in determining investment. This is evidence against our null hypothesis. Looking at the bank side, the results from the panel estimates suggest that the lending channel of monetary policy is not likely to be strong. This may be due to the strong bank networks and bank-firm relationships. Hence, any monetary policy effects beyond those going through the IRC should work largely through other channels (e.g., firm balance sheets).

Belgium

The IRC appears not to be very strong in Belgium. The VAR and the structural models both agree that interest spending does not move enough to give a full account of the output dynamics. This suggests a likely role for some sort of financial mechanism affecting consumption. The evidence on investment is not clear-cut, but our best judgement is that financial factors probably also matter for investment. On the bank side, previous evidence concluded that the role of bank lending in the transmission of monetary policy in Belgium is not likely to be important[62]. We lack micro-panel estimates of bank loan supply response, but other informal evidence we collected is in line with past findings. Hence, bank behaviour seems to us unlikely to be pivotal in explaining the main transmission patterns.

Finland

In Finland, the IRC seems to offer a satisfactory account of monetary transmission. The VAR and national econometric model suggest that this would be the case and we find the micro-economic evidence on investment to be consistent with this prediction as well. The prior banking evidence available on Finland was very limited. Our bank panel estimates (from the post-banking crisis period) signal that loan supply does not appear to be very responsive to monetary policy. In any case, considering that the IRC seems to be dominant, loan supply behaviour of banks should not play an important role[63] in the overall mechanism.

France

We had difficulty getting for France a consistent assessment of the role of interest sensitive spending components between the VAR and the structural model. Traditionally, it has been

[62] The partial exception is De Bondt (2000).

[63] Our main caveat surrounding this conclusion is that much of the evidence comes in the post banking crisis environment. Some prior studies had found that liquidity variables might matter for investment. We leave open the possibility that this may be the case again now that the adjustment to the crisis is over.

difficult to identify cost of capital effects on investment in France. Our evidence confirms that, in keeping with the findings of past studies, the cost of capital does not have a strong effect on investment, while financial factors — as captured by a cash-flow variable — appear important. On the bank side, the earlier literature placed France, alongside with Germany and Italy, among the candidates for a strong bank lending channel. The evidence we have does not fully confirm this. Bank liabilities do not appear to be strongly affected by monetary policy; however, loan rates react strongly to monetary policy. The panel evidence on banks suggests that loans supply is responsive to monetary policy.

Germany

A fairly consistent picture of monetary transmission in Germany emerges from our analysis. On the one hand, the interest sensitive spending components of output play a relatively small role in accounting for GDP movements in the wake of a monetary policy shift. The IRC dominance hypothesis thus seems rejected. In the other hand, the IRC seems to be the dominant, indeed almost the only relevant channel in explaining monetary policy effects on investment. The monetary shifts appear to alter loan supply. The obvious reconciliation of these facts is that loan supply shifts contribute to a substantial consumption adjustment in the aftermath of monetary policy shift (we do not have any direct evidence, but there are some hints that this is going on). All this combined suggests that a lending channel is present in Germany.

Greece

The large changes in the Greek economy over the last decade make it difficult for us to fit a stable VAR. But, based on the structural model of the Greek economy, it appears that the IRC dominance hypothesis could be rejected. Earlier authors have pointed at Greece as a candidate for significant loan supply effects, and the new econometric evidence we quoted points in this direction.

Ireland

Ireland is the country where our evidence on monetary transmission is scarcest. The only available one comes from the structural model of the economy and it suggests that the IRC could be quite important. But we lack any findings about firms or banks that allow us to test this conjecture.

Italy

Interest sensitive spending in Italy seems to largely account for output movements in the wake of a monetary policy shift. The investment response, however, shows clear signs of being affected by financial factors. This seems to reject the IRC dominance. Moreover, bank

lending responds to policy shifts. This picture is confirmed by a host of studies. Overall Italy is, along with Germany, a country where the case for the presence of lending channel seems strong.

Luxembourg

Our evidence for Luxembourg is somewhat incomplete. We do not have the data needed to fit a VAR, so relying solely on the structural econometric model we conclude that interest sensitivity spending movements dominate the monetary induced changes in GDP. The firm level evidence moreover suggests that investment does not appreciably depend on firms' liquidity holdings. The (limited) previously available evidence for Luxembourg suggests that bank loan supply is not likely to play a major role in monetary transmission. Our informal evidence supports this, though we lack any econometric evidence on bank behaviour in Luxembourg.

Netherlands

We also have incomplete information on the Netherlands. The VAR and econometric model each suggest that the IRC could be dominant, but we lack the firm level analysis to verify that this is the case. Past evidence is ambiguous as to whether investment responses can be fully explained by interest rate effects. There is clear evidence that bank loan supply changes following changes in monetary policy. The extension of household credit, however, does not appear affected. Thus, the outstanding question is whether the estimated change in unsecured business credit is relevant for Dutch corporate investment.

Portugal

As with Greece, Ireland and the Netherlands, the assessment of Portugal is impaired by lack of data. The structural changes in the economy limit our ability to estimate a VAR, so based solely on the econometric model we conclude that the IRC could be dominant. We lack the firm level evidence needed to test this proposition. However, it appears that bank loan supply does change following a shift in monetary policy. As in the Netherlands, we cannot determine whether this is material for the transmission.

Spain

Spain is the case where the evidence most consistently points towards a pure IRC explanation for monetary transmission. Following a monetary policy shift, investment movements are substantial, yet they do not appear to be dependent on financial factors. Loan supply also appears to be disconnected from monetary policy; the evidence on how banks also shielded their lending after regulatory induced deposit outflows reinforces this presumption. This all fits together and suggests that financial factors do not play an important role in the Spanish monetary transmission.

7.2 – Concluding comments on monetary transmission in the euro area

Together, the economy-wide analysis discussed in section 3 and the country evidence in sections 4-6 paint a rich, composite and, to some extent, surprising picture of the monetary transmission for the euro area as a whole. This picture can hopefully also serve as a point of departure when sufficient information to document, and measure, any changes in the transmission process resulting from the introduction of the single currency becomes available.

Starting with the unsurprising aspects, a bird's-eye overview based on VAR analysis suggests that an unexpected increase in the short-term interest rate temporarily reduces output, with the peak effects occurring after roughly one year. Prices respond more slowly, with inflation hardly moving during the first year and then falling gradually over the next few years. Structural econometric models, though not strictly comparable, provide a picture with similar qualitative features. Despite the somewhat artificial nature of the synthetic data for the area as a whole, these findings are theoretically sensible and broadly consistent with a large body of empirical literature analysing the other large currency area in the world, namely the US. Moreover, the delayed response of prices relative to that of output suggests that studying the transmission of policy to spending and output is a logical step, even if the aim of monetary policy is defined primarily or exclusively in terms of prices.

A further aspect of the assessment based on aggregate data at the area level is that both the VARs and the structural models highlight the importance of investment in driving output changes in the wake of a monetary policy tightening. This feature distinguishes the transmission mechanism in the euro area from that in the US, where much of the output adjustment appears to be due to changes in consumption.

Moving to a finer-grained assessment of the transmission, the first feature that stands out is that neither the IRC nor a broadly construed financial channel emerges as clearly and exclusively dominant. Although somewhat obvious, this conclusion contradicts both the presumption of an IRC dominance based on the just mentioned, quantitatively large role of interest sensitive spending in explaining output movements, and the presumption of a strong and widespread lending channel based on the overarching role of banks as providers of finance in the euro area. While making a precise quantitative estimate of the contributions of each channel is not yet possible at this stage, we can nonetheless further qualify the overall picture in several ways.

First, while not dominant on the whole, the IRC is still a prominent channel in the transmission. For the euro area as a whole, the interest sensitive demand components (proxied by investment) account for the bulk of the change in GDP after a monetary policy shift.

Moreover, in a group of countries, accounting for about 15% of the euro area GDP, the IRC is unambiguously the dominant channel. In all other countries for which we have the evidence (covering, together with the first group, about 90% of the euro area GDP) interest rate effects are always a sizeable, and sometimes the virtually unique, source of investment movements. It is interesting that there generally seems to be a significant effect of the user cost of capital on investment. This finding, based on a careful analysis of micro level data, is somewhat in contrast with the often more ambiguous results coming from aggregate data.

Secondly, in the transmission of monetary policy the IRC is complemented by financial factors in more than one way. Indeed, the cases where the IRC dominance can be rejected do not point to a single, prevalent alternative. In some of the countries it looks like the role of banks in supplying business credit to finance investment may be important. But this does not appear to hold everywhere, as there are cases in which if loan supply matters it is not likely to be true for investment. Thus, in terms of monitoring bank lending it is probably necessary to track both household and business lending. Moreover, there are also cases in which financial factors are important but banks are not likely to be an important ingredient in the picture.

Thirdly, the overall role of banks in the transmission mechanism is somewhat different, and perhaps smaller, than what might have been expected based on prior work. There are countries where bank lending appears irrelevant for transmission. In some, we suspect that government guarantees to support banks, the propensity of banks to operate in networks, and strong borrower-lender relationships may mitigate the strength of any loan supply effects. Taken together this means that even though the banks dominate the supply of credit in all euro area countries, they do not appear to be uniformly important.

Lastly, in assessing the role that the banks do play in the transmission, the relevant characteristics that appear to affect the potency of the lending channel are not always those that we (and probably others too, based on our reading of the past literature) would have guessed. Bank size and bank capital seems not to play much of role in shaping loan supply responses to monetary policy. We find the institutional reasons discussed by Ehrmann et al. (2001), and noted in section 6.1, to be a plausible explanation for this result. But this means that the vast heterogeneity in terms of size both across and within countries is probably not very important. In contrast, bank liquidity positions seem to be important in virtually all the countries where loan supply effects appear to be present. The direct quantitative effects of the liquidity differences do not appear large. But there are other potential supply effects that remain to be isolated.

7.3 - Next steps

All of our analysis has been based on the analysis of data from before the launch of the euro. Capital markets, bank market structure, and business financing already have changed substantially over the last three years. One obvious caveat to our analysis is that we cannot say whether this has changed the operation of the monetary policy transmission channels, as a result e.g. of increased monetary and financial integration. A natural continuation would be to update the analysis adding post 1998 data.

Whether or not our assessments are confirmed in future work, we believe that they still provide guidance about useful next steps in studying monetary transmission in the euro area. For instance, it would be very useful to fill in the missing pieces of evidence that would be needed to complete and make more robust our analysis for all the countries. In particular, being able to gauge the macroeconomic importance of the lending supply effects in those countries where our evidence confirms their presence would be very important to complete our picture on the role played by the bank lending channel in monetary transmission in the euro area. Also, for many of the countries the implication of the analysis is that consumption adjustment is surprisingly important for transmission. Compiling direct evidence on this is an obvious next step.

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Chart 1: Our Analytical Strategy

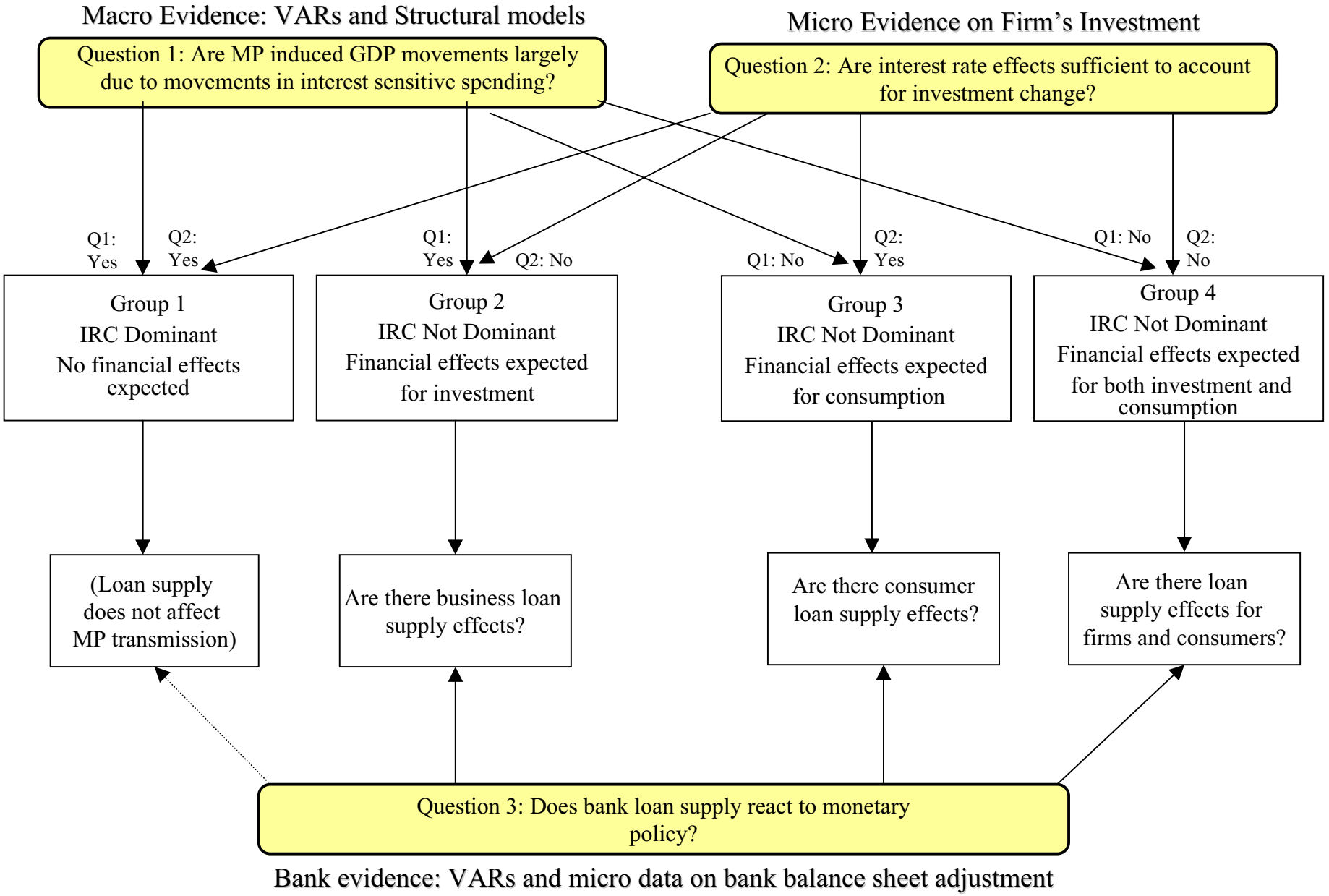
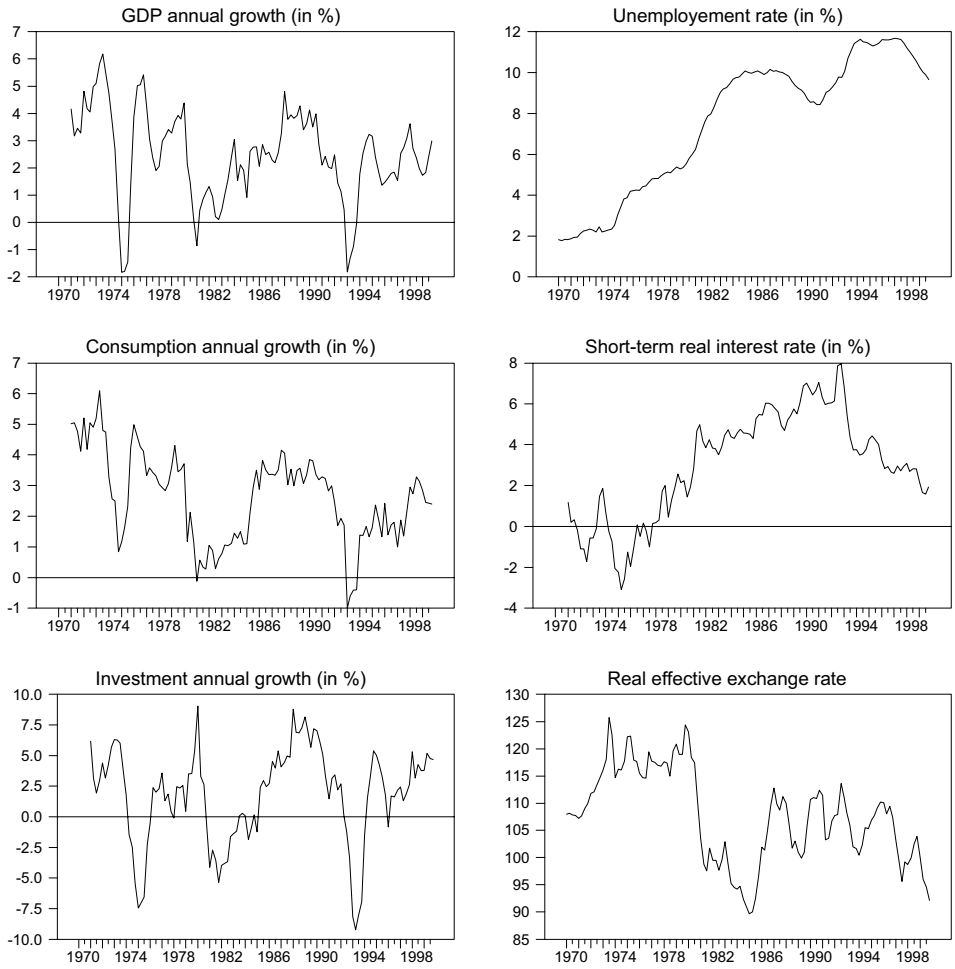
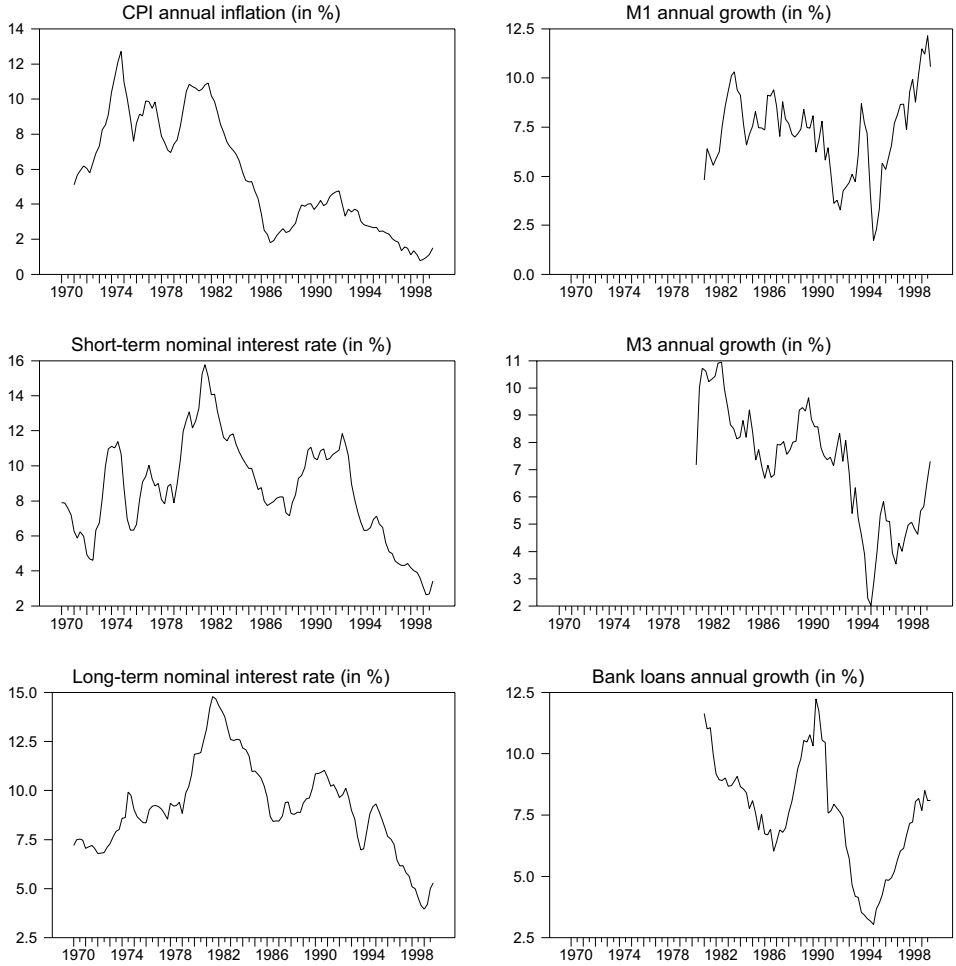


Chart 2a: Euro area macroeconomic variables



Source: ECB.
Note: The time series correspond to aggregates of the 11 countries that initially formed the euro area (i.e. the 12 current countries without Greece). The aggregates are based on the average of national growth rates weighted by 1995 PPP GDP weights. See Annex 2 of Fagan, Henry and Mestre (2001) for more details.

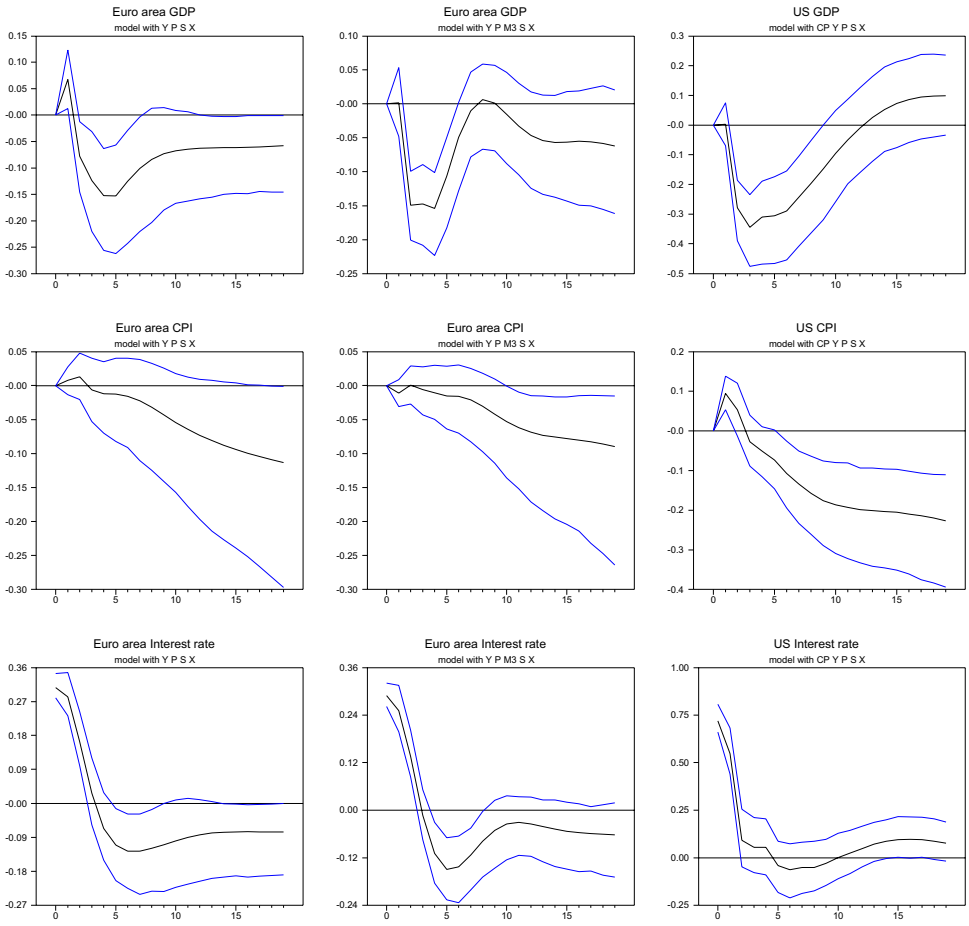
Chart 2b: Euro area macroeconomic variables



Source: ECB.
Note: The time series correspond to aggregates of the 11 countries that initially formed the euro area (i.e. the 12 current countries without Greece). The aggregates are based on the average of national growth rates weighted by 1995 PPP GDP weights. See the Annex of Fagan, Henry and Mestre (2001) for more details.

Chart 3: VAR based simulation of a monetary policy tightening

Effects of a monetary policy shock in the Euro area and in the US



Source: Peersman and Smets (2001). First column: VAR with the real effective exchange rate of the euro area as an endogenous variable and a commodity price index, US GDP and US short-term interest rate and a trend as exogenous variables. Second column: VAR with additionally M3 as an endogenous variable. Third column: VAR with a commodity price index, GDP, CPI, a short-term interest rate and the real effective exchange rate as endogenous variables and a trend as an exogenous variable.

Table 1: Business cycle fluctuations of the euro area and the United States (1970-2000)

	Euro area										
	St.Dev		Cross correlation with GDP(t+k)								
	absolute	relative to GDP	k -4	-3	-2	-1	0	1	2	3	4
GDP	0.84	1.0	-0.19	0.18	0.58	0.88	1.00				
Consumption	0.55	0.7	-0.13	0.09	0.37	0.63	0.79	0.80	0.66	0.40	0.09
Investment	1.85	2.2	0.06	0.34	0.62	0.81	0.86	0.75	0.51	0.21	-0.09
CPI (level)	0.68	0.8	0.28	0.26	0.16	-0.03	-0.26	-0.50	-0.66	-0.72	-0.66
CPI (inflation)	0.31	0.4	0.35	0.34	0.27	0.21	0.20	0.26	0.31	0.30	0.19
Stock prices	12.0	14.3	-0.10	-0.07	-0.01	0.05	0.08	0.06	0.01	-0.03	-0.02
Short-term rate nominal	1.09	1.3	0.27	0.54	0.73	0.76	0.61	0.30	-0.08	-0.43	-0.67
Short-term rate real	0.76	0.9	0.49	0.65	0.68	0.55	0.26	-0.11	-0.43	-0.61	-0.59
Long-term rate nominal	0.57	0.7	0.22	0.38	0.48	0.47	0.33	0.09	-0.17	-0.37	-0.46
Real ef. exchange rate	3.58	4.3	0.22	0.33	0.36	0.30	0.17	0.01	-0.12	-0.18	-0.18
M1	1.00	1.2	-0.22	-0.26	-0.20	-0.05	0.16	0.39	0.58	0.68	0.67
M3	0.72	0.9	0.45	0.23	0.01	-0.17	-0.26	-0.27	-0.19	-0.06	0.07
Total loans	0.85	1.0	0.59	0.55	0.48	0.37	0.23	0.10	0.00	-0.06	-0.08
			Cross correlation with own (t+k)								
CPI (level)			0.33	0.55	0.77	0.94	1.00				
CPI (inflation)			-0.36	0.01	0.47	0.85	1.00				
GDP deflator			0.27	0.50	0.74	0.93	1.00				
	United States										
	St.Dev		Cross correlation with GDP(t+k)								
	absolute	relative to GDP	k -4	-3	-2	-1	0	1	2	3	4
GDP	1.34	1.0	-0.09	0.24	0.60	0.89	1.00				
Consumption	1.01	0.8	-0.24	0.03	0.34	0.64	0.84	0.87	0.74	0.51	0.27
Investment	3.26	2.4	0.11	0.44	0.75	0.94	0.95	0.80	0.53	0.20	-0.10
CPI (level)	1.02	0.8	0.23	0.10	-0.07	-0.24	-0.41	-0.52	-0.56	-0.54	-0.49
CPI (inflation)	1.29	1.0	0.48	0.59	0.63	0.56	0.38	0.15	-0.09	-0.25	-0.31
Stock prices	7.92	5.9	-0.50	-0.50	-0.37	-0.12	0.16	0.39	0.47	0.40	0.22
Short-term rate nominal	1.31	1.0	0.38	0.56	0.68	0.67	0.50	0.21	-0.14	-0.44	-0.62
Short-term rate real	1.11	0.8	-0.11	-0.03	0.07	0.14	0.15	0.07	-0.06	-0.22	-0.36
Long-term rate nominal	0.82	0.6	-0.03	0.14	0.28	0.35	0.30	0.14	-0.07	-0.28	-0.41
Real ef. exchange rate	2.96	2.2	0.08	0.11	0.08	0.00	-0.07	-0.12	-0.12	-0.08	-0.01
M1	1.78	1.3	-0.22	-0.23	-0.18	-0.08	0.05	0.16	0.22	0.24	0.22
M3	0.87	0.7	0.25	0.37	0.42	0.39	0.28	0.12	-0.03	-0.13	-0.15
Total loans	1.99	1.5	0.75	0.78	0.68	0.48	0.19	-0.11	-0.34	-0.45	-0.45
			Cross correlation with own (t+k)								
CPI (level)			0.38	0.61	0.81	0.95	1.00				
CPI (inflation)			-0.06	0.25	0.60	0.89	1.00				
GDP deflator			0.35	0.58	0.80	0.95	1.00				

Source: Agresti and Mojon (2001). The standard deviations and cross correlations are based on filtered time series, obtained using a Baxter and King (1999) filter, with a band comprising periodicities between 6 and 40 quarters and 8 truncation leads and lags. See Agresti and Mojon (2001) for similar set of results based on alternative band pass filters as well as on the HP filter.

Table 2: Effects of two selected monetary policy shocks on the euro area economy

	VAR shock				100 basis point increase for two years			
	VAR		AWM		EMM		AWM	
	Year 1	Year 3	Year 1	Year 3	Year 1	Year 3	Year 1	Year 3
Short-term rate	0.17	-0.06	0.17	-0.06	1.00	0.00	1.00	0.00
Effective exchange rate	0.67	0.36	0.67	0.36	1.60	0.00	1.60	0.00
Consumer prices	0.00	-0.07	-0.08	-0.08	-0.09	-0.31	-0.15	-0.38
GDP	-0.15	-0.05	-0.18	-0.06	-0.22	-0.31	-0.34	-0.71
Consumption	-0.09	-0.03	-0.14	-0.03	-0.12	-0.19	-0.27	-0.54
Contribution to GDP (%)	*22*	*44*	*48*	*43*	*33*	*36*	*48*	*48*
Investment	-0.53	-0.08	-0.39	-0.03	-0.34	-1.22	-0.81	-2.96
Contribution to GDP (%)	*80*	*87*	*45*	*53*	*33*	*61*	*51*	*75*

Sources: EMM: Eurosystem macroeconometric models calculations presented in van Els et al. (2001); AWM: ECB area-wide model calculations; VAR: Peersman and Smets (2001).

Notes: The VAR shock corresponds to the path for the short-term interest rate as shown in column 2 of Chart 2. The implied appreciation of the effective exchange rate is shown in Chart 1 of Peersman and Smets (2001). For the short-term interest rate and the effective exchange rate, the figure reported is the average of the quarterly deviation from baseline in year one and year three, while the effects on prices, GDP, investment and consumption correspond to quarter 4 and quarter 12 deviations from baseline. The second shock is defined as a 100 basis point deviation from baseline for 8 quarters. The path of the long-term interest rate is set according to the expectations hypothesis, while the one of the exchange rate is the one implied by the uncovered interest rate parity assumption. Effects after one year and three years correspond to yearly average deviations from baseline.

The "contributions" are defined as the ratios of the response of investment (or consumption) to the response of GDP times the average share of investment (or consumption) in GDP. The responses to the VAR shock are cumulated. The price deflator for the VAR/AWM comparison is the CPI, while for the AWM/EMM it is the personal consumption expenditure deflator.

Table 3: Effects of selected sustained shocks on the euro area and the US

	Effects after one year					
	50 basis points STR increase			5 % NEER appreciation		
	Euro area		US	Euro area		US
	EMM	AWM	FRB-US	EMM	AWM	FRB-US
CPI	-0.02	-0.03	-0.05	-0.48	-0.54	-0.18
Real GDP	-0.11	-0.24	-0.14	-0.45	-0.91	-0.13
Private consumption	-0.10	-0.25	-0.17	-0.22	-0.63	0.07
Contribution to GDP (%)	*56*	*64*	*81*	*30*	*42*	*-36*
Gross fixed capital formation	-0.59	-0.68	-0.17	-0.22	-0.97	0.07
Contribution to GDP (%)	*115*	*61*	*21*	*11*	*23*	*-9*
	Effects after three years					
	50 basis points STR increase			5 % NEER appreciation		
	Euro area		US	Euro area		US
	EMM	AWM	FRB-US	EMM	AWM	FRB-US
CPI	-0.15	-0.21	-0.57	-0.96	-1.20	-0.48
Real GDP	-0.49	-0.63	-0.52	-0.81	-1.31	-1.10
Private consumption	-0.38	-0.62	-0.64	-0.55	-1.12	-0.41
Contribution to GDP (%)	*47*	*60*	*82*	*42*	*52*	*25*
Gross fixed capital formation	-2.43	-2.07	-1.08	-1.00	-1.84	-1.69
Contribution to GDP (%)	*107*	*71*	*36*	*27*	*30*	*27*

Sources: EMM: Authors' calculations based on the Eurosystem macroeconometric models simulations presented in van Els et al. (2001); AWM: ECB area-wide model calculations; FRB- US model calculations were kindly provided to us by Flint Brayton at the Federal Reserve Board.

Notes: Effects after one year and three years correspond to the quarter 4 and quarter 12 deviations from baseline. The consumption and investment contributions to GDP are equal to the ratio of the response non-cumulated (given the shocks are permanent) of consumption and investment to the non cumulated response of GDP times their average share in GDP. STR and NEER stand for short-term rate, long-term rate and the nominal effective exchange rate.

Table 4: Effects of monetary policy on investment, GDP and CPI according to two different econometric techniques (in %)

	Euro area			Austria			Belgium			Germany			Finland			France			Greece		
Horizon in years	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*
VAR simulation, shocks of different size across countries, (see Mojon and Peersman (2001))																					
Investment response	-0.53	-0.18	-0.08	0.10	0.15	0.02	-0.22	-0.61	-0.20	-0.41	-0.48	-0.19	-1.01	-1.15	-0.65	-0.73	-0.27	0.03	-0.02	0.00	0.01
GDP response	-0.15	-0.02	-0.05	-0.29	-0.17	0.00	-0.28	-0.17	-0.02	-0.16	-0.26	-0.19	-0.36	-0.34	-0.15	-0.15	-0.14	-0.10	-0.02	-0.01	0.00
Price response	0.00	-0.02	-0.07	-0.08	-0.24	-0.36	-0.01	-0.04	-0.13	0.00	-0.10	-0.23	-0.02	-0.11	-0.18	-0.07	-0.17	-0.24	-0.05	-0.07	-0.11
Macroeconometric models, permanent 100 basis point interest rates increase (based on Eurosystem macroeconometric models)																					
Investment response	-0.67	-2.44	-3.69	-1.10	-2.34	-2.65	-0.54	-0.48	-0.51	-0.38	-0.41	-0.25	-1.09	-1.03	-1.47	-0.19	-0.40	-0.48	-0.44	-1.89	-2.51
GDP response	-0.19	-0.56	-0.80	-0.33	-0.68	-0.84	-0.26	-0.26	-0.26	-0.54	-0.51	-0.26	-0.43	-0.35	-0.44	-0.24	-0.35	-0.41	-0.51	-0.92	-1.05
Price response	-0.13	-0.23	-0.31	-0.14	-0.25	-0.31	-0.18	-0.29	-0.35	-0.12	-0.32	-0.62	-0.79	-0.91	-0.67	-0.13	-0.18	-0.20	-0.24	-0.40	-0.53

	Ireland			Italy			Luxembourg			Netherlands			Portugal			Spain			USA		
Horizon in years	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*
VAR simulation, shocks of different size across countries, (see Mojon and Peersman (2001))																					
Investment response	-0.05	-0.04	0.00	-0.46	-0.32	-0.03	n.a.	n.a.	n.a.	-1.00	0.15	0.87	n.a.	n.a.	n.a.	-0.75	-0.23	-0.13	-0.22	0.08	0.46
GDP response	0.06	0.04	0.04	-0.17	-0.09	-0.03	n.a.	n.a.	n.a.	-0.30	0.06	0.26	n.a.	n.a.	n.a.	-0.10	-0.07	-0.03	-0.17	-0.12	0.01
Price response	-0.05	-0.04	-0.03	-0.05	-0.03	0.00	n.a.	n.a.	n.a.	-0.24	-0.32	-0.21	n.a.	n.a.	n.a.	-0.01	0.00	-0.01	-0.01	-0.08	-0.13
Macroeconometric models, permanent 100 basis point interest rates increase (based on Eurosystem macroeconometric models)																					
Investment response	-1.00	-3.95	-4.69	-1.24	-3.51	-4.71	-0.06	-1.43	-1.73	-0.63	-1.05	-1.47	-0.44	-1.97	-2.66	-1.18	-2.58	-3.20	n.a.	n.a.	n.a.
GDP response	-0.27	-0.54	-0.84	-0.51	-0.76	-0.83	-0.07	-0.13	-0.21	-0.28	-0.32	-0.44	-0.13	-0.60	-0.96	-0.26	-0.67	-0.89	n.a.	n.a.	n.a.
Price response	-0.14	-0.26	-0.28	-0.32	-0.59	-0.78	0.00	-0.11	-0.11	-0.27	-0.35	-0.42	-0.10	-0.33	-0.42	-0.12	-0.46	-0.77	n.a.	n.a.	n.a.

Sources: The top panels report the responses of the respective variable after 1, 2 and 3 years as obtained with country VARs presented in Mojon and Peersman (2001). The second panels correspond to author's calculation based on the Eurosystem macroeconometric models simulations presented in van Els et al. (2001).

Note: The price index used in the VAR is the CPI, while for the Eurosystem macroeconometric models the response of the consumer expenditure deflator is reported.

Table 5: Contributions of interest sensitive spending to GDP changes following a monetary policy shock (in % of the change of GDP)

	Euro area		Austria		Belgium		Germany		Finland		France		Greece	
Horizon in years	*3*	*av. 1-3*	*3*	*av. 1-3*	*3*	*av. 1-3*	*3*	*av. 1-3*	*3*	*av. 1-3*	*3*	*av. 1-3*	*3*	*av. 1-3*
VAR cumulated responses	103	110	-20	-3	57	30	54	65	90	83	60	90	-1	0
Macro econometric models based permanent shock	126	114	100	105	50	50	28	24	91	80	25	22	1	0
	Ireland		**Italy**		**Luxembourg**		**Netherlands**		**Portugal**		**Spain**		**USA**	
Horizon in years	*3*	*av. 1-3*	*3*	*av. 1-3*	*3*	*av. 1-3*	*3*	*av. 1-3*	*3*	*av. 1-3*	*3*	*av. 1-3*	*3*	*av. 1-3*
VAR cumulated responses	-2	-17	77	76	n.a.	n.a.	40	55	n.a.	n.a.	145	168	-15	16
Macro econometric models based permanent shock	145	144	149	111	254	206	90	80	83	94	99	110	54	43

Source: Authors' calculations based on Table 4.

Note: The contribution is equal to the ratio of the response of investment to the response of GDP times the average share of investment plus durable consumption relative to GDP. Data for durables was estimated at 6% for the Euro area, Belgium, Germany, Greece, Ireland, Luxembourg and Spain. The macro-model based contributions for the US are based on the simulations presented in Table 3.

Table 6: Elasticities of investment determinants with respect to the policy rate

	User cost			Sales			Cash Flow		
Horizon in years	1	2	3	1	2	3	1	2	3
Germany	0.14	0.17	0.18	0.04	0.04	0.03	0.00	-0.15	-0.24
France	0.18	0.29	0.26	0.0	-0.03	-0.09	-0.21	-0.27	-0.40
Italy	0.24	0.29	0.27	0.0	-0.07	-0.09	-0.36	-0.80	-0.59
Spain	0.39	0.56	0.57	-0.02	-0.02	-0.03	-0.03	-0.07	-0.11

For the description of the main features of the equations underlying this table, see the main text.

Table 7: Elasticities of investment with respect to the policy rate

Horizon in years		1	2	3
Germany	Full elasticity (1)	-.13	-.18	-.16
	Elasticity suppressing cash flow (2)	-.13	-.17	-.14
France	Full elasticity (1)	-.03	-.15	-.22
	Elasticity suppressing cash flow (2)	0	-.05	-.06
Italy	Full elasticity (1)	-.30	-.54	-.43
	Elasticity suppressing cash flow (2)	-.15	-.21	-.15
Spain	Full elasticity (1)	-.58	-.45	-.15
	Elasticity suppressing cash flow (2)	-.57	-.46	-.17
Belgium	Full elasticity (1)	-.02	-.09	-.15
	Elasticity suppressing cash flow (2)	-.01	-.04	-.05
Austria *	Full elasticity (1)	-.57	-.46	-.34
	Elasticity suppressing cash flow (2)	-.25	-.14	-.04
Finland	Full elasticity (1)	-.01	-.03	-.09
	Elasticity suppressing cash flow (2)	-.01	-.03	-.07
Luxembourg * #	Full elasticity (1)	-.57	-.29	-.10
	Elasticity suppressing cash flow (2)	-.57	-.17	0

Notes: For each country, the entries are the elasticities of investment with respect to the short term interest rate are calculated by simulating various investment equations in conjunction with the linkage equations shown in Table 6 (and described in the text). The investment equations for Germany, France, Italy and Spain are taken from Chatelain et al (2001) table 4. The most similar equations to these were used for the other four countries, with the Belgium estimates taken from Butzen et al. (2001; table 4, large manufacturing firms), the Austrian estimates taken from Valderrama (2001; table 3, benchmark model), the Finnish estimates taken from Topi and Vilmunen (2001; table 4), and the Luxembourg estimates taken from Lünnemann P. and T. Mathä (2001; table 4, within estimates). The baseline data for the calculation of the elasticities is constructed from micro summary statistics, mean values.

* Since the model includes the cash stock, rather than the cash flow, the relative link equation is not the average of those of the four largest countries, but is imposed to be what is mechanically implied by the duration of the stock of cash, which is assumed to be equal to 4 months (1/3 of a year, implying a constant elasticity of -0.33). # The estimates underlying our calculations are Within (and not GMM as in all other cases).

Table 8: Cumulative responses of bank variables to monetary policy shocks according to the Mojon and Peersman VARs

	AT	BE	FI	FR	DE	GR	IE	IT	NL	PT	ES
Initial VAR shock	0.3	0.2	0.6	0.5	0.4	1.7	0.8	0.7	0.5	n.a.	0.9
Policy rate cum. 4 q.	0.5	0.6	1.2	0.7	0.8	1.5	0.9	1.1	0.5	1.9	
Components of M3 and yield on time deposits (cumulated responses up to 4 quarters):											
M1	-1.1	-1.3	-1.2	0.1	-0.7	0.2	0.0	-1.8	-2.4	n.a.	-1.7
M3-M1	1.9	3.8	1.4	0.1	1.4	-2.6	2.9	-1.3	0.8	n.a.	1.1
Time deposit rates	n.a.	0.2	0.2	0.7	0.7	0.0	0.7	0.8	0.1	n.a.	0.4
Summary	Composition affected	Composition affected	Composition affected	No effect	Composition affected	Total affected	Wrong effect	Total affected	Composition affected	n.a.	Composition affected
Response of price and quantity of Loan rates (cumulated responses up to 4, 8 and 12 quarters):											
Short term loan rates	n.a.	0.4	0.6	0.7	0.7	0.0	0.7	0.8	0.7	n.a.	2.1
Loan volume responses (cumulated up to 4, 8 and 12 quarters):											
To firms (4 q.)	-0.6	1.1	n.a.	-0.5	0.7	-0.3	n.a.	n.a.	n.a.	n.a.	0.0
To firms (8 q.)	-0.3	-1.5	n.a.	-2.7	0.4	-0.6	n.a.	n.a.	n.a.	n.a.	-1.8
To firms (12 q.)	-1.7	-5.0	n.a.	-5.9	-2.3	-0.7	n.a.	n.a.	n.a.	n.a.	-3.0
To households (4 q.)	-1.0	-0.7	n.a.	0.1	-1.4	0.1	n.a.	n.a.	n.a.	n.a.	0.4
To households (8 q.)	-0.1	-1.4	n.a.	1.1	-4.9	0.0	n.a.	n.a.	n.a.	n.a.	-0.6
To households (12 q.)	1.0	-3.1	n.a.	3.9	-9.0	-0.1	n.a.	n.a.	n.a.	n.a.	-1.3
Total (4 q.)	-0.1	-0.4	-2.1	-0.1	0.2	-0.2	0.3	-1.8	-0.2	n.a.	0.3
Total (8 q.)	-0.3	-2.2	-6.0	-0.9	-0.9	-0.4	0.9	-4.5	-3.7	n.a.	-0.4
Total (12 q.)	-1.2	-4.8	-11.0	-2.3	-3.8	-0.5	1.3	-7.2	-7.2	n.a.	-1.0

Sources: Authors' calculation on the basis of the results of Mojon and Peersman (2001)

Table 9: Summary of country papers testing for monetary policy induced loan supply shifts

Country	Main conclusions regarding loan supply changes after a monetary policy shift
AT	Loan supply effects limited: lending responses appear to be asymmetric, during recessions loan supply does respond to monetary policy, but not during expansions
BE	n.a.
FI	Loan supply effects doubtful: neither size, liquidity nor capital level influence the amount of loan adjustment; only caveat is that the sample is all post-banking crisis
FR	Loan supply effects present: banks with fewer liquid assets adjust loans more
DE	Loan supply effects present: banks with fewer liquid assets adjust loans more (inter-bank deposits are the key to the liquidity position)
GR	Loan supply effects present: smaller banks and banks with fewer liquid assets adjust loans more (small, illiquid banks adjust most)
IE	n.a.
IT	Loan supply effects present: banks with fewer liquid assets adjust loans more (also strong evidence of deposit shifts)
LU	n.a.
NL	Loan supply effects present: unsecured lending for small, illiquid, or poorly capitalised banks adjusts more; household lending is not affected
PT	Loan supply effects present: less capitalised banks adjust loans more (very small sample)
ES	Loan supply effects absent: No evidence of supply shifts, even following an institutional reform that squeezed deposits

Table 10: Response of bank lending to monetary policy: evidence based on some indicators proposed in the literature

	AT	BE	FI	FR	DE	GR	IE	IT	LU	NL	PT	ES
Nr. of banks												
all banks	799	73	340	332	3207	60	77	759	209	135	18	243
Large bks mkt share	0.82	0.91	83.3	0.70	0.77	0.49	0.36	0.74	n.a.	0.75	90.7	0.60
Avg. asset (mio euros)												
all banks	405	8079	308	6398	1591	2198	3047	1863	2588	5645	12500	3612
large banks	8485	44718	5125	92330	24490	21321	21299	28900	n.a.	81897	34000	43670
Avg. Bank liquidity**												
all banks	16.9	31.4	12.3	40.1	33.8	24.6	15.8	39.9	19.0	44.4	16.0	40.7
large banks	12.7	34	11.2	29.4	34.2	25.9	15.5	25.7	n.a.	22.8	22.6	33.7
Av. Bank capitalisation**												
all banks	4.7	9.8	9.1	8.9	5.5	8.3	1.2	11.2	2.5	10.9	6.0	13.2
large banks	3.2	3.8	4.7	3.7	4.1	5.5	0.9	6.8	n.a.	4.5	6.3	4.9
Avg. Deposit share**												
all banks	52.9	45.6	50.8	58.5	74.7	71.2	21.2	50.8	26.6	47.1	42.8	61.4
large banks	22.3	41.0	45.1	43.8	42.3	77.8	19.1	34.6	n.a.	49.6	44.0	49.0
Avg. loan share**												
all banks	55.7	30.4	52.0	40.3	56.3	31.4	56.5	38.8	9.8	33.1	38.8	45.9
large banks	52.9	26.7	49.5	35.8	39.4	30.4	62.9	40.5	n.a.	52.0	38.0	46.6

Sources: DE, ES, FR, IT: Ehrmann et al. (2001), FI: Topi and Vilmunen (2001); GR: Brissimis et al. (2001), NL: De Haan (2001), PT: Farinha and Robalo (2001); AT, BE, IE and LU: Eurosystem databases.

Notes: Data for the Netherlands are 1990-1997, otherwise, 1998. Large banks are defined as those above the 95th percentile (PT: top third, BE top 12 largest banks and AT top 41 banks). For DE, ES, FR, IT, GR and PT, the reported statistics are not based on the full population of banks, but on the cleaned sample used in panel regressions in the above mentioned papers. Liquidity is defined as securities other than shares held by banks. * median value. ** expressed in percents of total asset.

Table 11: Final Assessment of Monetary Policy Transmission in Euro Area Countries

Bank evidence	Data lacking to determine relevance of the IRC	IRC dominance rejected			IRC dominance not rejected
		Financial factors expected for **Consumption and Investment**	Financial factors expected for **Consumption but not Investment**	Financial factors expected for **Investment but not Consumption**	No financial factors expected
Loan supply reacts	NL, PT	GR, FR?	DE	IT, FR?	
Loan supply insensitive				AT	FI, ES
Loan supply assessment not possible	IR	BE			LU

Note: there is conflicting information about France and therefore we show it as having two possibilities.

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