Doctoral (PhD) Dissertation

THE EFFECTS OF COMMON CURRENCY AND INTERNATIONAL FINANCIAL INTEGRATION ON THE MONETARY TRANSMISSION MECHANISM

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The effects of increased international financial integration and common currency on the monetary transmission mechanism

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Table of contents

List of tables

List of figures

Chapter 1. Introduction

„Setting a single interest rate for 12 countries has been hard enough, even with low inflation. Choosing one for a much more mixed bag of 20-odd may be impossible"
(The Economist [2003] p. 16.)[1]

1.1. Research history

In 2003 as a bachelor student at the University of Debrecen, I was reading The Economist in the library and found an article in the editorials about the challenges - the freshly appointed president of the European Central Bank - would face. The sentence cited above made me curious: how would the central bank set its interest rate for so many different countries? It didn't take much reading to find the answer: the ECB defined the Harmonized Index of Consumer Prices (HICP) and sets its interest rate in accordance with the inflation measured using this price index. But an interest rate set by monetary policy relying on an average change in prices can't guarantee price stability in all the member countries. If the member countries are different then they should respond differently to the same monetary shock. Thus the problem still puzzled me. As a consequence I wrote my master thesis about the differences between the Hungarian households' balance sheet and the balance sheet of households in the euro area. In my thesis I tried to describe, how these differences would affect the transmission of the monetary policy. In 2005, by the time I had to choose a theme for my dissertation, I already knew what I would be interested in: differences in the monetary transmission channels.

If one reads about the European Monetary Union it wouldn't take much time to encounter the optimal currency area literature (the fact that my supervisor previously researched this theme definitely accelerated this process). In the optimal currency area literature the possibility of endogeneity thrilled me.[2] This made my research topic of differences in the monetary transmission mechanism even more interesting. Thus not only could there be differences in the transmission mechanism, but these differences would react to the introduction of the common currency.

Originally the effect of increased international integration of financial markets on monetary policy transmission was a separate research project. However, later it

[1] In this way editors of The Economist wished good luck to the new president of the European Central Bank, Jean-Claude Trichet at fall of 2003.
[2] I thank Dóra Győrffy for this idea.

developed to serve as a probable alternative explanation next to the introduction of common currency for the changes found in the transmission mechanisms.

The research of the changes in the transmission mechanism due to the accumulation of the foreign exchange denominated debt is a direct descendant from my master thesis. It also started as separate project and I spent the summer in 2008 at the Magyar Nemzeti Bank as a visitor researcher to develop the idea. Later this paper also found its place in the dissertation as a case study for international integration.

All these ideas and subsequent research I had done, as described above, have one thing in common, i.e. the research question of this dissertation: **How do major changes in the monetary policy's (technological, policy etc.) environment change the transmission of the monetary policy?**

1.2. Motivation behind research question

There are several motivations why this research question might be an interesting one. First, the questions about transmission are older than the independent science of economics. The transmission of a change in the quantity of money is already described by *Hume* [1752][3] in his essay Of Money. *"Accordingly we find, that, in every kingdom, into which money begins to flow in greater abundance than formerly, every thing takes a new face: labour and industry gain life; the merchant becomes more enterprising, the manufacturer more diligent and skilful, and even the farmer follows his plough with greater alacrity and attention. This is not easily to be accounted for, if we consider only the influence which a greater abundance of coin has in the kingdom itself, by heightening the price of Commodities, and obliging every one to pay a greater number of these little yellow or white pieces for every thing he purchases."* (*Hume* [1752] II. III. 6.) As the citation shows, in the short run economic activity increases after a monetary 'expansion', the increase of prices follows only in the long run. The notion that prices need time to adjust to changes in the quantity of money was adapted by other promoters of the quantity theory of money, as described by *Humphrey* [1974]. The questions arising from the investigation of the transmission are even today the most important questions of monetary macroeconomics: the interaction between nominal and real variables; the frictions causing the monetary policy having real effects; the overwhelming role of expectations; the causes of business cycle movements etc.

[3] I thank Pál Czeglédi for this citation.

Second, the monetary transmission process is a very complex system, as shown later in Chapter 2, the transmission comprises of several steps, more than dozen different channels, all in interaction with each other, with changing expectations and policy environment. In addition, many structural variables, institutional arrangements, historical events influence the transmission mechanism. The transmission mechanism is always hit by different shocks, it is always changing, developing. So to find out how a major change in the policy environment would affect separate channels or the whole mechanism, is not only an intellectual challenge, but also a methodological one. The third motivation could be the practical consequences of this research. The better knowledge of the transmission of monetary policy is welcomed by the policymakers, as it might help to foresee the consequences of their decisions. To show an example for the use of information about the changes in the monetary policy transmission take the example of autumn 2008, after the bankruptcy of Lehman Brothers. The financial turmoil reached Hungary and bond markets reached the state of 'sudden stop' (*Dornbusch et al.* [1995]). Traditionally in such a case monetary policy decreases its interest rate to provide additional liquidity for the market, to avoid second-round effects of financial distress. This wasn't possible in case of Hungary because of the huge amount of foreign currency debt accumulated over the years by Hungarian households' and companies'. In the Hungarian case a drop in the interest rate would have further depreciated the exchange rate, increasing the instalments denominated in domestic currency, decreasing the disposable income of the households and through this the consumption. Many households' would have been incapable of paying these increased instalments, and the emerging non-performing loans would have further weakened the financial system. The knowledge that the transmission might have changed because of widespread foreign currency lending led to an increase in the monetary policy's instrumental variable to defend the exchange rate, and this way it saved from the worst of the crises (or in this case postponed its effects).

To answer the research question, two major changes in the monetary policy's environment were chosen. The first is the increased international integration of financial markets, the second the introduction of the common currency in the member countries of the European Monetary Union. This complicates the matters at hand because the two events happened almost at the same time and some of their effects coincide.

1.3. Outline of the dissertation

Chapter 2 is dedicated to theoretical and methodological questions. First the transmission mechanism is introduced, from policy decision, to its effect on the inflation dynamics. Selective review is given about the most important questions of monetary decision making, covering themes as: credibility, accountability, nominal anchor, communication etc. In the next step a small model is shown to explain the basic mechanism behind interest rate pass-through, the connection between the short term interest rate used as policy instrument and the credit rates set by the banks. Then different channels of transmission are introduced, all transmitting the shock from the financial sector towards the inflation rate. The second part of Chapter 2 is devoted to methodological questions. As already mentioned pinning down the consequence of a change in the environment given a complex system, is not an easy task. I use different types of vector autoregressive models throughout the dissertation. The methods used in the dissertation are: split samples and simple non-linear. In Chapter 2 I introduce the basic concepts, identifications and problems, the specific usage is kept for the later chapters.

The aim of Chapter 3 is to show how increased financial integration influences the monetary policy's ability to affect different variables of the economy to pursue its goal. Detailed literature review is used to form a hypothesis about the effects of the globalisation. These hypotheses are tested in a case study. The case study tries to measure how the foreign currency denominated debt accumulated by the Hungarian households changes the Hungarian monetary policy's main transmission channel, the exchange rate channel.

In Chapter 4, I try to tackle the idea of endogeneity, so the goal is to investigate the effect of common monetary policy on the monetary transmission mechanism. As a first step the optimum currency area literature is examined, to serve as a framework for the investigation. The question here is whether the differences in the monetary transmission make the common monetary policy a source of asymmetric shock? The advantage of phrasing the problem within the optimum area literature would be that the concept of endogeneity could be introduced in relation to the interaction between the common monetary policy and the differences in the transmission process. The next step is to state whether there were differences in the effects of national monetary policies before the third stage of EMU. And if there were differences, what happened to them after the

introduction of the euro? The common shock made the financial markets more integrated; there is plenty of evidence for that in the literature. What happened to the other parts of the transmission process? Through literature review I try to identify the ‘euro effect’ in structural changes of the economy and later use vector autoregressive models to quantify the effect of these changes on the whole monetary transmission mechanism.

At the end, Chapter 5 summarizes the results of the dissertation in form of theses.

Chapter 2. Transmission of monetary policy

Introduction

The aim of this chapter is to show how the term transmission of monetary policy is defined and used throughout in this dissertation, describe the different channels of transmission and the method used in the rest of the dissertation to measure them. In this way, this is a theoretical and technical chapter and its content is needed to present the results of the forthcoming chapters.

Accordingly, section 2.1 presents a general description of monetary policy, aiming to show the way modern monetary policy works. This section concentrates on the different phases of monetary transmission mechanism and the different channels through which the monetary policy affects the economy. In addition, I present empirical examples for the USA and Hungary, as examples concerning the member countries of the EU will be cited later in Chapter 4. Section 2.2 is dedicated to the methodology used in this dissertation, namely vector autoregression models often used to characterize the monetary transmission.

2.1. Monetary transmission

> *"The transmission mechanism of monetary policy, which traces the various linkages from central bank actions to spending and inflation, involves a complex set of relationships."* (*Freedman [2000] p. 211.*)

The transmission of a monetary policy decision/shock could be summarized as follows:
Step 0. The decision making body of the monetary policy sets the value of the instrument according to its aim. In an inflation targeting framework this would mean that if the forecasted inflation is higher than the aim, the body would increase the instrument interest rate.[4]

[4] Other variables could serve as an instrumental variable, in fact most textbooks as *Walsh* [2003a] treat monetary policy as if some kind of monetary aggregate would serve as an instrumental variable, which is surprising because most central banks use an interest rate as operational target. See *Bindseil* [2004] for a historical review of the central banks' operational targets. See *Christiano et al.* [2007], *Disyatat* [2008], *Komáromi* [2008] for other roles monetary aggregates can serve in conducting monetary policy.

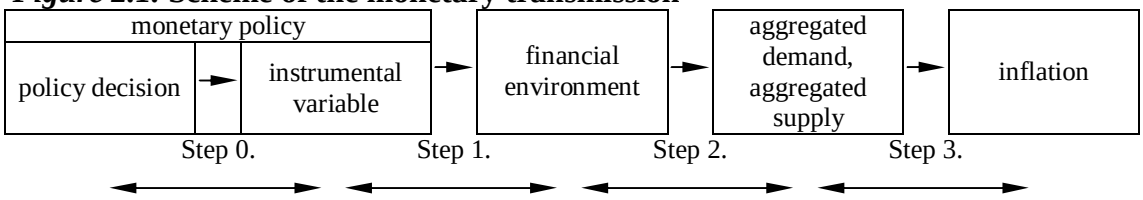
Step 1. The instrument variable is changing the prices and liquidity of the other assets in the financial system (partly through direct channels and partly through affecting the expectations of the economic agents).

Step 2. The changes in the financial environment influence the decisions and choices of the household and the business sector – and through this they affect the aggregate demand and supply of the economy

Step 3. The altered aggregate demand and supply has it effects on the inflation dynamics

So the scheme to describe these relationships is:

Figure 2.1. **Scheme of the monetary transmission**



In accordance with the Figure above I start with Step 0. and then follow the path of transmission.

2.1.1. Policy decision (Step. 0.)

To understand the monetary policy transmission one needs to begin with the role and methods of the monetary policy. For a long time conducting monetary policy decisions was regarded as something mystical. *Mishkin* [2007c] claims that the monetary policy is more and more based on scientifically proved facts and connections, and although it still needs the 'mystical' professional judgment in some situations, in the last two decades it made bigger steps towards becoming a scientific approach than ever before.

The questions that must be treated include: the role and possibilities of the monetary policy, which limit the possible aims, and the best means to reach them. In the following subsections I follow the introduction of *Mishkin* [2007c][5] and *Issing* [2009].

Goal of monetary policy

First main question is the goal of the monetary policy. The consensus of the academic literature and monetary policy makers is that because price stability is valuable in itself[6]

[5] *Mishkin* [2000] groups the same connections differently.

[6] Price stability helps the effective allocation of resources through the stability of relative prices. About the other traditional costs of inflation see Briault's review (*Briault* [1995]). *English* [1999] adds a further

and as inflation is always a monetary phenomenon, the aim of the monetary policy should always be to maintain price stability.[7]

But how to define price stability? Among others *Blinder* [2006] is making the point, that 2% inflation is on the one hand high enough to protect against the upward biases of the CPI (defending against deflation) and low enough to minimize the cost of inflation. According to *Blinder* [2006] it is also useful for central banks to aim a measure of core inflation (*Ball* [1999] even advises to filter out the effects of the exchange rate for small open economies), because it is easier for the authorities to forecast and influence it. Despite of this advantage, most central banks prefer to aim an easily understandable measure of inflation for communication reasons, which is hazardous because in this case the monetary policy might react to shocks it can not influence (an oil price shock for instance), and end up being too restrictive causing losses, measured either in output or excess volatility.

Best practices to achieve the goal of price stability

It is possible for the central bank to achieve its goal of price stability by anchoring the agent's inflation expectations. Inflation expectations influence among others, investments, wage bargaining and pricing decisions.

In a rational expectations framework with flexible prices the Phillips curve is vertical, resulting in the independence of the real and nominal variables (classical dichotomy). As shown in *Sargent and Wallace* [1975, 1976] in such an environment systematic monetary policy effects only the inflation without any real effects and only unexpected changes in the monetary policy can have short-run real effects.[8] The only advantage to drive expectations in such an environment is to misinform, to be able to move unexpectedly.

But any deviations from the assumptions of the model: either in rational expectations (learning, not perfect information), in the flexibility of prices[9] or the perfect functioning

type of cost, higher inflation results in an over investment into the financial sector, which again is a misallocation and as so ineffective.

[7] *Adam* [2007] finds that in a model with imperfect common knowledge (with firms having limited ability to process information) the focus of monetary policy depends on the persistence of shocks. In case of strategic complementary pricing and without persistent shocks the firms don't react to aggregated shocks, which brings the monetary policy in a position where it is able to stabilize the output, but in case of persistent shocks the firms have time to learn about the nature of the shock, which is why the monetary policy is limited to stabilize the price level only.

[8] For the attempts to prove this proposition empirically and for their critiques, see e.g. *Barro* [1977, 1978], *Gordon* [1979], *Mishkin* [1982] and *Pesaran* [1982] among others.

[9] For basic literature see *Calvo* [1983], *Mankiw* [1985], *Rotemberg* [1982] and *Taylor* [1979] or see *Taylor* [1999] for a summary. *Golosov and Lucas* [2007] also show that in a model using "menu costs" in

of the markets (e.g. agents are only able to make financial transactions occasionally[10]), make even the systematic monetary policy capable of influencing the real variables of the economy.[11] This ability of affecting the real economy could lure the monetary policy to make surprise inflation for the sake of increased output (or decreased unemployment) after the inflation expectations are well anchored at a low level. But if rational agents (not even perfectly rational agents are needed) expect this time inconsistency in the behaviour of the central bank and they also expect the resulting high inflation, which in itself causes the higher inflation.[12] And this makes expectations a crucial part of the inflation dynamics, so the central banks have developed many ways to be able to influence the expectations (not just the inflation expectations, but the expectations concerning their own actions), and to look trustworthy in order to avoid these time-inconsistency problems.

Policy rules are important tools to protect the monetary policy against the time-inconsistency problems. A well published policy rule can serve as a reference point to evaluate the actions of monetary authority and the policy stance. It can also demonstrate the decision making mechanism of the monetary policy, and help to guide the expectations. Among the rules it is necessary to mention the Taylor rule (*Taylor* [1993]):

$$i = \pi^{target} + 1.5\left(\pi - \pi^{target}\right) + 0.5\left(gap\right) + r \tag{2.1}$$

where i is the instrument interest rate, π is a measure of inflation, π^{target} is the inflation target, gap is the output gap and r is the real interest rate. The coefficient of the inflation gap (the deviation of the inflation from the target) is higher than one, which means that the monetary policy should raise interest rate levels in higher proportion than the inflation shock, so that the real interest rate increases, which helps to stabilize prices. There are two reasons for including some measures of output gap into the policy rule, first the real variables deviation from their long term equilibrium level forecasts future inflation, and second the monetary policy must have an eye on the sacrifice ratio as well.[13]

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pricing decisions, the real effect of monetary shock is less persistent than in one incorporating Calvo style randomly timed pricing opportunities.

[10] For 'limited participation' models see e.g. *Grossman and Weiss* [1983] and *Christiano and Eichenbaum* [1992].

[11] See *Altissimo et al.* [2006] for further discussion of deviations from the assumptions of the new-classical model and their consequences.

[12] See *Kydland and Prescott* [1977] for being the first to bring up this problem

[13] In models the loss function of the monetary policy takes a similar form (besides the deviation of the inflation from the target, the volatility of real variables also cause losses for the monetary policy), but *Nelson* [2000] makes a difference between a monetary policy rule (being a reaction function) and a lost

Many questions arise about which rule is optimal for a given country and/or environment. *Blinder* [2006] asks the question whether output or unemployment should be the real variable in the policy rule in case of an uncertain environment. I shall return to this question later in Chapter 3. *Ball* [1999] finds that the optimal rule for a small open economy should use a monetary condition index (MCI), which is the weighted average of the exchange rate and the interest rate, as a variable to measure policy stance. *Hidi* [2006] also finds that although the simple Taylor rule (with fixed coefficients) fits well to the Hungarian interest rate movements, a rule extended with exchange rate fits even better (and using the central banks' own forecasts as the exchange rate measure makes the fit almost perfect). *Choi and Wen* [2010] and *Walsh* [2007] stress the timing of the monetary policy reaction. This is important because if the monetary policy affects the economy with lag, than the optimal policy (and the policy rule as well) must be forward looking, so that by the time the shock affects the variables in focus, the monetary policy shock also reaches the same variables stabilizing them (more simply, monetary policy should react to causes instead of consequences).[14]

If the monetary policy were bound to a policy rule, that could help to eliminate time-inconsistency problems, but in practice rules applied compulsorily proved to be too rigid.[15] But in a system where discretionary policy moves are allowed, personal safeguards must appear to fight the aforementioned inflation bias. *Rogoff* [1985] shows in his model, that it is rational for the society to appoint a central banker, who places more weight on the inflation stabilization than the rest of the society (hence it is called a conservative central banker). This way the time-inconsistency problems can be minimized. On the other hand if the feedback rules are too rigid or/and the central banker is 'too' conservative (infinite weight on the inflation) than the inflation can be brought down to the social optimal level at a cost of having more volatile employment. In *Walsh* [1995]'s model, the contract of the central banker can work as a inflation targeting policy rule as long as it raises the central banker's marginal cost of inducing

function (showing the preferences of the policy maker) – if there is need for bigger step to achieve the price stability (increase in the coefficient of the difference between the price level from the target in the reaction function) doesn't mean automatically an increase in the disfavour of the inflation (an increase in the coefficient of the difference between the price level from the target in the preferences of the monetary policy)

[14] According to *Issing* [2009], this is why the horizon for monetary policy cannot be set in advance. Sometimes it pays out to look far ahead, beyond the average lag of monetary transmission; and sometimes the economy can be expected to return to price stability within a much shorter period. But a central bank always has to ensure that the expectation quickly revert to its declared policy objective.

[15] See *Issing* [2009] for review.

surprise inflation. The dependence of benefits (wage[16], employment) on the achievement of the headlight inflation goal (or other easy accessible public information) helps build accountability, commitment and credibility. This method eliminates inflation bias, and at the same time preserves the advantage of discretion. *Barro and Gordon* [1983b] extends the model of *Barro and Gordon* [1983a] with reputation, and in their model the potential loss of reputation motivates the policymaker to achieve the aim of price stability. In the end this approach results an equilibrium which is superior to the entirely discretional solution, but is inferior to the ideal rule. It depends on the policymaker's discount factor to which of the two solutions it is nearer. *Issing* [2009] claims that personality issues disappeared from the academic research agenda, but the appointment of a known conservative central banker still might give a strong signal to the public about the commitment of the policy makers, and so helps build credibility and form expectations.

Beside rules, credibility can also be important to avoid time inconsistency problems. One way to become credible is gaining independence[17], which in a democratic country can only mean instrument independence (the monetary policy can freely choose its instruments to reach its target) and not goal independence, because it isn't an elected board so it doesn't have the democratic delegated power to set its own aim. The goal is usually set together with the government, which can be hazardous because the goal shouldn't be changed for short sighted political advantages, because than the problem of time-inconsistency re-emerges (*Mishkin* [2000]). According to *Issing* [2009] and *Walsh* [2007] credibility can be gained by a convincing track record, as private agents will believe the central bank's promises about future policies only if it already has kept its past promises. But to sustain its credibility, the central bank must commit itself to a policy that leads to its goal, and doing so also requires communicate its policy intentions in a transparent way.

A well defined nominal anchor can help the communication and this way it can be useful to anchor expectations. The most important requirement against a nominal anchor is that it must have an easily understandable connection with the price stability.[18] This can be the ground that most central banks are operating an inflation targeting regime which aims the headlight inflation instead of the core inflation. *Castelnuovo et*

[16] For example the Reserve Bank of New Zealand has contracts for their central bankers which are written in this manner.

[17] *Alesina and Summers* [1993] and *Cukierman* [2007] also found that countries with more independent central banks tend to have more stable prices, without any cost in other measures of economic performance.

[18] According to *Bernanke* [2005a] the most important role of the fixed exchange rate is that it makes a very explicit, easily understandable nominal anchor.

al. [2003] prove on a sample of 15 industrialised countries, that the form of announcing an explicit quantitative target (definition of price stability, point or range) has no effect on the monetary policy's capability to anchor the long-run inflation expectation. In their result the credible commitment is more important than the phrasing of this commitment.

Transparency helps to make the monetary policy more accountable, credible and predictable, reducing uncertainty and therefore fluctuations.[19] This explains why central banks all around the world are getting more and more transparent.[20] However there is the question of degree of transparency. *Morris and Shin* [2002] is often quoted to show that becoming more transparent (providing more precise public information) can cause social welfare losses. *Svensson* [2006] shows that the results of *Morris and Shin* [2002] are often misinterpreted, because as Svensson states the result holds only in the very unlikely case that the public information provided by the central bank is lesser quality than the private information of the economic agents. In all other cases greater transparency increases the social welfare. *Cukierman* [2009] also claims that that central bank transparency has its limits. Sometimes it is neither feasible nor desirable to reach full transparency. Limits to feasibility include the 'art of monetary policy' (heuristics, rule of thumb decisions, especially in a changing environment etc.), which can not be communicated in a transparent way. As an example for the limit of desirability, *Cukierman* asks the question whether the central bank should transmit the information that there are solvency or liquidity problems in the financial system (provided that this information might even be noisy)? The following bank-run certainly does more damage than the gains from transparency would be.

On the list of *Mishkin* [2007c] the last but not the least important principle is that the monetary policy should have an eye on the soundness of financial system, because the business cycles and financial disturbances are highly correlated. This is why *Blinder* [2006] suggests that it should be built in directly into the loss functions of the monetary policy, through the volatility of the interest rates. This is again a question I shall cover more in detail later on in Chapter 3.

Next to this empirically supported facts and connections the decision makers still need their professional experience and judgment, especially in situations where the lack or the nature of the data makes it difficult to use more subtle methods, or where structural

[19] See e.g. *Woodford* [2005], *Gosselin et al.* [2007] and *Blinder* [2009] for theoretical and empirical question.

[20] See *Bernanke* [2008] for the steps toward more transparency in case of the Federal Reserve.

breaks increases uncertainty[21]. Partially conducting monetary policy is still an 'art' according to *Mishkin* [2007c].

2.1.2. Interest rate pass-trough (Step 1.)

Changes in the instrumental variable of the monetary policy should influence the economy through the financial system. For this to happen, the instrumental variable should affect the financial environment, prices and quantities as well. The narrow interest rate pass-through is the effect of the instrumental variable of the monetary policy on the other market and bank interest rates. Sometimes a wider definition of the interest rate pass-through is used in this dissertation, the broad interest rate pass-through is defined as the effect of the official interest rate on the financial prices, including the foreign exchange rate, equity prices, bond yields and market interest rates.

To show how the monetary policy is able to influence the market interest rate by setting its instrumental interest rate(s), I present a simple model from the third chapter of *Bindseil* [2004]. As a first step let's consider the balance sheet of the central bank. The assets and liabilities are grouped in four main sections: autonomous liquidity factors, open market operations, standing facilities and commercial banks' reserves with the central bank (see *Figure 2.2*).

Autonomous factors are the items in the balance sheet which do not reflect monetary policy operations or the reserves of banks, and are not controlled by the monetary policy function. In most cases these are the amount banknotes issued, the foreign exchange reserves, the deposits of the government and if there are any then the securities held for investment purposes. These items can be found on both side of the balance sheet, so I denote the net value of the autonomous factors on the liability side with A

Open market operations are conducted at the initiative of the central bank to achieve the desired level of market interest rates. These are mainly reverse operation (collateralized credit operations or repurchase agreements).

M on the asset side of the balance sheet stands for the net value of the securities held in connection with the open market operations.

Standing facilities are monetary policy operations conducted at the initiative of the commercial banks. These can either be a liquidity-providing (borrowing, denoted with B) or a liquidity-absorbing (deposit, denoted with D) facilities. Rates of standing facilities are fixed by the central bank and form the ceiling and floor of the corridor

[21] One can find the same 'division of labour' between science and art in *Issing et al.* [2005].

within which short-term money market rates move. Let's assume that the inter-bank market is perfect and banks only use these facilities if there is an aggregated need or supply for liquidity by the banking sector. This means that there is either B or D in the balance sheet. *The commercial banks' reserves* are the good of which the short term market interest rate is the prices for. The banks are either required to hold them, but they can also hold reserves above the required amount, which is called excess reserves. These excess reserve items can also be used as a clearing balance as shown in Chapter 3.

Figure 2.2. **Balance sheet of the central bank**

Asset	Liability
M	A
	R
	B or D

A further assumption is that the reserve requirements are lagged and averaged, which means that the commercial banks know at the beginning of the reserve maintenance period how much reserves they need to keep in average during the given period. Given this the balance sheet identity can be described as following:

$$\bar{B} - \bar{D} = \bar{A} + \bar{R} - \bar{M}\,, \tag{2.2}$$

where the upper bars indicating period averages. To make the model even more simpler, let's assume that no working balance is needed, and the banks are allowed to average their reserves around zero ($\bar{R} = 0$). As mentioned previously the central bank has no real control over the autonomous items. The amount of the banknotes in circulation is the function of the cash demand of the households usually high around Christmas and other holidays. The deposits of the government depends on dates of taxation. The changes of foreign exchange rate reserves depend on the exchange rate system. But as the other items of the balance sheet (especially the open market operations) need to be set in accordance to the autonomous items, the monetary authority needs to forecast the components of the autonomous part. If $\bar{M} > \bar{A}$ than $\bar{B} = 0$ and $\bar{D} = \bar{M} - \bar{A}$, the market is in 'long' position, on the other hand if $\bar{M} < \bar{A}$ than $\bar{D} = 0$ and $\bar{B} = \bar{A} - \bar{M}$, the market is in 'short'. In a case without uncertainty (in the level of $\bar{A}$ and $\bar{M}$) this would mean that in the first case $i_1 = i_2 = ... = i_{\mathrm{T}} = i_D$, and in the second case $i_1 = i_2 = ... = i_{\mathrm{T}} = i_B$, where $i_1, ..., i_{\mathrm{T}}$ are the overnight interest rates on the T days of the reserve maintenance

period and i_B, i_D are the rates of the deposit and borrowing facilities at the end of the maintenance period respectively.

In a case with uncertainty further assumption are needed: let the information set I_t, $t = 1,..,\mathrm{T}$, be homogenous among the market participants[22] and denote with $f_{(\bar{M}-\bar{A}|I_t)}$ the probability density function money market participants assign during the trading session to the random variable $\bar{M} - \bar{A}$. Then according to *Bindseil* [2004], the market interest rate depends on

$$\begin{aligned} i_t &= E\left[i_B \middle| I_t\right] P('short') + E\left[i_D \middle| I_t\right] P('long') = \\ &= E\left[i_B \middle| I_t\right] \int_{-\infty}^{0} f_{(\bar{M}-\bar{A}|I_t)}(x)dx + E\left[i_D \middle| I_t\right]\left(1 - \int_{-\infty}^{0} f_{(\bar{M}-\bar{A}|I_t)}(x)dx\right) \end{aligned} \tag{2.3}$$

As can be seen in equation (2.3) the overnight rate in any day will respond to the weighted expected rate of the two standing facilities, the weights being the respective probabilities that the market will be 'short' or 'long' of reserves at the end of the maintenance period before having recourse to standing facilities.

Apart from expectations of standing facility rates, the received density function $f_{(\bar{M}-\bar{A}|I_t)}$ is obviously crucial. Since the central bank controls open market operations, it should also be able to exert some influence on $f_{(\bar{M}-\bar{A}|I_t)}$. This requires mainly (a) forecasting of autonomous factors (and make the forecast available for public) (b) understanding the expectations formation of the market, and (c) building up an appropriate reputation.

According to equation (2.3) the central bank has two tools to steer the short-term market interest rate: the rates of the standing facilities, and the reserve supply through open market operations. Therefore, central banks have in principle one degree of freedom for achieving their target rate. Most central banks use the standing facility rates to vary them with the monetary policy stance. At the same time the central bank keeps constant the scarcity of reserves, in the sense of the probabilities of recourse to each of the standing facilities.

If the density function of A is symmetric (all other characteristics can be ignored), then the monetary policy has to set the level of open market operations to $M = E(A)$, which would provide that $P('short') = P('long') = 1/2$ and equation (2.3) becomes very simple $i = (i_D + i_B)/2$. So if the monetary policy would like to achieve a given market rate i^*, then it only has to set the standing facilities correspondingly symmetric around

[22] Lifting this assumption would complicate the model considerably, see *Bindseil* [2004] section 3.5.

this target rate (symmetric corridor), and the market interest rate stays at the middle of the corridor.

Looking at the changes in the environment, if the desired i^* changes, then the corridor of standing facilities needs to be shifted parallel.[23] In contrast the central bank does not need to change its open market operations, because the relationship $M = E(A) \Rightarrow i = (i_D + i_B)/2$ is independent of the level of the target rate. Another possibility is that density function of A changes. If the mean of autonomous factors changes then $M = E(A)$ should be set accordingly. In contrast if the variance (or higher momentum) of autonomous factors changes, then the monetary policy doesn't have to react to it, because as long as the density function is symmetric, the overnight interest rate stays in the middle of the interest rate corridor.

Empirical evidence

However the interest rate pass-through is not always complete, even if the monetary policy reaches its target short rate market interest rate, other interest rates tend to be sticky. *Toolsema et al.* [2001] cites different explanations for the sticky interest rates. First, banks might try to avoid adverse selection and moral hazard problems, as they are unwilling to increase their lending rates to the equilibrium rate after a contractionary monetary policy move, resulting credit rationing (*Stiglitz and Weiss* [1981]). The second explanation also arises from information problems. For a bank it is costly to find out the true characteristics of its clients, and as granting credit can work as a public signal of creditworthiness, another bank might take a free ride and attract creditworthy clients with cheaper loans. To avoid this, the bank can build switching costs into the system, either administrative barriers or build its cost right into the interest rate, making it less responsive to the refinancing rate of the central bank. Another reason could be an adjustment cost, like the menu costs in case of prices. *Mojon* [2000] shows that the effect of an increase in the refinancing interest rate can have different effect than a decrease in the same interest rate (interest rate react asymmetrically). After an increase in the official interest rate the credit rates react elastically, but the deposit rates tend to be sticky, after a decrease of the instrumental interest rate the opposite is true, credit rates become sticky and deposit rate react flexibly.

[23] As shown in *Disyatat* [2008] the central banks in practice can move the interest rate with a credible announcement, without any open market operations. The central bank in that case operates as a 'market maker', and its ability to use the instruments at its disposal to reach its target short term interest rate is often enough and no further step is needed to be done.

Mojon [2000] also proves that the monetary regime financial markets work in can also influence the pass-through, past inflation experience accelerates, the volatility of money market rate prolongs the respond (this can be in connection with adjustment costs). Competition among banks positively (also in *van Leuvensteijn et al* [2008]) affects the speed and proportion of the adaptation of the banks' credit and deposit interest rates to the changes in the money market rate.

For the case of Hungary *Horváth et al.* [2006a] use panel error correction methodology to estimate the interest rate pass-through. They find that intense competition in the corporate loans and deposits market causes both the degree and the speed of the adjustment to be complete. On the other hand the lack of competition in the household loans and deposit segment results in slower and lower degree pass-through (long term adjustment is significantly lower than one), but even these results are not far from the European average. *Horváth et al.* [2006a] also found that reactions are asymmetric, even the interest rates of corporate loans are more rigid toward downward, than upward movements. At the same time the grater the movement of the money market interest rate, the faster is the adjustments.

Looking at the wider definition of interest rate pass-through, *Rezessy* [2006] uses an event study approach to show that the Hungarian monetary policy is able to influence the exchange rate, the monetary market rate and the stock index. A 50-basis-point increase in the monetary policy instrument appreciates the exchange rate with 0.3 percent within the day but the effect increases threefold if the sample extended to a two day period. Result of *Vonnák* [2006], based on a structural vector autoregressive model, also strengthens the evidence that the Hungarian monetary policy is able to influence the exchange rate.

2.1.3. Channels of the monetary transmission (Step 2. and Step 3.)

The changes in the financial environment influence the decisions of the agents in the economy, which on an aggregated level influence the aggregate supply and demand. Several channels of monetary policy transmission are distinguished in the literature according to effect of instrument variable changes on asset prices and on the behaviour of the agents of the economy. To model these channels draws such a complex system, that it would be almost impossible to build them in one small model. This is the reason I rely on schematic representation. The description of channels is mostly based on *Mishkin* [1995] and [1996].

Step 3. is not explained separately, but in all cases the expected reaction of the inflation is also included to the figures. Of course in all cases the proportion the inflation reacts to changes in the aggregate demand and supply depends on the stickiness of the prices.

Boivin et al. [2010] divide the transmission channels into two basic types: neoclassical channels and non-neoclassical channels. In case of neoclassical channels it is presumed that the financial markets are perfect. These 'traditional channels' (*Boivin et al.* [2010] p. 6.) are based on the core models of investment, consumption and international trade behaviour developed during the mid 20th century. Market imperfections are at the heart of the non-neoclassical channels, mainly imperfections of the credit market.

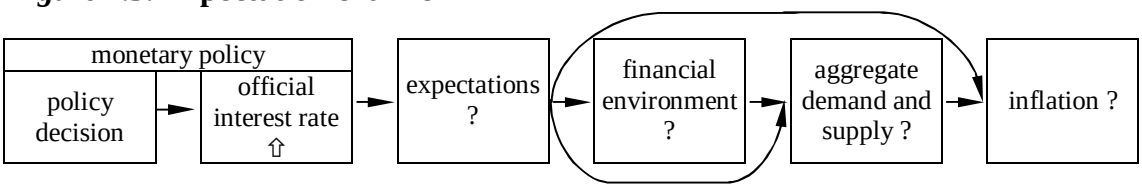
Neoclassical channels

Expectation channel

As already mentioned several times the transmission of monetary policy crucially depend on the way how agents think about the commitment of the monetary policy to fight inflation. As seen before the monetary policy usually only influences a short term interest rate, and its effect on other asset prices depends on the expectation of the agents in the economy. The whole credibility, transparency, communication issues mentioned previously serve only one goal, to make the monetary policy able to use the short term interest rate as a signal and through it influence the expectations (see *Woodford* [2005]). This makes this channel the most important channel of all.

The movement in the official interest rate in *Figure 2.3* with proper communication serves as a signal to the general public. Affecting the expectation of the economic agents this signal can influence the financial environment, the decisions resulting aggregate demand and supply and directly the inflation through wage and price setting decisions.

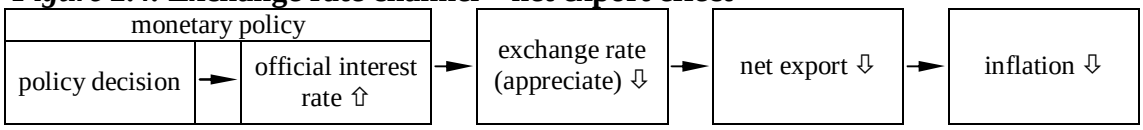
Figure 2.3. **Expectation channel**



Exchange rate channel

The first step of the exchange rate channel is that an increase of the domestic interest rate relative to foreign rates tends to appreciate the exchange rate through the logic of the uncovered interest parity.

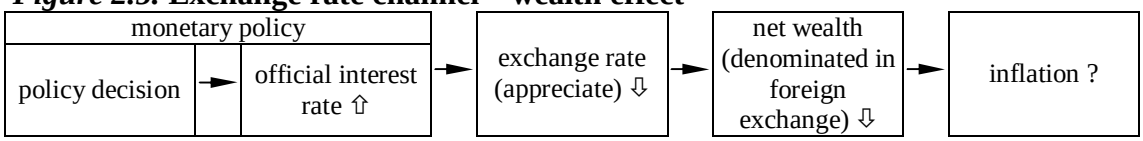
Figure 2.4. **Exchange rate channel – net export effect**



In the 'classical' exchange rate channel, shown in *Figure 2.4*, this appreciated exchange rate increases the price of the domestic products relative to the foreign products. This decreases the foreign demand for domestic export and increase the domestic demand for foreign import. Through decreasing the net export, the increase in the interest rate can affect the overall aggregate demand and eventually the inflation dynamics.

This mechanism thought to be more important in open economies, and its importance rises with the degree of openness (*Mishkin* [1996]), which means that in relatively closed economy like the USA, its effect should not be too significant.

Figure 2.5. **Exchange rate channel – wealth effect**

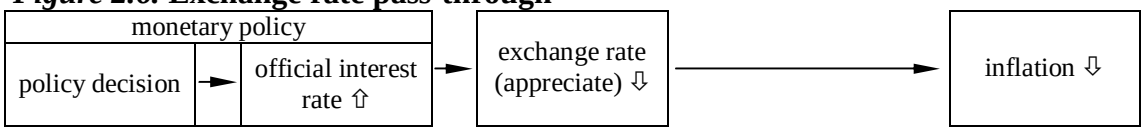


In case that either households or firms have a sizeable proportion of their net wealth (assets or liabilities) denominated in foreign exchange, than the appreciation of exchange rate can change the domestic value of this wealth, inducing the effects explained later by wealth and balance sheet channels (see *Figure 2.5*). The effect on inflation depends on the sign of the net wealth (in case the assets outweighs liabilities denominated in foreign exchange, then the appreciation means wealth loss, decreasing the aggregate demand, and the inflation). I shall cover this channel as one possible result of higher financial integration later in section 3.2.

An appreciation caused by an increase in the instrumental variable of the monetary policy could also cause directly a fall in the price level, by reducing the prices of imported goods and services. This affect also depends on openness (*Berben et al.* [2004]), but also on the pricing strategies of the importers, and the extent to which they price-to-market or passively accept exchange rate induced price changes *Campa and Goldberg* [2005]. This mechanism is depicted in Figure 2.6. The exchange rate pass-through is also relevant for the small, open Hungarian economy, where the pass-through

into consumer prices is between 6 and 90% depending on the methodology used (see the results and summary in *Herczeg* [2011]).

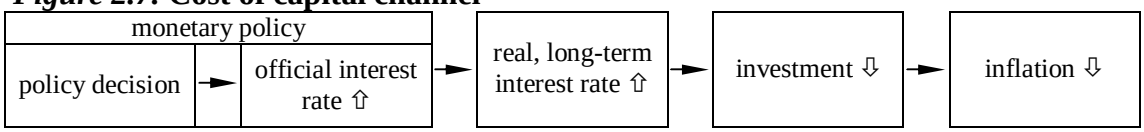
Figure 2.6. **Exchange rate pass-through**



Interest rate channel

As shown in the previous subsection the change in the official interest rate can influence the market interest rates either in capital markets or in banks.

Figure 2.7. **Cost of capital channel**



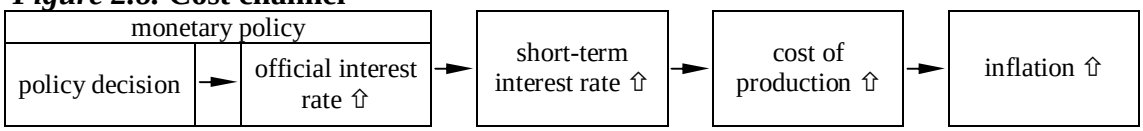
This is a channel that is built in all basic macroeconomic models since Keynes. As can be seen in the *Figure 2.7* above, the role of real, long-term interest rates is emphasized in this channel. How can the official interest rate, which is a short-term nominal interest rate, influence the yield curve? The key is sticky prices, so that contractionary monetary policy which increases the short-term nominal interest rate also increases the short-term ex-post real interest rate (as prices don't react immediately to the interest rate), and this would still be true in a world with rational expectations (see *Taylor* [1995]). The expectations hypothesis of the term structure, states that the long-term interest rate is an average of expected future short-term interest rates, suggest that the higher real short-term interest rate leads to an increase in the long-term interest rate.[24] However this is not always so simple, given that monetary policy can influence inflation expectation.

[24] If the long range interest rates were more important for the transmission mechanism, why would the central bank use a short-range interest rate as an operational target. The main problem with targeting rates longer than overnight can be shown in a very simple example, used by *Bindseil* [2004]. Assume that the monetary policy is targeting a 90-day rate, and assume also that the central bank is predictable in its changes of interest rate targets and it achieves its target with high degree of precision. Concretely, assume that on day *T* the central bank is expected to reduce its 90-day target rate from 5 per cent to 4 per cent. According to the expectation hypothesis the 90-day interest rate can be described in a simplified linear form as the average of the overnight rates of the next 90 days, so $i_{90,t}=\sum_{i=0}^{89} i_{1,t+i}/90$, where $i_{90,t}$ is the 90-day and respectively $i_{1,t}$ is the overnight rate on day t. In this case the difference in the 90-day rate between *T-1* and *T* translates into the difference of the overnight rate on date *T-1* and *T+89*, given that $90\left(i_{90,T-1}-i_{90,T}\right)=\sum_{i=0}^{89} i_{1,T-1+i}-\sum_{i=0}^{89} i_{1,T+i}=i_{1,T-1}-i_{1,T+89}$. From this follows that assuming $i_{1,T+89}=4\%$, $i_{1,T-1}=94\%$. This temporary increase of the overnight rate is an anomaly, since the intent of the central bank was to decrease the overall interest rate level.

Let's assume that monetary policy already gained credibility fighting inflation, in this case the expected inflation should decrease after a contractionary monetary policy move, which should also lead to proportionally higher increase in the long term interest rates. On the other hand agents could also think, that the central bank knows something about a future inflation shock and is increasing the short term interest rate in advance, so depending on what agents believe about the chance, that the monetary policy can fight this inflation shock, will the inflation expectation and the long-term interest rate increase or decrease (see *Romer and Romer* [1996]). Change in the long-term, real interest rate can influence the user cost of capital and investment of firms, as built into the 'IS' curve. *Mishkin* [1995] expands this channel with housing investment and consumer durables (see later).

The strength of this channel might be expected to depend on the financial structure and the conditions faced by firms. For instance, effects may be larger in economies where firms are more indebted (*Berben et al.* [2004]). Finally, industrial structure may matter as some industries may be more affected by changes in interest rates due to either their capital requirements or the nature of the goods they produce (e.g. durables, non-durables, intermediate or investment goods).

Figure 2.8. **Cost channel**

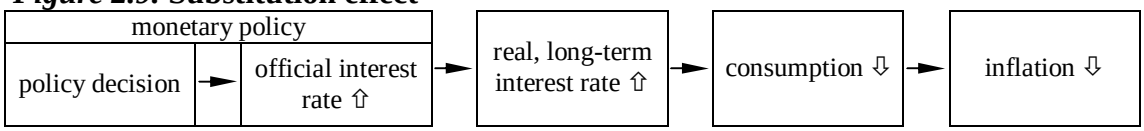


Barth and Ramey [2000] points out that the rising interest rates not only affect the long term investment decisions but also the short term operational environment of the firms. As long as working capital is essential for production, a monetary policy contraction can increase the cost of production, forcing the firms to raise their prices (*Figure 2.8*). This cost shock affects the supply side, and moves the aggregate supply.

Barth and Ramey [2000] find that this channel was more important before 1979. After that the deregulated financial system, flexible exchange rates (appreciation makes the imported materials cheaper, counterbalancing the cost push from the interest increase) reduce the importance of the cost channel. *Tillman* [2009] explains this change with the cyclical properties of financial frictions. *Barth and Ramey* [2000] also show using industrial data, that for many industries the monetary policy contractions mean an increase in their costs, prices, nominal and real wages (*Kim and Lastrapes* [2007]), even after taking the usual preventive steps against 'price puzzles' (see later in subsection

2.2.1). *Chowdhury et al.* [2006] shows that the effect of interest rate on the cost of working capital is important factor in Canada, France, Italy, the United Kingdom and the USA. They also find that the cost channel is stronger in economies where the competition in the financial sector is intensive (full interest rate pass through, and banks don't shelter the firms from interest rate increases).

Figure 2.9. **Substitution effect**



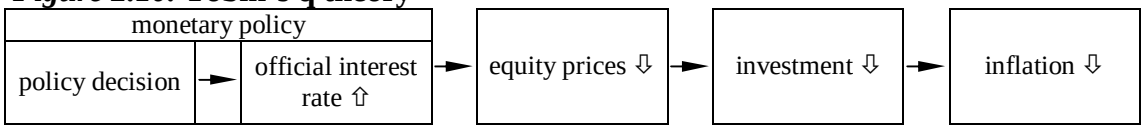
The substitution effect on *Figure 2.9* describes the reaction of consumption on a change in the long-term interest rate. After a rise in the real interest rate, it becomes more rewarding to delay consumption and increase saving, as the future value of these savings increase after the monetary tightening. As present consumption decreases, so does the aggregate demand, decelerating the inflation.

Hall [1988] estimates low elasticity between the consumption and the expected real returns (unlikely above 0.1 and may as well be zero) for the USA. *Berben et al.* [2004] assume that this effect would depend on the proportion of GDP accounted by consumers' expenditure and the sensitivity of consumption to changes in interest rates. The latter may be linked to the financial strategies adopted by consumers (e.g. whether they feel the need to maintain precautionary balances) and the financial conditions they face (e.g. whether they face credit constraints). For the latter reasons it is often assumed that self-employed persons should be more affected by substitution effect, as they are usually more exposed to changes in the interest rate.

Wealth channels

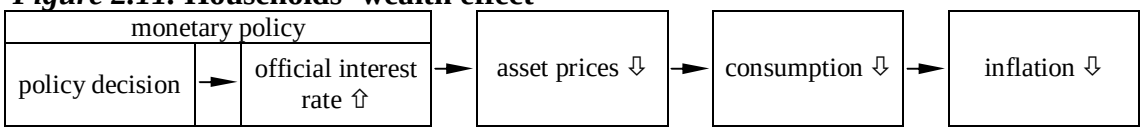
In case of the wealth channels interest rate is considered as a discount factor which can alter the value of financial assets, stocks and bonds. This change in wealth can influence the behaviour of both households and firms.

Figure 2.10. **Tobin's q theory**



As a first step the monetary policy must be able to influence the equity prices (which by the definition above is a part of the broad interest rate pass-through). This effect could be explained by portfolio choice model, as monetary policy increases the official interest rate, the return of short-term bond also rises, causing a re-arrangement in the portfolios for the favour of this bonds, away from the equities. Tobin's q theory (shown in *Figure 2.10*) provides a mechanism how this revaluation of equities can affect the investment activity of the firms (see *Tobin* [1969]). Tobin defines q as the market value of firms divided by the replacement cost of capital. If q is high, the market price of firms is high relative to the replacement cost of capital, and new plant and equipment is cheap relative to the market value of business firms. Companies can then issue equity and get a high price for it relative to the cost of the plant and equipment that they are buying. Thus investment spending will rise because firms can buy a lot of new investment goods with only a small issue of equity. On the other hand, when q is low, firms will not purchase new investment goods because the market value of firms is low relative to the cost of capital. If companies want to acquire capital when q is low, they can buy another firm cheaper and acquire old capital instead, resulting in low investment spending.[25]

Figure 2.11. **Households' wealth effect**



This channel was strongly advocated by Franco Modigliani (see *Modigliani* [1971]), as it is based on the life cycle model developed by *Brumberg and Modigliani* [1954] and *Ando and Modigliani* [1963]. According to the theory, consumption spending is determined by the lifetime resources of consumers, which include both human capital, real capital and financial wealth. In this theory a major component of financial wealth is common stock. When stock prices fall, the value of financial wealth decreases, thus decreasing the lifetime resources of consumers, and consumption should also fall.

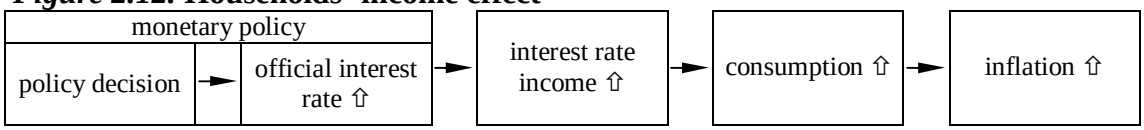
The results of *IMF* [2000], that stock prices are leading indicators of output growth, are in line with the operation of this channel. *Lettau et al.* [2002], on the other hand find that the proportion of monetary transmission which acts through the wealth channel is neglectable in the USA. *Lettau and Ludvigson* [2004] later showed that the variation of

[25] This approach is very popular in micro-based modelling, because of the formal links between q-theory and the user-cost approach in the dynamic adjustment cost approach presented by *Hayashi* [1982]. See *Boivin et al.* [2010] for more details.

the household's asset wealth is dominated by transitory movements (88 percent of the postwar variation in households net worth is generated by transitory innovations, primarily associated with fluctuations in the stock market component of the wealth – transitory here doesn't mean daily or even monthly fluctuations, but 'bull market' up to several years), which again have no effect on the consumption level, as only permanent changes in the wealth has wealth effect. The other estimations, like *Modigliani* [1971], tend to overestimate the wealth effect as, they concentrate on the trend effects, and most changes in the wealth are not trend movements.

As shown above the households' stock holdings are tightly connected to this channel, so the proportion of quoted stocks in the financial wealth should give a good approximation to the strength of this effect. The other component of wealth that can be influenced by monetary policy is the property wealth, but as it is part of several distinctive transmission mechanisms, I return to it at the end of this section.

Figure 2.12. **Households' income effect**



A rise in the interest rate increases the interest income of the net lenders, and traditionally households are seen as the net savers in the economy. The increase in the income should lead to a rise in the consumption, strengthening the inflation pressure in the economy (shown in *Figure 2.12*) only if some households are subject to a liquidity constraint or if their permanent income is affected.

Mojon [2000] collects ways the household's balance sheet structure can influence interest income. There are three major determinants of the income effects of a change in monetary policy: the size and composition of the financial balance sheet, the reference maturity for deposit and credit contracts and the financial asset price responses to monetary policy shock.

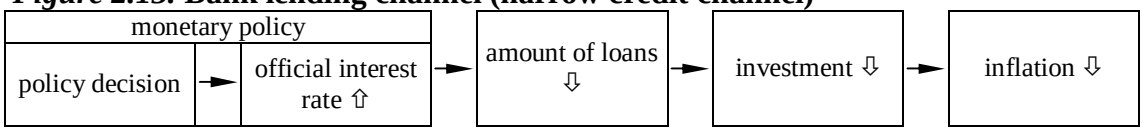
Non-neoclassical channels

Credit channels

The credit channels are complementary to the previous channels inasmuch the effect of a shock created by the monetary policy also amplifies the problems caused by

asymmetric information in the financial system, which makes the real effects of the monetary shock last longer.

Figure 2.13. **Bank lending channel (narrow credit channel)**



The bank lending channel of monetary policy is based upon the view that banks play a special role in the financial system, because they are especially well suited to solve asymmetric information problems in credit markets. Because of this special role, as *Gertler and Gilchrist* [1993] point out, certain classes of borrowers may be forced to rely primarily on bank credit (small firms and households) as a source of funding. In case the monetary policy is able to influence the amount of credit and there is no perfect substitutability of retail bank credits with other sources of funds, these small borrowers should be stronger affected, decreasing their investment more than lesser constrained firms of the economy. This is a credit supply side effect, as the banks can't grant loans because of tighter monetary policy.

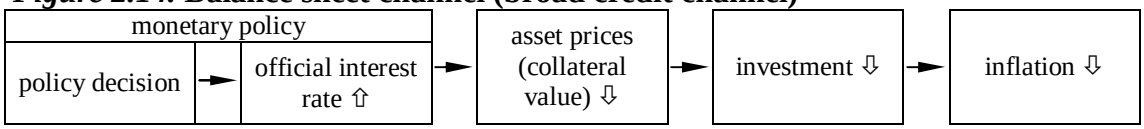
Gertler and Gilchrist [1993] find empirically that after an increase in the interest rate the amount of credit provided for households and small firms declines substantially. This makes small firms unable to smooth the impact of declining sales, even though they typically suffer a proportionately larger drop in sales.[26] An important branch of the empirical literature tries to answer the question which banks are primarily forced to decline their lending after a contractionary monetary shock. *Kashyap and Stein* [1995] finds that the reaction of small bank is different. *Kashyap and Stein* [2000], takes this reasoning one step further, and find that the lending channel of monetary policy is stronger in banks, that have less liquid balance-sheets (lower securities to assets ratio). These banks also happen to be the smaller banks as well. *Baum et al.* [2004] show that in case one controls for the uncertainty in the financial system, the bank lending channel found in the USA by *Kashyap and Stein* [2000] disappears. [27]

Horváth et al. [2006b] found that the changes in the supply of loans in Hungary are heterogeneous and depend on the bank-characteristics *Kashyap and Stein* [2000] found (size, liquidity and capitalization). At the same time they also prove that the loan

[26] The procyclical movement of the credits, was also used by *Bernanke and Blinder* [1988], who show in a simple IS-LM like model, that if the money demand shocks are greater or/and more prolonged than the credit demand or credit supply shocks, than the credit stock is a better forecaster of the real output.
[27] See *Bernanke and Gertler* [1995] for classic review or *Bernanke* [2007] for a new literature.

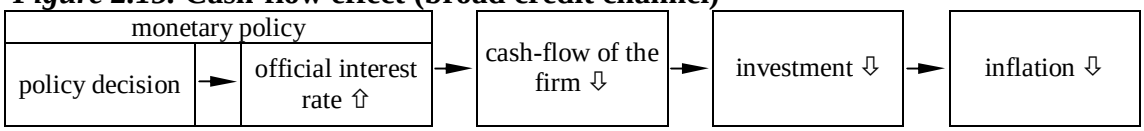
demand is homogeneous across the banks with different characteristics. They also found that the cost of funding for smaller, less capitalized bank increases disproportionately after an increase in the policy rate. According these findings, they cannot rule out the existence of the bank lending channel in Hungary.

Figure 2.14. **Balance sheet channel (broad credit channel)**



First traces of balance sheet channel can be found in *Bernanke and Gertler* [1989], who built agency cost in their small neoclassic growth model resulting an endogenous business cycle dependent on the borrower's balance sheet position. As the net position is pro-cyclical, this addition cost amplifies the business cycle movements (financial accelerator). The balance sheet position was connected with the credit channel of monetary policy by *Gertler and Gilchrist* [1993], who find that the small borrowers, forced by capital market imperfections to rely on bank credit, could also be hit by the second round effects of the monetary policy, as their creditworthiness depends on their balance sheet quality, which is needed as a collateral for the lending (*Stiglitz and Weiss* [1981]). But as the balance sheet position is a function of the macro environment, influenced by monetary policy, the creditworthiness depends on the stance of monetary policy. This channel operates without affecting the amount of credit provided by banks, as it affects demand side of the credit market. Tighter monetary policy means, as shown in *Figure 2.13*, a lower quality balance sheet and graver future prospect of growth affecting the ability of the small firms to borrow, and through this their ability to invest.

Figure 2.15. **Cash-flow effect (broad credit channel)**



A second mechanism going through the balance sheet position of the firms could be the so called cash-flow effect (*Figure 2.15*). This works on similar logic as the income effect in case of the household, but there is one essential difference. Increased interest rates can decline the cash-flow of the firm, but here the amount of investment is only indirectly affected by this change, as first the creditworthiness of the firm declines, leading to the inability of borrowing and in the end to the decline of investment.

The changes in the stance of monetary policy can both affect the collateral value and the cash flow (income channel) of the given firm. Both ways the increase in the official interest rate increases the adverse selection and the moral hazard problems, affecting the possibility of receiving lending from outside source. A distinctive feature, in which this channel differs from the traditional cost of capital channel, is that here the nominal interest rate is important.

Mishkin [1996] also mentions a third balance sheet channel (besides collateral and cash flow), which operates through monetary policy effecting the general price level. Because dept payments are contractually fixed in nominal terms, an unanticipated rise in the price level lowers the value of firms' liabilities in real terms (decreases the burden of the debt), but should not lower the real value of the firms' assets. Monetary expansion that leads to an unanticipated rise in the price level therefore raises real net worth, which lowers adverse selection and moral hazard problems, thereby leading to rise in investment spending and aggregate output. This mechanism fit right into the reasoning before, as the monetary policy has a second round effect because of the financial frictions, which prolong the real effect of the monetary policy.

As it is not easy to separate empirically the bank lending channel from the balance sheet channel, *Ashcraft and Campello* [2007] investigate the lending behaviour inside bank conglomerates. Inside these conglomerates the bank lending channel doesn't exist, as all the banks belonging to a group have the funds from the conglomerates' internal capital markets available. So if the response to a monetary shock differs across subsidiaries located in different regions, then the within conglomerate shift in the lending activity must be influenced by the creditworthiness of the firms to which banks lend. They find that the negative response of loan growth to monetary contractions is much stronger for subsidiary banks operating in states with recessions than for subsidiaries of the same conglomerate that operate in state with booms. Put differently their evidence implies that borrowers' strength drives the allocation of loanable funds. Balance sheet channel accounts for only 14% of the aggregate response of bank lending to a policy innovation after four quarters, but it explains about one-third of the aggregate response after eight quarter.

Transmission through property prices

The channel through property prices is not a separate channel, but the property wealth of the households can play a role in several channels of monetary transmission (*Mishkin* [2007b]). *McCarthy and Peach* [2002] find that the changes in the housing finance

system changed the monetary transmission through residential investment. First of all it changed the channel through which the monetary policy affects the housing activity. Before the liberalisation of the market the monetary policy could influence the amount of credit, but since the mid-80 the primary channels are through prices, user and transaction cost. The connections between the later channels are more complex, which could explain why the reaction of the investment is much slower, although the magnitude of reaction is still the same.

The first channel could be the user cost of capital, through which the real interest rate can influence the investment decisions, and the demand for residential capital. Higher interest rate would decrease the demand generally resutling lower prices, as the elasticity of the supply is usually very low.[28] Higher short term interest rates on the other hand can lead to lower supply, through the cost channel (*McCarthy and Peach* [2002]).

Another channel could be the wealth channel, as property gives a fairly large proportion of the wealth of households. *Carroll et al.* [2006] estimate the wealth effect of housing on the consumption for the US, and find that immediate effect is much smaller than the medium-run effect. In particular, they find that the immediate (next quarter) marginal propensity to consume for 1$ change in the housing wealth is about 2 cents, with final long-run effect of 9 cents. They also find that the housing wealth effect is considerably larger than the stock wealth effect. This later statement is opposed by *Mishkin* [2007b]'s argument, who explains that the stock market wealth effect should have a larger effect on the consumption as it more clearly connected with the future increases of production potential, and so might be believed more permanent.

Greiber and Setzer [2007] describe a third channel, which is part of the credit channel and considers the collateral value of the property. Increase in the house prices in this sense makes the owner to borrow and consume more (see the model in *Iacoviello* [2005]). *Aoki et al.* [2004] also finds that housing has its role in the credit channel serving as collateral and this role amplifies and propagates the effect of a monetary policy shocks on house prices, consumption and housing investment.

In the Hungarian case *Kiss and Vadas* [2006] found that a lasting 1 percent increase in the households' mortgage interest rate can cause 3 percent decline in the property prices. They also found that changes in the property prices have little effect on the consumption of the households through the interest rate channels (income and wealth

[28] *Mishkin* [2007b] explains this lack of elasticity with the scarcity of land, further strengthened by land-use regulations in most municipalities.

effect), but the housing equity withdrawal is significant. The two channels together results a 0.9-1.9 per cent decline in the consumption in the first year (1.5-3.1 per cent decline in the second year) as a response to the aforementioned lasting 1 percent increase in the mortgage interest rates.

2.1.4. Summary

This section was dedicated to show the different phases of the monetary transmission mechanism, from the policy decision, through the reaction of financial environment, households and non-financial corporations, till its effect to the inflation. The channels introduced in this section will be the subject of examination in the following chapters. The next section introduces the methodology used in the later part of the dissertation.

2.2. Method to measures MTM

"…identification in macroeconomics is a dirty business."
Faust and Leeper [1994] p. 24.

There are several methods how different researchers and central banks tried to describe or measure the transmission of the monetary policy. As it could be the subject of a whole dissertation to describe all of them (differences, advantages, disadvantages), so here I just concentrate on the methodology applied in this dissertation namely vector autoregressive models.

An empirical work to measure the impact of the various channels of monetary policy immediately comes up against a number of challenges. The first challenge is that of simultaneity. Typically, the central bank responses endogenously to economic conditions, which is why it is difficult to identify the effect of policy. The second challenge in assessing the strength of any particular channel of monetary transmission comes from the concurrent operation of multiple channels as shown in the previous section (*Kuttner and Mosser* [2002]).

2.2.1. Vector autoregression

A substantial portion of the literature researching the transmission of monetary policy has adopted a vector autoregression (VAR) framework. The first paper to estimate the impact of monetary policy on the real economy using VAR was written by *Sims* [1972]. The method became more and more popular, despite debates about its usefulness (see later). For a summary of the empirical findings for the USA see *Leeper et al.* [1996], for

detailed a summary of methodology see *Christiano et al.* [1998] or *Hamilton* [1994] for references on the econometrics. In the following short introduction I follow *Walsh* [2003a], the appendix at the end of chapter (Appendix 2A) presents the method to calculate the confidence intervals around the impulse response functions, used in the later part of the dissertation.

Assume a bivariate system in which y_t is the natural log of real output at time t and m_t is the measure of the monetary policy stance, let's say the short term interest rate[29]. In this case the simple VAR system can be written as:

$$\begin{bmatrix} y_t \\ m_t \end{bmatrix} = A(L)\begin{bmatrix} y_{t-1} \\ m_{t-1} \end{bmatrix} + \begin{bmatrix} u_{y,t} \\ u_{m,t} \end{bmatrix} \tag{2.4}$$

where $A(L)$ is a $2x2$ matrix polynomial in the lag operator L and $u_{i,t}$ is a time t serially independent innovation to the i^{th} variable. These innovations can be described as linear combinations of independently distributed shocks to the output $(e_{y,t})$ and to the policy $(e_{m,t})$:

$$\begin{bmatrix} u_{y,t} \\ u_{m,t} \end{bmatrix} = \begin{bmatrix} e_{y,t} + b_{12}e_{m,t} \\ b_{21}e_{y,t} + e_{m,t} \end{bmatrix} = \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}\begin{bmatrix} e_{y.t} \\ e_{m,t} \end{bmatrix} = B\begin{bmatrix} e_{y,t} \\ e_{m,t} \end{bmatrix}. \tag{2.5}$$

The one-period ahead error made in forecasting the policy variable m_t is equal to $u_{m,t}$ and according to (2.5), $u_{m,t} = b_{21}e_{y,t} + e_{m,t}$, so these errors are caused by the exogenous output and policy disturbances ($e_{y,t}$ and $e_{m,t}$). Letting Σ_u denote the $2x2$ variance covariance matrix of the $u_{i,t}$'s, $\Sigma_u = B\Sigma_e B'$ where Σ_e is the (diagonal) variance matrix of the $e_{i,t}$'s.

The random variable $e_{m,t}$ represents an exogenous shock to policy variable (like change in the preferences, see explanations in *Christiano et al.* [1998]). The effect of e_m on the movements of output and other macro variables can be identified as the effect of monetary policy on these variables. But how to identify it, after all as long as $b_{21} \neq 0$, the innovation to the observed policy variable m_t will depend both on the shock to

[29] Traditionally some measure of monetary aggregate could also serve this purpose (see later), but as already shown in the previous sections, most monetary authorities use short term interest rates as an instrumental variable.

policy $e_{m,t}$ and as well on the non-policy shock $e_{y,t}$. The estimation of $u_{m,t}$ does not provide a measure of the policy shock unless $b_{21} = 0$.

To make the example even more explicit, suppose the VAR system is

$$\begin{bmatrix} y_t \\ m_t \end{bmatrix} = \begin{bmatrix} a_1 & a_2 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} y_{t-1} \\ m_{t-1} \end{bmatrix} + \begin{bmatrix} u_{y,t} \\ u_{m,t} \end{bmatrix}, \tag{2.6}$$

where $0 < a_1 < 1$. Then $m_t = u_{m,t}$, and $m_{t-1} = u_{m,t-1}$, so $y_t = a_1 y_{t-1} + u_{y,t} + a_2 u_{m,t-1}$ and y_t can be written in moving average form as

$$y_t = \sum_{i=0}^{\infty} a_1^i u_{y,t-i} + \sum_{i=0}^{\infty} a_1^i a_2 u_{m,t-i-1} \,. \tag{2.7}$$

Estimating (2.4) in this case yields an estimations of $A(L)$ and Σ_u, from which one can calculate the effects of $u_{m,t}$ on $\{y_t, y_{t+1}, ...\}$ using (2.7). If u_m is interpreted as an exogenous policy disturbance, then the response of $y_t, y_{t+1}, ...$ to a one period policy shock would be

$$0,\ a_2,\ a_1 a_2,\ a_1^2 a_2,\ ...$$

To estimate the impact of the a policy shock on output, however, one needs to calculate the effect of a realization of the policy shock $e_{m,t}$ on $\{y_t, y_{t+1}, ...\}$. In terms of the true underlying structural disturbances e_y and e_m, (2.5) implies that

$$\begin{aligned} y_t &= \sum_{i=0}^{\infty} a_1^i \left(e_{y,t-i} + b_{12} e_{m,t-i} \right) + \sum_{i=0}^{\infty} a_1^i a_2 \left(b_{21} e_{y,t-i-1} + e_{m,t-i-1} \right) \\ &= e_{y,t} + \sum_{i=0}^{\infty} a_1^i \left(a_1 + a_2 b_{21} \right) e_{y,t-i-1} + b_{12} e_{m,t} + \sum_{i=0}^{\infty} a_1^i \left(a_1 b_{12} + a_2 \right) e_{m,t-i-1} \end{aligned}, \tag{2.8}$$

so that the impulse response function giving the true response of y to the exogenous policy shock e_m is

$$b_{12},\ a_1 b_{12} + a_2,\ a_1 \left(a_1 b_{12} + a_2 \right),\ a_1^2 \left(a_1 b_{12} + a_2 \right),\ ...$$

This response involves the elements of $A(L)$ and the elements of B. But while $A(L)$ and Σ_u can be estimated from (2.4), B and Σ_e are not identified without further restrictions.[30]

[30] In this example, the three elements of Σ_u, the two variances and the covariance term, are functions of the four unknown parameters: b_{12}, b_{21}, and the variance of e_m and e_y.

Identification[31]

"the difficulty of distinguishing central bank actions from their origins and consequences"
Friedman [1995] p. 14.

In a majority of cases two basic approaches are followed to solve this identification problem. The first possibility is to impose additional restrictions on the matrix B linking the observable VAR residuals to the underlying structural disturbances (see (2.5)). This approach has been used by *Sims* [1972], *Bernanke and Blinder* [1992], and *Bernanke* [1986] among many others. If policy shocks affect output with a lag, for example, the restriction that $b_{12} = 0$ would allow the other parameters of the model to be identified. All together one needs at least $n(n-1)/2$ restrictions (where n is the number of equation in the system) for the VAR to be identified.

The next question is what kind of restriction should be used. The most popular identification approach is to restrict some elements of matrix B to be zero. This strategy has the advantage that a structure of contemporaneous impacts can be translated to delayed reaction. As a special case, the so-called recursive identification involves an ordering of the variables. *Sims* [1972] used this approach, where the nominal money supply (M1) was used as the measure of monetary policy, and policy shock were identified by assuming that $b_{21} = 0$. This means that the approach is based on the assumption that the money supply is predetermined and that the disturbances in money supply are policy innovations and the non-policy innovations don't affect it contemporaneously, perhaps because of information lags in formulating policy. In this case, $u_{m,t} = e_{m,t}$, so from the fact that $u_{yt} = b_{12}e_{m,t} + e_{y,t} = b_{12}u_{m,t} + e_{y,t}$ means that b_{12} can be estimated from the regression of the VAR residuals $u_{y,t}$ on the VAR residuals $u_{m,t}$.[32] Alternatively one could assume that $b_{12} = 0$, in which case the policy shock has no contemporaneous impact on output.[33] This type of restriction is imposed for example by *Bernanke and Blinder* [1992]. How reasonable such an assumption might be clearly depends on the unit of observation. In annual data, the assumption of no

[31] For a detailed discussion of the identification problems, see *Zha* [1997].
[32] This leads to the same solution as a Choleski decomposition of the VAR residuals with policy variable ordered first.
[33] This leads to the same solution as a Choleski decomposition of the VAR residuals with output variable ordered before the policy variable.

contemporaneous effect would be implausible; with monthly data, it might be much more plausible.

Another special case of restricting the matrix B is the so called sign restriction. As described in *Vonnák* [2006] the risk of imposing too disputable restrictions can be reduced by being less ambitious and letting parameters (response to certain periods, cross correlations, etc.) lie in interval instead of requiring them to take a certain value. This approach can be considered as a robustness check of identification restriction trying to answer the implicit question: how stable are the results if one perturbs the parameters of the parameter set? This was the original idea behind *Faust* [1998]'s approach. Some authors impose their restrictions on the impulse responses. *Faust* [1998] considers only the immediate effect, but *Uhlig* [2005] requires the restrictions to hold throughout a longer period of time.[34] He also does a robustness check with respect to the length of the period. See also *Vonnák* [2006] and later in Chapter 4 the results of *Kieler and Saarenheimo* [1998] for this approach.

The second approach often used, manages the identification by imposing restrictions on the long-run effects of the disturbances on observed variables. For example, the assumption of long run neutrality of money would imply that a monetary policy shock (in this case the monetary instrumental variable would be some kind of money aggregate) has no long-run permanent effect on output. In the example above, long run neutrality of the policy shock would imply that $b_{12} + \left(a_1 b_{12} + a_2\right)\sum a_1^i = 0$ or $b_{12} = -a_2$. Examples of this approach include *Blanchard and Quah* [1989], *Judd and Trehan* [1989], *Hutchison and Walsh* [1992], *Galí* [1992]. The use of long-run restriction is heavily criticized by *Faust and Leeper* [1994] perhaps their most important criticism is that in finite samples the long-run effect of shock is imprecisely estimated and so the impulse responses are biased.

The identification gets an even more complicated issue if one tries to build nominal exchange rate into the system, which is advisable for small open economies, examined in this dissertation. Let's continue with the example above, so y_t is still the natural log of real output, m_t is the short term interest rate and ex_t is the natural log of the nominal exchange rate. In this case the simple VAR system can be written as:

[34] *Uhlig* [2005] states that impulse response functions are often used to select the 'right' identification (identification is set to get the IRFs, which are in line with common knowledge in the literature), what he does is to follow this practice in a more verifiable way.

$$\begin{bmatrix} y_t \\ m_t \\ ex_t \end{bmatrix} = A(L) \begin{bmatrix} y_{t-1} \\ m_{t-1} \\ ex_{t-1} \end{bmatrix} + \begin{bmatrix} u_{y,t} \\ u_{m,t} \\ u_{ex,t} \end{bmatrix} \tag{2.9}$$

where $A(L)$ is now a $3x3$ matrix. There is also a new structural shocks to the exchange rate (e_{ext}), which could be seen as for example as a risk premium shock. It also can be built in the linear system which connects the structural shocks and the residuals:

$$\begin{bmatrix} u_{y,t} \\ u_{m,t} \\ u_{ex,t} \end{bmatrix} = \begin{bmatrix} b_{11}e_{y,t} + b_{12}e_{m,t} + b_{13}e_{ex,t} \\ b_{21}e_{y,t} + b_{22}e_{m,t} + b_{23}e_{ex,t} \\ b_{31}e_{y,t} + b_{32}e_{m,t} + b_{33}e_{ex,t} \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix} \begin{bmatrix} e_{y,t} \\ e_{m,t} \\ e_{ex,t} \end{bmatrix} = B \begin{bmatrix} e_{y,t} \\ e_{m,t} \\ e_{ex,t} \end{bmatrix}. \tag{2.10}$$

But how would matrix B look like? The identification used here is follows that of *Smets* [1997] and *Smets and Wouters* [1999][35]. In the main part of the matrix B recursive identification is used, but it is surely not appropriate between the shocks and residuals of the policy measure and exchange rates. To see what this means, consider the following short-run reduced model as in *Smets and Wouters* [1999]:

$$u_{m,t} = b_{22}e_{m,t} + b_{23}e_{ex,t}, \tag{2.11}$$

$$u_{ex,t} = b_{32}e_{m,t} + b_{33}e_{ex,t}. \tag{2.12}$$

Equation (2.11) can be considered as a short run reaction function of the monetary authorities. Interest rate is adjusted to changes in the monetary policy stance $e_{m,t}$ or to the movements of the exchange rate due changes in risk premium or foreign interest rate shocks $e_{ex,t}$. Equation (2.12) states that in the equilibrium the exchange rate depends on domestic policy innovations and exchange rate shocks.

The model in (2.11) and (2.12) is under-identified. The recursive scheme would imply that either $b_{23} = 0$ or $b_{32} = 0$. As the integrated capital markets and flexible exchange rates are one of the main characteristics of increased financial integration so to assume $b_{32} = 0$ (meaning that the exchange rate does not react contemporaneously to changes in the monetary stance) would be too restrictive, actually because of the interest rate parity the sign of b_{32} should be positive. The assumption of $b_{23} = 0$ would mean that the monetary policy doesn't react to the shocks of the exchange rate within period, which seems to be inappropriate for a small open economy.[36] This problem of simultaneity should be resolved.

[35] See also *Mojon and Peersman* [2001].
[36] *Kim and Roubini* [2000] use this identification and are heavily criticized by *Faust et al.* [2003].

As my main interest is the identification of $e_{m,t}$, I solve the equation (2.11) and (2.12) for the monetary policy shock:

$$e_{m,t} = \frac{b_{33}}{b_{33}b_{22} - b_{32}b_{23}} u_{m,t} - \frac{b_{23}}{b_{33}b_{22} - b_{32}b_{23}} u_{ex,t}, \tag{2.13}$$

and following *Smets* [1997] renormalize the monetary policy shock such that the sum of the weights on the domestic interest rate and exchange rate residuals gives one, so multiply both side with $\frac{b_{33}b_{22} - b_{32}b_{23}}{b_{33} - b_{23}}$ resulting:

$$e_{m,t} = \frac{b_{33}}{b_{33} - b_{23}} u_{m,t} - \frac{b_{23}}{b_{33} - b_{23}} u_{ex,t}. \tag{2.14}$$

Equation (2.14) can be rewritten as

$$e_{m,t} = (1-\omega) u_{m,t} + \omega u_{ex,t}, \tag{2.15}$$

where $\omega = -\frac{b_{23}}{b_{33} - b_{23}}$, (2.15) can be interpreted as a short-run monetary condition index (MCI) which is often used to measure the changes in the stance of monetary policy. In case of depreciation the monetary policy, which aims to stabilize the exchange rate, would raise the interest rate, so b_{23} should be positive. With $b_{33} > 0$ (because the exchange rate shock have a direct positive effect on the exchange rate), the weight ω should be smaller than zero.[37] The change in this weight could be used as a measure of the monetary policy regime, as it takes up the changes in the focus of the monetary policy. The weight ω can be calculated from the estimated equation (with the assumption that $e_{m,t} = 0$)

$$u_{m,t} = -\omega / (1-\omega) u_{ex,t}, \tag{2.16}$$

using two stages least squares method with various instrumental variables to tackle the endogeneity problems.

Equation (2.15) and the weight from equation (2.16) can be built in the identification through the following equation

$$\Sigma_u = B \Sigma_e B', \tag{2.17}$$

[37] As *Smets and Wouters* [1999] use the exchange rate definition foreign currency price of the domestic currency (the invert of the definition used here), d_{56} is negative in their paper, which together with $d_{66} > 0$ means that $\omega = -\frac{d_{56}}{d_{66} - d_{56}}$ is between zero and one.

It is assumed that the structural shocks are orthogonal to each other, so the matrix Σ_e is diagonal. This is the estimated relationship and the weight ω is built into matrix B^{-1} the following way[38,39]

$$B^{-1} = \begin{pmatrix} 1 & 0 & 0 \\ \beta_{21} & 1-\omega & \omega \\ \beta_{31} & \beta_{32} & 1 \end{pmatrix}. \qquad (2.18)$$

which means that an identified structural policy shock affects the short term interest rate and the exchange rate simultaneously, rising the interest rate and appreciating the exchange rate. In the following chapters I use this identification to obtain the empirical results.

Expected movement of impulse response functions and puzzles

According to the literature the output variable and also the price variable should decline after the well identified contractionary monetary policy shock. If the policy variable is the short term interest rate and some measure of money is also included into the model, then the quantity of money should also decline.

If in a VAR model the variables in the impulse response functions doesn't 'behave' according to the expectations (driven from the literature) then one speaks about puzzles and tries to explain what could have caused this 'misbehaviour'.

Frequently found puzzles are:

- liquidity puzzle: monetary policy shock identified by monetary aggregate shock causes a rise in the nominal interest rate instead of making it to decline
- price puzzle: monetary policy shock identified by interest rate shock causes a rise in the price level (temporary or even durable)
- exchange rate puzzle: a positive interest rate shock causes depreciation instead of appreciation

In the following paragraph I show the proposed solutions for the puzzles above. According to *Sims* [1992] monetary aggregate shock shouldn't be used as a monetary policy shock, because if the rise in the aggregate is caused by the demand side movement, then it can cause a rise in the interest rate as well, resulting a *liquidity*

[38] This is also a restriction on the matrix B, but not zero restriction showed before.

[39] *Faust et al.* [2003] also estimates the connection between exchange rate and interest rate on high frequency data and then builds the estimated reaction into the VAR model.

puzzle. So the cure is not to use monetary aggregate as instrumental variable in a VAR.[40]

Price puzzle got lot more attention in the literature: *Sims* [1992]'s explanation for this phenomenon is that the monetary policy uses a wider information set to identify future inflation pressure then the one built in the model. So as the monetary policy sees inflation pressure to build up, this might rise the interest rate in advance and so the increased interest rate and the higher prices happen in the same time. The solution could be to add more information variables (*Sims* [1992] suggest commodity prices as inflation expectation proxies) which may help to identify the connection between the monetary policy's interest rate moves and the future inflation. This solution is not perfect as already in *Sims* [1992] the 'puzzling' price responses do become smaller, but do not disappear in all cases, when the commodity price index or nominal exchange rate is included in the VAR. As already mentioned an alternative interpretation of the price puzzle is provided by *Barth and Ramey* [2000]. They argue that contractionary monetary policy operates on aggregate supply, through the cost channel. The negative supply effect raises prices and lowers output. In this interpretation, the puzzle is simply evidence of the cost channel rather than evidence that the VAR is misspecified.

Grilli and Roubini [1995] successfully apply the same explanation and treat for the *exchange rate channel* as in case of the price puzzle

Criticisms of the VAR approach, debate of usefulness

Measures of monetary policy based on the estimation of VARs have been criticized on several grounds.[41] First of all because in the presence of the puzzle described above, make the interpretation of the impulse response functions troublesome. As already stated, identification is always problematic and discretionary, leaving much space for argument.

The time series of the identified policy shocks in analysis using VAR methodology don't coincide with monetary policy shocks identified historically with other methods.[42]

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[40] *Chari et al.* [1995] built a general equilibrium model in which they find explanation for the facts that monetary base and broader money aggregates tend to co-vary positively with present and future short term interest rates. In their model a positive exogenous non-policy (technology) shock endogenously increases both the interest rate (reaction of the monetary policy) and the money aggregates (banks tend to increase their lending).

[41] These criticism are detailed in *Rudebusch* [1998] and *Cochrane* [1998].

[42] Another identification method is shown in *Romer and Romer* [1989], who use a so-called narrative approach to identify the monetary policy shock from the minutes of the FOMC meetings. They search for signs in the records that decision makers tried to take measures against inflation, and using this as a dummy variable they try to estimate the effects of the identified policy shocks. On the one hand this approach can be criticized because it is highly judgemental and on the other hand the monetary shocks

Especially *Rudebusch* [1998] reports low correlations between the residual policy shocks he obtains based on funds rate futures and those obtained from a VAR by *Bernanke and Mihov* [1998]. How much of a problem this is, depends on the question asked. *Sims* [1998] argues that if the objective of the research is to estimates the average reaction of output to a monetary policy shock, than this can be done with different methods resulting different residuals (and identified monetary policy shocks), but with the same result. On the other hand if the question is the effect of monetary policy in a special historical case, like in *Walsh* [1993], then VAR methodology might not be the best solution. Put in another way, the investigation of monetary policy shocks does not help much to characterise the monetary policy, but rather the response of variable to monetary policy, making it a perfect candidate for investigate the transmission mechanism (*Vonnák* [2006]).

Another problem according to *Rudebusch* [1998] is that the reaction function estimated inside the VAR model, describing the systematic policy steps, differs considerably from the policy rules resulting from other estimation methods. One explanation for this difference could be that in VARs usually revised data is used, while more direct attempts to estimate the monetary policy's reaction function often use the preliminary dataset available for the policy makers at the time of the decision (see e.g. *Orphanides* [2001]).

In the VAR the identified policy shock is a random deviation from the endogenous policy response.[43] So it can't say anything about effects of the systematic monetary policy, which again accounts for the most part of the variation in the monetary policy instrument. But on the other hand if the monetary policy shock is not orthogonal to the other disturbances (which means the residual of the reaction function) than the reaction of the economy displays simultaneously the effect of the shock and the reaction of the monetary policy to this shock, which does not help to answer questions about the effect of monetary policy on the economy.

Co-integration and non-stationarity problems

The models in the dissertation are estimated in (log) levels for a number of reasons (see *Clements et al.* [2001] and *Ramaswamy and Slok* [1998]). First doing analysis on levels one allows for implicit cointegration relationship. In light of this cointegration the

extracted aren't orthogonal on the other shocks hitting the economy, so the responses incorporate the reaction to exogenous monetary policy shocks, exogenous shocks affecting the other variables and the endogenous response of monetary policy to the exogenous shock (*Leeper* [1997]).

[43] In *Cochrane* [1998]'s interpretation this means that only unanticipated monetary policy steps matter.

system's dynamics can be estimated consistently, however not efficiently (*Sims et al.* [1990] and *Hamilton* [1994]). Second, estimating a model in first differences alone when cointegration do exists discards the information contained in the levels (loss of information) and leads to model misspecification. On the other hand imposing inappropriate cointegration relationships (by using an error-correction model) may bias impulse responses from reduced form VAR (*Ramaswamy and Slok* [1998]). The loss of efficiency resulting from estimating the VAR on levels seems more attractive. Furthermore, as noted by *Ramaswamy and Slok* [1998], there is an economic rationale for estimating the model based on the effect of interest rates on output in levels, rather than first differences. The impulse response of the first difference of output to an interest rate shock tends to have the implication that monetary shocks have a permanent impact on the level of the output. In contrast, in the case of the impulse response of the level of output to an interest rate shock, history determines whether the effects of monetary shocks are long lasting or not. This is the reason why much of the literature on this topic estimates the VAR in levels.[44]

2.2.2. Summary

The section above introduced the methodology used in the later chapter of the dissertation. Despite the clear drawbacks of vector autoregression methodology, it can be applied successfully to compare the monetary transmission in different periods and different countries.

Summary of the chapter

As already stated in the introduction, this chapter is dedicated to the description of the monetary transmission mechanism, the definition of different channels of transmission. I also presented the method to describe these mechanisms, and be able to compare them across different countries or across different time samples. The next two chapters build on these descriptions, definitions and methodological presentation to ask questions about the effect of international financial integration and currency union on the monetary transmission mechanism.

[44] For other examples of VAR estimated on levels see *Mojon and Peersman* [2001], *Peersman and Smets* [2001] among many others.

Appendix 2A

The method used calculating the error bands for VARs in the dissertation can be found in *Hamilton* [1994] on page 337. Let's say the VAR model can be represented in the following way:

$$z_t = c + \sum_{i=1}^{p} A_i z_{t-i} + u_t \,. \tag{2.19}$$

In the original example above, z_t' would be $[y_t \quad m_t]$, $c' = [0 \quad 0]$ and $p = 1$ (the number of lags). In the following paragraphs let n denote the number of (endogenous) variables in z_t. The $(1 \times (np+1))$ vector x_t is $x_t' \equiv [1 \quad z_{t-1}' \quad z_{t-2}' \quad \ldots \quad z_{t-p}']$ and the variance-covariance matrix of the explanatory variables is denoted $\hat{Q}_T = \frac{1}{T}\sum_{t=1}^{T} x_t x_t'$, where T is the sample size. Let $\hat{\pi}_T$ denote a $(n(np+1) \times 1)$ vector of coefficients resulting from OLS regression of each of the elements of z_t on x_t for the sample T:

$$\hat{\pi}_T = \begin{bmatrix} \hat{\pi}_{1.T} \\ \hat{\pi}_{2.T} \\ \vdots \\ \hat{\pi}_{n.T} \end{bmatrix},$$

where

$$\hat{\pi}_{i.T} = \left[\sum_{t=1}^{T} x_t x_t'\right]^{-1} \left[\sum_{t=1}^{T} x_t z_{i.t}\right].$$

$\hat{\Omega}_T = \frac{1}{T}\sum_{t=1}^{T} \hat{u}_t \hat{u}_t'$ is the estimated variance-covariance matrix of the residuals, $\hat{u}_t' = [\hat{u}_{1t} \quad \hat{u}_{2t} \quad \cdots \quad \hat{u}_{nt}]$ where $\hat{u}_{it} = z_{it} - x_t' \hat{\pi}_{i.T}$. Finally $\Psi(\ )$ is the impulse response function calculated from a vector of coefficients. Monte Carlo methods can be used to infer the distribution of impulse response function, $\Psi(\hat{\pi}_T)$. An $(n(np+1) \times 1)$ vector should be generated randomly by drawing from a $N\left(\hat{\pi}_T, (1/T)\left(\hat{\Omega} \otimes \hat{Q}^{-1}\right)\right)$ distribution, where $\otimes$ denotes the Kronecker product. [45] Let's denote this vector by $\pi^{(1)}$ and calculate the impulse-response vector for it. Next draw a second vector form the same distribution $\pi^{(2)}$ and calculate $\Psi\left(\pi^{(2)}\right)$. After repeating this exercise 10000 times, one should find the values $\underline{\Psi}_1$ and $\overline{\Psi}_1$ so that 9500 first elements of the resulting 10000

[45] *Hamilton* [1994] proofs in proposition 11.1 (p. 299) that the coefficients distribution is $N\left(\hat{\pi}_T, (1/T)\left(\hat{\Omega} \otimes \hat{Q}^{-1}\right)\right)$.

impulse responses are between these values. In this case $\left(\underline{\Psi}_1, \overline{\Psi}_1\right)$ can be used as a 95% confidence interval for the first element of $\Psi(\hat{\pi}_T)$. After repeating this procedure for the other elements of $\Psi(\hat{\pi}_T)$, one can get the 95% confidence interval for the whole $\Psi(\hat{\pi}_T)$, $\left(\underline{\Psi}, \overline{\Psi}\right)$.

Chapter 3. Monetary Transmission and Increased Financial Integration – A Change in the Environment

"*Monetary policy has certainly not been immune* [to financial globalization]"
Bollard [2007] p. 1.

Introduction

The aim of the chapter is to investigate how the monetary transmission mechanism has been altered by the increased financial integration. Financial integration is driven by a new technological environment (the spread of the internet, decreased communication costs) and led to globally integrated financial and capital markets.

The worldwide integration of financial markets changes economic relations, so one can assume that the transmission mechanism has been altered as well, which means that monetary policy makers should reconsider which changes in the instrumental variable(s) are necessary to reach the goal of price stability, and how these changes would alter other variables in the economy. There is no reason why the monetary transmission mechanism should remain immune to the effects of financial globalization, so the actual question might be to what extent and in what direction the transition mechanism has changed, and not whether or not changes have actually occurred. The chapter focuses on the changes occurred until 2008, so it doesn't treat the affects of the recent financial crises.

The remainder of the chapter is built up as follows: first I survey the literature to be able to set up hypotheses about the direction of the change (3.1). Then I test this hypothesis in a case study, section (3.2) concentrates on a special appearance of the financial integration, and tries to measure the change of transmission due to the accumulation of foreign exchange rate debt by Hungarian households. Summary closes the chapter.

3.1. A change in the environment – literature survey[46]

One could define the global financial and capital markets as "*one where economic agents face a single set of rules, have equal access and are treated equally.*"

[46] A previous version of this subsection was published in Hungarian, see *Herczeg* [2008]

(*Gudmundsson* [2008] p. 9.) Because of frictions the law of one price can not be observed, but nevertheless the tendency towards integrated market is observed around the globe.

According to *Genberg* [2008] the integration is driven by changes in legislation (mainly liberalization, interest rate deregulation), technology, theoretical development, monetary strategy (mostly exchange rate regime variation). In the next paragraphs I focus mainly on the effect of technological change.

First one should look how the new communication technology alters the way the financial intermediation can carry out its function. The problem of asymmetric information lies in the centre of *Mishkin and Strahan* [1999]'s reasoning, as financial intermediation mainly developed to solve these problems. The asymmetric information problems that are valid in this case, are:

- *adverse selection* – only those are ready to accept high interest rates, who feel that they probably don't have to pay the loan back – collaterals are usually used to address this problem;
- *moral hazard* – after the granting of a loan, the debtor has an incentive to take uncontrolled risks because the excess gains are his, but the excess risk lies at the lender. Monitoring could solve the problem of moral hazard, but it is a public good, because if one bank monitors a debtor the other banks can have a free ride and so they can save the costs of monitoring. The question emerges who should bear the cost of this public good?

If the new technology offers new solutions to these problems, then the change in the technological surrounding affects the efficiency of financial intermediation as well. What new solutions does the technology offer:

- new methods are developed to tackle the problem of adverse selection and moral hazard (for example scoring systems) and as a consequence the volume of credit increased in all sectors (households, small and middle enterprises) all over the developed world;
- standardized loans are more transparent, making it easier and cheaper to securitize these loans;
- derivatives and securitization make it possible to spread risk;
- changes in the payment system, like internet banks or even the wide spread of ATMs.

All these changes alter the role of financial institutions – instead of offering simple deposit schemes they can offer well diversified portfolios to their customers. This

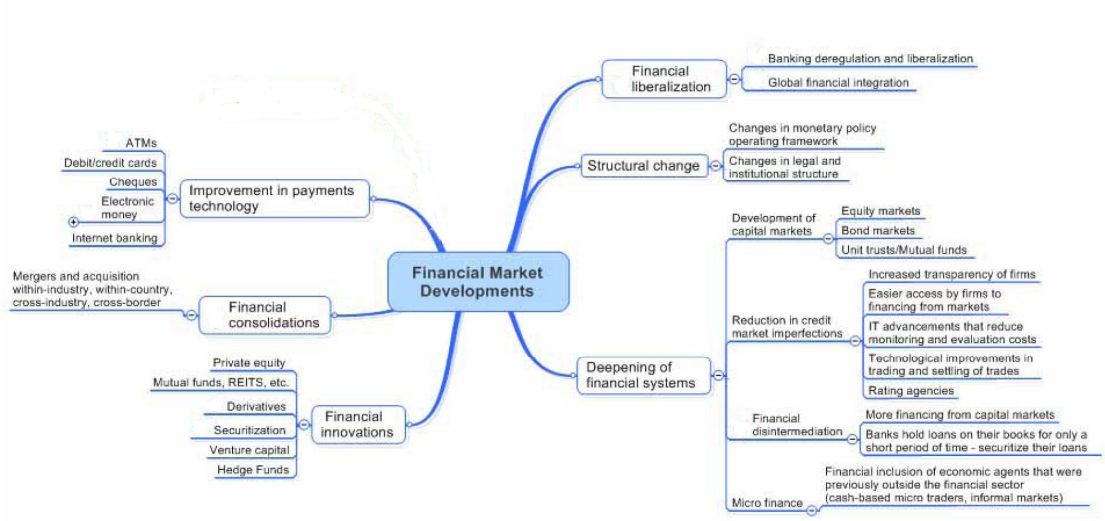
process also has its effect on the consolidation of the banking sector, as the methodology behind scoring models and infrastructure behind electronic services increases the fix costs and so increases the efficient bank size. And as the new methods for managing the asymmetric information problems devalue local knowledge, they also make it possible for local branches of large banks to provide loans for small local companies. The concentration of banking industry affects the lobbying strength of the banking sector as well, making the legislation more aware of their needs and problems. The consolidations also changes the competition, especially the geographical size of the market on which the financial institutions compete with each other (for example even a small bank from the outskirts of a town can present competition for larger banks in the centre with some well placed ATMs) – meaning that for example the legislative background and the competition supervision have to keep up this changes.

Genberg [2008] states that there is no sense for the traditional distinction between bank-based and capital market-based financial systems anymore (see for e.g. *Zysmann* [1983]), it is more worth talking about distinction between relation based intermediation (sharing private information with borrower in a long-lasting relationship) and arm's length intermediation (based on public information). In this respect the main changes are the decrease of the role of relation based activities, integration of earlier separated markets and increase opportunity for companies to raise funds. According to *Roldos* [2006] this decrease makes the firms more sensitive to interest rate changes because the participants of the capital markets don't shield their clients from interest rate changes, as banks would do in a relation based intermediation.

See the main developments in *Figure 3.1*

Bordo et al. [1999] reach the conclusion that the integration today is unprecedented in the history, the integration is deeper and spread to more regions of the world than ever before. *Obstfeld and Taylor* [2002] reach a similar conclusion by investigating indices of financial integrations. They show that according the four chosen indexes (quantity of capital, co-movement of real interest rates, bond and equity yields, uncovered interest parity) the integration of financial markets shows a U shape between 1870 and 2002.

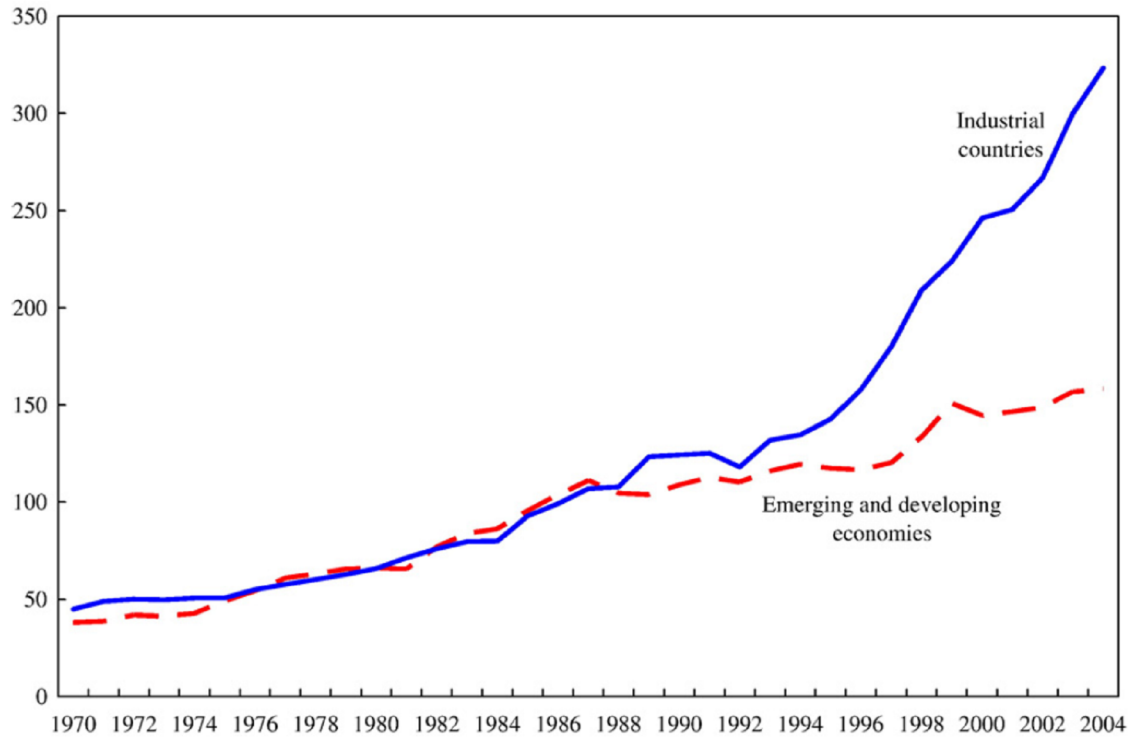
Figure 3.1. **Overview of financial development**



Source: Sukudhew et al. [2008] p. 51.

The shape of the process was mainly influenced by the barriers and not by the structure of the economy (for example the technical development should have generated a constantly increasing integration). *Ehrmann and Fratzscher* [2006] measure integration of financial markets with the speed and the strength of the transmission in the first 30 minutes after a shock caused by announcements after the meetings of the Federal Open Market Committee, to 50 equity markets around the world. They found that the transmission of shock is more affected by the openness of the financial markets and the composition of the equity indexes than by the declared (de jure) exchange rate regimes. *Feldstein and Horioka* [1980] show that the capital markets are segmented, because 80% of the savings were invested in the country they originated from, causing a strong connection between savings and investments. *Feldstein* [2005] shows that the segmentation has decreased, but the home bias is still characteristic for big industrial countries, in contrast with small open economies which grew more integrated in the capital markets since 1980. These findings are in line with the conclusion that can be drawn from the database of nations' external wealth introduced by *Lane and Milesi-Ferretti* [2007], and is demonstrated in *Figure 3.2*

Figure 3.2. **International financial integration, 1970-2004**



Source: Lane and Milesi-Ferretti [2007] p. 235.
Note: Ratio of sum of foreign assets and liabilities to GDP, 1970-2004.

Greater integration caused crises and tensions inside and between trade partners before 1914. *Bordo et al.* [1999] find, that the tensions seem to be smaller today than before the first world war, despite the fact, that economic integration reaches the pre-1914 level. *Bordo et al.* [1999] explains this decreased of tension with the fact, that the advantages of the advanced integration reach more people then the disadvantages. The reasons for this can be grouped in two big categories. On the one hand the better flow of information and developed institutions (accounting standards for example) make it possible to deal with asymmetric information problems and making financial distress rarer. On the other hand the better quality of institutions (social network) and the risk sharing, made possible by financial innovations[47], provide a better defence against downturns. An interesting difference between today's integration and that before 1914 is that today the main driving force is diversification finance, with the result the US being the biggest debtor and the biggest creditor at the same time, in contrast with the integration before 1914, when development finance was more significant with principal

[47] Recent events question the ability of financial innovations to spread risk. As *Adrian and Shin* [2010] observe, despite the fact that securitization was intended to disperse risk to those who were thought to absorb it better, in the end the securitization served to increase the fragility of the financial system, allowing banks and other intermediaries to leverage up, buying each other's securities.

creditors (*Obstfeld and Taylor* [2002]). It is beyond the scope of this work to tackle how the current crises will affect the level of integration (financial or even trade).

In the past two decades, beyond financial integration, there was another phenomenon which can have a link with monetary policy and monetary transmission, i.e. the decrease of output volatility, the so called Great Moderation.

According to *Stock and Watson* [2003] the G7 countries variance of the output between 1984 and 2003 was only 50-80% of their output variance between 1960-1983, which is remarkable, even if the authors admit that the variance might be reduced with the various countries having different sub sample breakpoints and the changes in the trend filtered out.[48] The real puzzle is what caused this reduction?

On the one hand better conducted monetary policy could be responsible for a more stable inflation and through it for a stable output. But this explanation can not hold, because better monetary policy in itself can not have such big affect. *Stock and Watson* [2003] simulated the processes from 1960-83 with aggressive anti-inflationary monetary policy rules, estimated for the period 1984-2003, and despite the fact that the volatility got reduced, the reduction was not large enough to explain the observed output variance decrease. On the other hand the change in the structure of the economy could explain the changes, the new technology might make production more flexible (smaller stocks, flexible part time employment), financial integration makes more funds available for the households, making it easier for them to smooth their consumption (this explanation is also supported by *Cecchetti* [2002]). In contrast *Kose et al.* [2006] found that the volatility of consumption rose relative to output[49], and that there is "*no systematic empirical relationship between financial openness and output volatility*" (*Kose et al.* [2006] p. 17.) Another explanation could be a change in the sectoral composition of the economy, the volatile sectors' (production of durable goods) weights decreasing versus an increase of the more stable sectors' (services) weights in the economy. But *Stock and Watson* [2003] dismiss these explanations, because the decrease of output variance emerged sharply, opposed by the changes in sectoral composition which is a longer

[48] *Schmidt-Hebbel and Walsh* [2009] find that the decline of the output growth volatility can be only partially explained by the decline in the potential output growth volatility, so the output gap shows only modest decline in volatility. Their explanation of this phenomenon is that there might have been an increase in the volatility of the level of potential output over the period, in accordance with the hypothesis that the greater inflation stability should come at the cost of some increase in output gap volatility.

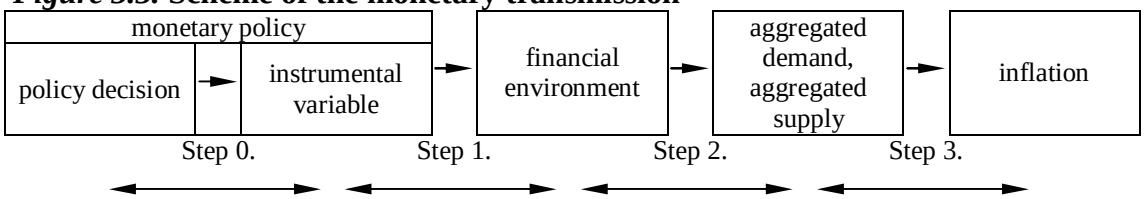
[49] See their comprehensive review about the connection between growth and integration, with the conclusion that "*if financial integration has a positive effect on growth, it is apparently not robust, once the usual determinants of growth are controlled*" (*Kose et al.* [2006] p. 13.), and seek empirical evidence for 'collateral benefits', institutional changes as a consequence of an open economy. I touch this theme later in connection with the changes in the incentives to inflate.

process, endure since 40's and the technology should spread gradually as well, making the decrease of the variance a longer process to take effect. These authors drew the conclusion that the changes might only be temporary, caused by the smaller outside shocks.[50] One of which, according to *Rogoff* [2006], could be the general decline in the size of military conflicts and casualties in recent decades (particularly in the developed world), giving a background for stability and growth.

Again it is still unclear, whether the Great Moderation will survive the current recession or not. It depends, if 'good luck' had stood behind the phenomenon, then it has never been meant to be everlasting, eventually one runs out of luck. If on the other hand it had been caused by 'good policy', then might still have a chance to survive the recent turbulences.

In the next subsections I focus on the effects the new environment could have had on the connections of the transmission mechanism shown in detail in Chapter 2. Recalling the scheme of transmission mechanism:

Figure 3.3. **Scheme of the monetary transmission**



In other words, I focus on the 'arrows' between instrument variable and the market prices of financial assets (interest rates, exchange rates, bond and equity yields), between asset prices and aggregated demand, and between the domestic aggregated demand and the inflation.

3.1.1. Effect of increased integration on the connection between monetary policy instruments and other asset prices

"Given that monetary policy works through its influence on prices in the financial system, some of these changes could have important implications for the way monetary policy changes are transmitted through the financial system. These changes could have

[50] *Boivin and Giannoni* [2002b] found using counterfactual VAR experiments that 60% of the output variability reduction is explained by the change in outside shocks, but the reduced variability of the inflation is rather (60%) explained by the change in the economy, included the change in monetary policy.

important implications for effectiveness of monetary policy" (*Sukudhew et al.* [2008] p. 49.)

The first arrow in *Figure 3.3* is the so called interest rate pass-through, the degree to which the instrumental variable can influence the market prices and yields of financial assets.

Freedman [2000] and *Friedman* [1999] pose the question, how is the monetary policy able to influence huge capital markets and through them interest rates with relative small and insignificant open market operations (relative to the size of the market). Their answer to this question is that the monetary policy can influence the markets because it has a monopoly in creating reserves. But what is monopoly worth, if there is no demand for the given product? There are several conditions which create demand for the reserves created by central banks.

The first condition that ensures demand for reserves is the need of households for money to carry out their transactions. This condition can be distorted by any money substitutes.[51] These substitutes have only served as a medium of exchange till now, but later on they can also became a unit of account, which could make the forecast of money demand. This problem is valid even if the money demand doesn't vanish altogether[52], which is probable, because the government won't let money vanish (and its seigniorage income) and will use its legislative power to prescribe some transactions to be carried out with them, like taxation or transfers.[53] A second condition for demand of central bank's reserves could be if financial institutions could only issue liabilities covered with central banks' reserves reserve requirements. But there is an ever greater volume of liabilities issued by non-bank creditors (like insurance companies and pension funds who aren't obligated to create reserves) and no reserves need to be created in case of securitized debt creation. Third condition could be if official reserves were needed by financial institutions to operate the clearing system. But there are examples of clearing systems to operate without a central bank in the centre. Fourth, low substitution among national currencies could assure demand for reserves, but the substitution increased as well, making it much easier to take loans in foreign exchange (see for example carry trades).

[51] *Freedman* [2000] places access devices (like ATM's), stored-value cards, prepaid software product and network money into the group of money substitutes (e-money).
[52] *Haydar and Seyfettin* [2006] envision a cashless world, which is energetically attacked by *Friedman* [2000].
[53] *Blinder* [2000] adds the problem, that central banks without seigniorage income would need to be financed externally, which means that their independence would decrease (together with their credibility).

Looking at the model of *Bindseil* [2004] presented in Chapter 2, the changes presented above mean that the variance of the density function of the autonomous factors increased. As stated in Chapter 2, this shouldn't affect the monetary policy's ability to influence the short term interest rate, which means that the central bank isn't gone (to use *Friedman's* [2000] term) be 'decoupled' from the economy. In accordance with this *Gudmundsson* [2008] finds that the integration of the financial markets (provided the essential institutional condition are at hand) should develop and deepen the intermediation and through this alone make it easier for the central bank to influence the short term market interest rate. Similar result is found by *Sukudhew et al.* [2008], who shows empirically that interest rate pass-through is stronger in financially developed countries (marked with greater competitiveness, breadth and depth of bond and equity markets), not only on bank interest rates, but long term market interest rates as well. As always stronger pass-through means faster speed of adjustment and higher immediate and long term pass-through.

Gudmundsson [2008] also finds that in case of small open economies the long term interest rate is more determined by global expectation and factors, than before. Even in the US, the connection between the short term domestic interest rate, influenced by the monetary policy and the long term interest rate got looser, as shown in *Bernanke* [2007a]. Between June 2004 and July 2006, the ten-year Treasury bond yield increased by less than 40 basis points, despite the fact that, during the same time, the US central bank raised the Federal funds rate target by 425 basis point. The phenomenon was called 'conundrum' by former Federal Reserve Chairman Alan Greenspan, but there are several explanations for it. *Boivin and Giannoni* [2008a] presents evidence that common (global) factors capture an increasing fraction of the fluctuation of US long-term interest rates. *Bernanke* explains the conundrum (*Bernanke* [2005b], [2007a]) with a the stronger demand for US liabilities, but he also mentions two other possible explanations for the correlations between long term interest rates around the world. First it is possible that monetary authorities all react in the same manner to the same global shocks. Second there are signs that the US short-term interest rate asymmetrically leads the other interest rates. In the latter case there would still be connection between short and long-term interest rates, even if it got looser, which allows *Gudmundsson* [2008] to say that *"even if the interest rate channel might be getting weaker, it cannot be proclaimed dead."* (p. 23.)

Weber [2007] claims that exchange rate channel is more than able to compensate for the decline in the ability to influence long-term rates.[54]. But according to *Gudmundsson* [2008] "*the basic problem is that the exchange rate has dual nature. On the one hand it is a macroeconomic adjustment tool and probably the most important relative price of small and medium sized open economies, and on the other hand it is an asset price with all the potential problems that can be associated with that. This means that the exchange rate can potentially be both a tool for stabilisation and a source of shocks. What aspect dominates in this regard is ultimately an empirical question and will in specific cases depend on structural features of individual countries and might be affected by constellation of monetary, fiscal and prudential policies."* (p. 23.). Or as *Rogoff* [2006] states exchange rates are naturally born 'schizophrenics' that are both relative good prices and asset prices. Their movements are generally more influenced by the second characteristic, which makes them less informative, and harder to influence in case of well-developed and deep financial markets.

Looking on other asset prices *Wagner and Berger* [2003] show that increased financial integration results in more volatile asset prices. With more possible investments and noisier information about fundamentals it is getting much more expensive and difficult to get an overview over markets. Following investors thought to have the information needed for the decisions is rational behaviour in such an environment. This leads to herding, more volatile asset prices and bubbles.[55] As already mentioned in Chapter 2 the stability of the financial system, as it is the main carrier of monetary policy impulses, is very important for the monetary policy. "*Monetary stability can be maintained only if the financial system is sufficiently stable to transmit monetary policy signals."* (*Weber* [2007] p. 4.) The question emerges should the monetary policy try to burst the asset price bubbles or at least try to decrease the volatility of the markets? Doing this would be favourable because if the bubble burst from itself, then it would have consequences on real variables, further strengthened by the before mentioned credit and wealth channels. The burst of a bubble is often followed by financial distress making the

[54] Even in the Mundell-Fleming model (*Mundell* [1963], *Fleming* [1962]) the monetary policy can more effectively reach its goal given a flexible exchange rate regime, if capital mobility is high.

[55] *Diebold – Yilmaz* [2008] found that volatile fundamentals cause volatile stock markets. So according to their results, lower volatility in real output (great moderation), should also mean that the volatility in asset prices, especially exchange rates became smaller. But the volatility in asset prices didn't decline. *Rogoff* [2006] cites several possible explanations for this phenomenon: first long run risk affecting the asset prices doesn't necessarily diminish in proportion to reduction in short-run volatility. Second it can take time for the investors to learn what recent considerably lower output volatility means for asset prices. Third as level of risk declined, the riskier assets are proportionally more sensitive to changes in the interest rates or the perceived level of risk.

monetary policy signal transmitted noisier, and the financial integration also heightened the risk of contagion. But the task of stabilising the market also raises a significant problem because to be able to recognize a bubble, the monetary policy should identify the fundamental price of assets. According to *Bernanke and Gertler* [1999] this delicate job could be avoided by monetary policy by reacting only to increases of asset prices in as much as they hold information about inflation and endanger price stability. So the price and financial stability can and should be handled inside the (explicit or implicit) inflation targeting framework.

To sum up, the variance of the autonomous parts of the central banks' balance sheet increased because of financial integration, but these changes shouldn't affect a monetary policy's ability to influence the short-term interest rate. Additional to this the interest rate pass-through is even getting stronger because of the increased competition the integrated markets offer. At the same time even in the USA the connection between the long-term and short-term interest rate is getting more determined by global factors. This latter consequence weakens the link between central banks' instrumental (short-term) interest rate and the market interest rates (long term interest rates and other yields). Other asset prices like exchange rates and equity prices tend to become even more volatile as a result of the financial integration. As result the effect of a monetary shock on the long term interest rates and other asset prices becomes less predictable.

3.1.2. Effect on the connection between asset prices and aggregated demand

Through interest rate channel monetary policy can influence opportunity cost/cost of capital and thus investments and consumption (substitution effect). Interest rate channel should be strengthened by the liberalization and especially by the interest rate deregulation. As relation based intermediation loses importance, the banks move from quantity to price determination, making clients react more on price movements. Disintermediation could as well strengthen the reaction of aggregated demand, if the non-financial agents hold more interest-sensitive assets in their balance sheets (*Sukudhew et al.* [2008]).

On the one hand according to *Mylonas et al.* [2000] and *Sukudhew et al.* [2008] the increased financial wealth (due to the increased integration) makes the aggregate demand more sensitive to the monetary policy shocks through the wealth channels of the monetary policy. Volatile asset prices (see previous subsection) together with the stronger effect mentioned before this makes the reaction of aggregate demand more

unpredictable (see *Wagner* [2002]). On the other hand if the volatile changes in wealth were not perceived by the households as permanent changes, then the aggregate demand wouldn't react to the changes in the asset prices at all.

The consolidation of the financial system increased the size of the average bank and financial innovations made it possible to lend without having assets in the books, so the importance of common bank lending channel decreased, during the period before the crises. At the same time the development and integration of the capital markets makes alternative funding for companies available. In addition the technical developments made, to an extent, asymmetric information problems easier to solve, which according to *Mishkin and Strahan* [1999] explanation makes the collateral less important and the balance sheet channel weaker. As both of its components weakened the significance of the credit channel and financial acceleration should decline.[56]

Exchange rate is one of the economies' most important relative prices and tools of adjustment which connects an economy with the other countries. A deeper global integration of different economies and markets should make this tool more important, and thus also the importance of the exchange rate channel might be expected to increase. Despite this effect the change in the exchange rate channel is not clear, because the integration made it also possible for the companies and households to hold liabilities denominated in foreign exchange, which makes the wealth and income effect of the monetary policy weaker or in extreme cases even reversed.[57]

One can summarize the changes caused by the globalization, grouped according to different channels of monetary transmission. In *Table 3.1* the channels are grouped whether changes caused by financial integration made the transmission of the monetary policy stronger or weaker.

[56] It is harder to detect it empirically as well (see for example the summary of *Bernanke* [2007b])

[57] This means that a drop of interest rate, which depreciate the exchange rate, revalue the debt denominated in the foreign exchange, increasing the repayments and decreasing the disposable income, reducing the consumption or investment. An example for such behaviour is shown in case of Hungary in section 3.2 in this Chapter.

Table 3.1. **Expected effect of the changes of different channels on the monetary transmission process' strength**

Changes of different channels make the MTM's	
stronger	weaker
- interest rate channel (*Sukudhew et al. [2008]*) - exchange rate channel (without foreign currency debt) - wealth channels (*Mylonas et al.* [2000])	- bank lending channel (*Bernanke* [2007b])

3.1.3. The effect of increased financial integration on the connection between domestic demand and domestic inflation

A change in the inflation dynamics, so in the way inflation reacts to changes in the environment, can be very important addition to the changes monetary policy must be aware of. *Mishkin* [2007a] describes the following stylized facts:

- the persistence of low inflation increased in the USA, which means that short term shocks have smaller effect on the trend of the inflation. On the other hand *Levin and Piger* [2004] find that after controlling for the drop in the mean of inflation, there is no change in the persistence of inflation in other industrial countries;[58]
- the slope of Phillips curve declined, which means that it got harder to accelerate the inflation but this also means that it also got harder to slow inflation down;[59]
- the effect of various variables on the inflation declined (for example in regressions the coefficient of the oil price declined).

What could have caused the changes in the persistence of inflation? There are several explanations. *Mishkin* [2007a] and *Weber* [2007] among others explain the above changes in the inflation dynamics with improved quality of monetary policy. But *Rogoff* [2003a, 2003b] makes the point that the inflation also decreased in countries where the characteristics of better quality monetary policy (namely independence, conservative central bankers, better techniques) aren't observable.[60]

Another theory explains the changes with a shift in the pricing behaviour of the companies. For example in *Davig* [2007] the low inflation makes the companies too

[58] Countries in the sample were: Australia, Canada, France, Germany, Italy, Japan, the Netherlands, New Zealand.

[59] There is empirical evidence for the Phillips curve getting flatter, for example *Williams* [2006b] or *Kohn* [2006], who finds that the employment gap has a smaller effect on inflation.

[60] *"One can't help but draw an analogy between a stock market boom – when everyone is an investment genius – and a global disinflation—when every central banker is an inflation-slayer." Rogoff* [2003a] p. 54.

comfortable and so they decrease their frequency of price increases, this would make the lower inflation endogenous.

Other explanations can be brought in connection with different components of the increased economic integration. *Razin and Binyamini* [2007] tried to answer this question, relying on small model, augmented with all major factors the integration of markets characterized with:

- increased international trade volume causes specialization in production and diversification (internationalization) in the consumer basket;
- as a consequence of migration, the correlation between domestic wages and incomes decreases as there are foreign substitutes for domestic labour which makes the labour supply more wage elastic;
- increased financial integration makes it possible for households to smooth their consumption with the result, that the labour supply gets less volatile.

All this together has the consequence of weakening the link between domestic inflation and domestic output fluctuation – the welfare of households looses connection with the domestic output as an economy opens up. And with each step of integration (1, only the commodity market is integrated, 2, commodity and capital markets are integrated, and 3, all markets are integrated (commodity, capital and labour)) the short-term Phillips curve gets flatter and the same output gap generates smaller inflation.

Together with the changes in inflation dynamics, the level of inflation also decreased in the industrial world. *Levin and Piger* [2004] found in case of seven industrial country that there is a significant drop in the mean inflation, somewhere in the late 1980's, and the early 1990's.

Rogoff [2003a, 2003b] explains the decrease in inflation persistence with external factors, like increased competition on integrated markets, which makes it harder for monopolies to emerge. Another possibility is that positive trade of terms shock, like the integration of China in the world trade system, with high amount of cheap labour, could influence the relative prices and through them the inflation as well. *Rogoff* [2006] thinks that although such favourable outcomes can be utilized by opportunistic central banks, these effects can only be temporary.

In *Yellen* [2006] the falling import prices can increase the real wage and through the reduced wage demand increase the inflation dynamics itself. This presents another channel through which reduced import prices can influence the inflation in a given country. *IMF* [2006] contradicts this explanation by showing that the income effect of

the increased real wage would also increase the demand and price of other products, resulting in changes of relative prices only, and not the price level altogether.

Both *Kohn* [2006] and *Ihrig et al.* [2007] show evidence, that the decreasing import prices affected the inflation dynamics, even if in some cases the flexible exchange rate absorbed much of its effect (*Kohn* [2006]). *IMF* [2006] estimates that in years of global spare capacity increase (1997-98, 2001-02) the decline in the import prices had a sizeable affect on inflation in one- to two-year periods. During this time the actual inflation can even be 1 percentage point lower than a case without a decline in import prices. *Boivin and Giannoni* [2008a] found evidence in their FAVAR model that common (global) factors capture an increasing fraction of the fluctuation of import and export price series (but not other measures of inflation).

Weber [2007] contradicts the reasoning that increased competition could be the reason for altered inflation dynamics, because the integration of commodity markets began earlier than the era of low inflation (according to *Levin and Piger* [2004] in most industrial countries the latter happened in the late 1980's, and the early 1990's). He even goes further by suggesting that the rapid industrialization of newly integrated countries (like India and China) can lead to a rising demand of resources and energy, which ends up in price increases and inflation shocks. So the increased integration can as well pose as a threat for price stability (also found in *Bernanke* [2007a]).

Rogoff [2003a, 2003b]'s other point is that the competition (especially in the capital markets) intensifies the pressure on actors of economic policy to meet the requirements of 'good' economic policy and environment. An important factor of this environment is the low, stable inflation.[61,62] Given that the increased competition makes the product and commodity prices more flexible and short term Phillips curve flatter, there is less short-term trade-off between inflation and growth. At the same time as sticky prices are needed for the monetary policy to be able to affect the country's output and unemployment, the ability of monetary policy to sacrifice price stability for short-term employment gains is hampered too. The fact that there is less incentive to inflate can even improve monetary policies credibility. Other parts of this 'good' policy environment (low taxes, low deficit) limit the ability of fiscal policy to fulfil other

[61] *Wagner and Berger* [2003] make the same conclusion: competition between companies results in a single price level drop and competition between governments puts continuous pressure on the inflation.

[62] According *Wagner* [2002] the low and stable inflation is part of the infrastructure that can attract mobile capital in the locational competition. *Cukierman* [2007] shows that integrated capital markets and their demand for stable macro surrounding are in the background of increased independence of central banks, which can be seen as a commitment for stable inflation.

demands in the global competition for mobile capital: anti-cycles steps and investments into infrastructure.[63] This can load a lot of pressure on the monetary policy, as there could be increasing claims for its seigniorage income, resulting in higher inflation. The problem with the reasoning above is, as shown in *Bernanke* [2007a], that *Rogoff* [2003b]'s explanation of lower possibility to inflate because of more flexible prices, can be interpreted, as a steeper Phillips curve as well, which is contradicted by the empirical evidence shown below.

Spiegel [2008] tests the hypothesis if the financial openness really has any disciplinary effect. To measure integration he uses the measure introduced by *Kose et al.* [2006] and because of its endogeneity, the exogenous instrument of financial remoteness (defined as the distance from the nearest financial centre London, New York, Tokyo). *Speigel* finds that it is hard to isolate the effect of financial globalization empirically, because the negative effect of the financial openness on the average inflation isn't robust across specification.

Another paper with similar result is from *Borio and Filardo* [2007], who made a distinction between the conventional domestic and the new global approach in the determining of inflation. In the domestic approach the inflation only depends on the domestic output gap and unemployment. The processes of the world economy are only transmitted through import prices and exchange rate and the commodity and labour markets are segmented. This means, that domestic and foreign products or domestic and foreign labour can't be substituted with each other. In case of global approach the opposite assumptions are made: know-how and capital move freely across borders, the domestic and foreign commodities are perfect substitutes for each other. Additionally global output gap is a major factor in determining the domestic inflation and the relative prices and wages are given for most countries. In the global approach shocks of the global economy aren't solely transmitted through exchange rates and import prices, but through the export markets and foreign demand as well. The estimations were carried out on a dataset of 16 developed countries, and the results show that the inflation is less sensible for the domestic output gap, while the foreign output gap gained significance These results are robust for additional independent variables that are usually used to capture global shocks (e.g. oil prices etc.). *Chmielewski and Kot* [2006] estimated analogous equations like *Borio and Filardo* [2007] for the Polish economy, and they found that if the product categories with broad international trade (clothes, shoes, telecommunication devices – altogether 6% of the core consumer basket) are dropped

[63] Among others *Cecchetti* [2002] makes a similar conclusion about fiscal policy.

from the consumer basket used to calculate the core inflation, then the domestic output gap has a significant effect on the remaining 66% of the basket (gas and food are missing because of core inflation approach). So according to this result there is a part of the domestic inflation which is affected weaker by domestic demand and supply conditions. *IMF* [2006] also manages to connect the declining effect of domestic spare capacity on inflation with the degree of openness.

The robustness of *Borio and Filardo* [2007]'s results are highly criticized. For example according to *Kohn* [2006] the increasing effect of foreign output gap on inflation depends highly on the definition of the foreign output gap, and so the result of *Borio and Filardo* [2007] is not robust. *Ihrig et al.* [2007] criticizes the autocorrelation among the error terms, which according to *Ihrig et al.* [2007] comes from *Borio and Filardo's* chosen definition of domestic inflation: the difference of headlight and core inflation. Using a more 'common' specification *Ihrig et al.* [2007] finds no significant effect of foreign output gap on the domestic inflation. Neither do they find any connection between the decreasing coefficients of domestic output gap and higher international integration in case of the 11 OECD countries in their sample.

To sum up, there is strong evidence that in the studied economies the inflation process has changed and the Phillips curve has become flatter. There are several competing theories, and some of them explain these changes with increased economic integration, but there is a debate about proportion of this change which can be explained by integrated financial and product markets. But the flatter short-term Phillips curve alone (caused by integration or not) has consequences for monetary policy, shown in *Bundesbank* [2007] and *Mishkin* [2007a], as inflation rates react less intense to the shocks of demand (or policy errors), but at the same time this also means that policy makers cannot influence the price dynamics easily through demand channels, which increases the importance of credibility and anchoring of expectations even more for conducting a successful monetary policy (*Bundesbank* [2007], *Yellen* [2006], *Kohn* [2006]).

3.1.4. Tackling uncertainty

So what changes were caused by increased financial and economic integration? In the subsections above I showed that the reaction of the long run interest rate and other asset prices to a monetary shock became more unpredictable, as did the reaction of aggregate demand on the changes of asset prices. The flatter short term Phillips curve damps some

of these unpredictable movements, but even so the uncertainty of monetary transmission has increased. [64]

At the other hand decision makers think that the effect of increased financial integration is altogether gradual and limited[65] (*IMF* [2006], *Kohn* [2006], *Yellen* [2006], *Bernanke* [2007a]). According to *Bernanke* [2007a], monetary authority, especially the FED is still capable to influence the financial condition to pursue its goal. As consequence all the changes in the environment added is a dimension of complexity, making the work of policy makers harder, as they have to take these added factors into account. Similarly *Rogoff* [2006] adds that increased integration only influences the forecasting techniques (maybe a recalibration of models is due), but not the main focus and responsibility of the monetary policy, which remains that of reaching and maintaining price stability. And in the long run the inflation is always determined by monetary factors, and so by monetary policy.

The uncertainty can be grouped in accordance with their source (the discussion follows the one found in *Bean* [2005]):

- *data and measurement uncertainty* – because most macro data comes with lag the decision makers often have to rely on their professional judgement and if it weren't enough there are certain key variables, which can only be estimated without a mature definition or methodology (the most prominent examples are the potential output and the natural rate of unemployment, which are needed for every output gap calculation[66]). *Orphanides* [2001] explain the loose monetary policy of the 1970-s by the fact that the decision makers mistakenly overestimated the potential output with the data at hand at time of the decision, and tried to reach this higher potential output with monetary expansion, which resulted in high inflation;
- *shock uncertainty* – the decision makers cannot be sure if a given shock is only temporary or permanent (because only permanent shock should be addressed by the monetary policy);
- *model uncertainty* – monetary policy isn't able to track the changes in the structure of the economy and an increase in this uncertainty is addressed in this section.

[64] See also *Bundesbank* [2007] for similar reasoning and conclusion..

[65] *Boivin and Giannoni* [2008a] also found no strong significant evidence of a change in the transmission of monetary policy due to global forces, main changes are in the persistence of the reactions, and not in their initial responses.

[66] *Walsh* [2003b] proposes the solution to build the first difference of output growth into the rules instead the difference in levels. On the other hand *Schmidt-Hebbel and Walsh* [2009] finds that due to the time variation of the estimated growth rate of the potential output, the problem of estimating the level of potential output cannot be eliminated by simply focusing on growth rates.

The uncertainty caused by increased financial integration has every one of the elements above. *"Under normal circumstances, monetary policy is a challenging endeavour. Policymakers are faced with making reliable forecasts in the presence of both difficulties in gauging the current state of the economy and uncertainty about the nature and persistence of economic shocks. This complexity becomes magnified when the economic structure is thought to be undergoing significant changes. In those situations, traditional relationships among economic variables may break down and the information content of economic indicators may be altered, reducing policymakers' confidence in their ability to understand the economy and produce reliable forecast." Sellon* [2003] p. 1.

Increased complexity and unpredictability should be addressed by the monetary policy authority. *Williams* [2006a], *Orphanides and Williams* [2002, 2007] among others experiment with the estimation of robust policy rules that are optimal with regard of all the above mentioned uncertainties. Their results are asymmetric in the way that the underestimation of the uncertainty creates more losses (measured in output and inflation volatility), than the overestimation of it. Their results are in accordance with previous proposals to decrease uncertainty, as also *Brainard* famous article from 1967 can be interpreted in this way[67], that because of the additive uncertainty the certainty equivalent method can not be used and so the decision making bodies should try to reach their goal with smaller, more cautious and gradual steps. *Blinder* [2006] explains this cautiousness and gradualism with human factors, the decision makers don't want to risk their credibility and instead of big steps, they usually take smaller one's, which makes it easier to stop an interest rate raise, without reserving the course if it is necessary.[68,69]

3.1.5. Conclusion

Relying on the literature the conclusion can be drawn that international financial integration weakened the broad credit channels, and strengthened the interest rate and the wealth channels. The effect on exchange rate is dubious, as it depends not only on trade integration but also on cumulation of foreign currency debt.

[67] See *Blinder* [2006] or *Walsh* [2003b]
[68] If the FED starts to increase or decrease interest rate, then it does it in small steps by average 3.75 percentage point over a span of two years, see *Jorda* [2005] how this observation effects the yield curve.
[69] *Choi and Wen* [2010] found that the reaction of monetary policy in the USA got more gradual.

International financial integration made the transmission mechanism even more unpredictable then before, forcing the monetary policy to make slower and more cautious steps toward its goal.

3.2. The impact of households' high foreign currency liabilities on monetary policy transmission mechanism: case of Hungary[70,71]

In the previous section I showed what the literature says about the effect of increased financial integration on monetary transmission mechanism. In current section, I measure whether the accumulation of foreign currency denominated debt made the Hungarian households more sensible towards exchange rate fluctuations, and so affects the transmission of the Hungarian monetary policy through the exchange rate channel. There are competing explanations about the incentives the accumulation of foreign currency denominated debt was caused by: competition among banks in the retail segment, neglected exchange rate risk, optimistic view about the future etc. (see later). But the fact that credits denominated in domestic currency could be substituted by credits denominated in foreign currency was made possible by financial globalization. So throughout in this subsection I interpret this problem as a special case of the connection between financial integration and monetary transmission.

There is an expanding literature which tries to explain why lending in foreign currency is getting widespread in some countries.[72] The most often found causes are interest differences, banks matching their foreign currency liabilities with foreign currency assets and banks ownership, as banks with foreign ownership have better access to foreign borrowing to fund domestic credit growth.[73] The motivation behind the papers listed in the footnote is that the accumulated foreign currency debt can induce financial distress and balance sheet problems as in *Calvo et al.* [2004] where liability dollarization lies behind 'sudden stops'.

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[70] The working paper, this section is based upon, was prepared with help of a visitor researcher grant at the Magyar Nemzeti Bank in summer 2008, I would like to thank Balázs Vonnák and Bálint Tamási for their comments and advice I got during that time and ever since; all remaining errors are of course mine.

[71] Previous versions of this subsection were presented on the 1st annual Conference of the Hungarian Society of Economics (19-20th December 2007. Budapest, Hungary) and on the 14th International Conference on Macroeconomic Analysis and International Finance (27-29th May 2010. Crete, Greece).

[72] Some papers call this process financial dollarization or euroization, other ask for the motivation of loan substitution, *Beer et al.* [2010] even call the Austrian households carry traders.

[73] For the causes see e.g. *Basso et al.* [2007], *Brzoza et al.* [2010], *Calvo* [2002], *Csajbók et al.* [2010], *Luca and Petrove* [2008] and *Neanidis and Savva* [2009]

In difference to this literature the main emphasis of this section lies in other effects of foreign currency borrowing as this paper asks how the widespread use of foreign currency borrowing affects the monetary transmission mechanism, as it makes households more sensitive to exchange rate fluctuations. My conjecture is that if households' exchange rate sensitivity had changed due to the increasing amount of debt denominated in foreign exchange, than this would have weakened the exchange rate channel of monetary policy. How would this happen?

Among main transmission mechanisms of monetary policy identified by *Mishkin* [1996] four work through the households' wealth. These are the income-, wealth-, cash flow- and balance sheet channels introduced in Chapter 2. Typically, household wealth is not affected by exchange rate shock. However, in presence of high amount of foreign currency liabilities, exchange rate shocks affect household wealth. In the following the channels are described with a positive exchange rate shock:

- *income channel:* a depreciation would increase the domestic value of the foreign currency denominated debt and also increase the monthly domestic denominated instalment and through this decrease the disposable income and also consumption;
- *wealth channel:* a (lasting) depreciation would increase the domestic value of the foreign currency denominated debt, resulting in a decrease in the net wealth, which could lead to less consumption;
- *cash flow channel:* the decreased disposable income (income effect) makes it more difficult to receive additional credit and to smooth consumption;
- *balance sheet channel:* the increased liabilities make it more difficult to receive credit (because the reduced net financial wealth can act as collateral for fewer liabilities) and smooth consumption.

All the above channels point in the same direction: the depreciation of the exchange rate in the presence of significant foreign currency debt can cause a reduction in consumption, and through this a reduction in output.

According to the uncovered interest rate parity, the domestic interest rate reduction (ceteris paribus) leads to depreciation of exchange rate, this would mean that the effects of an expansionary monetary policy step is weakened or reversed.[74] This means that

[74] *Braggion et al.* [2009] show a model of the 1997-98 financial crises, in which financial and real frictions reverse the transmission of monetary policy, making an increased interest rate the optimal answer to the financial shock.

monetary policy's short term ability to cause countercyclical movements, as well as to affect inflation in accordance to its aim, would be limited.

To measure the effect of foreign debt on consumption I use the case of Hungary. The motivation for this is twofold. Firstly, Hungary is a small and highly open economy, where as shown by *Jakab et al.* [2006] the main channel of monetary policy transmission is the exchange rate channel. Secondly, in Hungary the amount of foreign currency denominated debt increased faster between 2000 and 2008 (from 0% of the GDP to 25%) than in any other new member state of the European Union.

To show the effect of this large accumulation of foreign currency denominated debt I estimate a nonlinear structural vector autoregression model, so that the resulting impulse response functions are conditional on the amount of foreign currency debt. In this way I am able to compare the reaction of households' consumption to the same shock[75] with a small amount of foreign currency debt and also with today's total amount.

The rest of this section is organized as follows: in the next subsection I introduce some stylized facts relating to developments on the liability side of Hungarian households' balance sheets. After that I demonstrate the econometric method used in this section which is followed by the estimation results.

3.2.1. Case of Hungary: increased accumulation of foreign currency debt

This subsection briefly reviews some stylized facts about the consumption and the financial wealth[76] of Hungarian households.

As a starting point let us consider the results of *Árvai and Menczel* [2000]. These authors discuss the Hungarian households' decreasing propensity to save between 1995 and 2000. They found that the development of a liberalized financial system and the increasing competition between banks lowered the liquidity constraint,[77] which might explain the saving behaviour. What type of a saving behaviour is that? Besides the

[75] Although a nonlinear system is also shock dependent in the interest of comparability the same shock is used in the two cases.
[76] Concerning the development of other types of wealth, real estate and durable consumption goods see *Vadas* [2007].
[77] According *Vadas* [2007] the liquidity constraint eased due to increasing income, and that is why HUF denominated loans become available in 1998

developments in the financial system they found two special explanations that are typical of the transition economies. Firstly an increase in the expected permanent income could inspire a higher consumption and indebtedness rate, secondly this is further strengthened by impatience caused by the postponed consumption during the transition crisis. These processes together with the state subsidized real estate mortgage loans between 2001 and 2003, the 20% wage increase in the public sector in 2002, and the introduction of tax free minimum wage, also played a dominant role in increasing households' consumption and further lowering their saving *MNB* [2004].

Parallel to the decrease in savings and increase in consumption, an indebtedness process also took place resulting in an increase in the debt level. The household debt to GDP ratio was 31.7% in the first quarter of 2008, which, compared to the 59.85% euro area average, is still low, but considering the financial liabilities to financial wealth ratio Hungary caught up to the euro area level (36.5% against 32.5%). *Kiss et al.* [2006] tried to establish whether this indebtedness process had been a fundamentally justified catching-up trend or a risky credit boom. They found that the fast credit growth experienced in Hungary can be explained by convergence.[78]

As can be seen in *Figure 3.4* foreign currency denominated consumption loans first appeared in 1996, but it was not till 2004 that they started a rapid expansion, so that by 2008 the share of foreign currency debt accounts for approximately 65% of households' liabilities. *Rosenberg and Tirpák* [2008] searched for the incentives that affect the level of foreign currency loans in the new member states of the European Union. They found that Hungarian households increased their foreign currency borrowing by 50 percent between 2000 and 2007, which is a bigger increase than households in any other new member state. *Rosenberg and Tirpák* [2008] also found that the interest differentials have a major influence on foreign currency borrowing. They added that the tightening of eligibility criteria for housing subsidies in Hungary in 2003 is believed to have induced consumers to switch to cheap foreign currency loans.[79] The expected introduction of the euro also has an indirect effect, because it boosts the private sector's confidence in future exchange rate stability, which makes the exchange rate risk seem negligible.

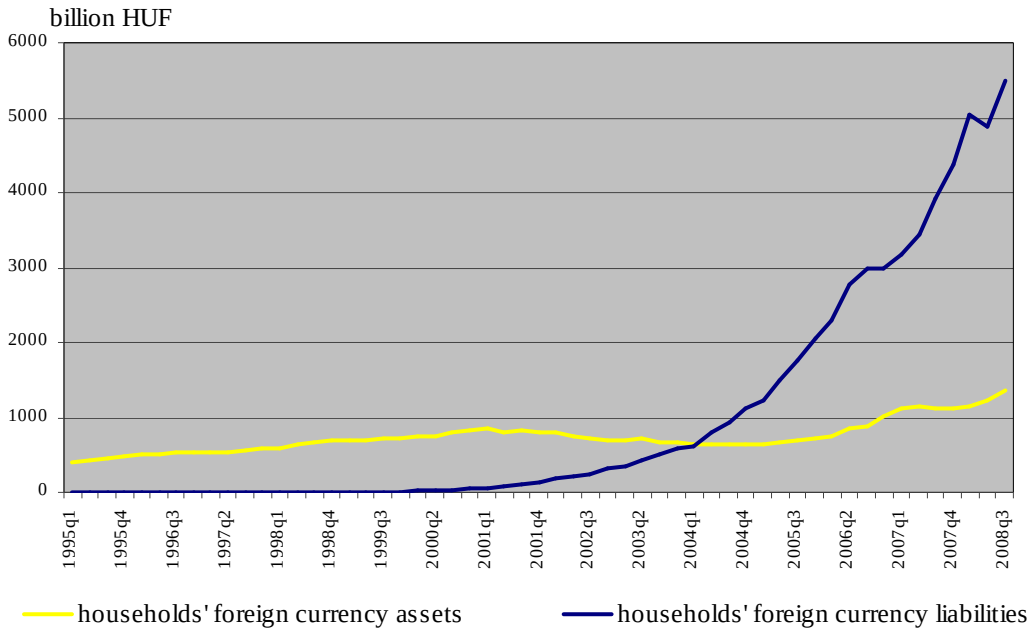
[78] The re-estimation of the model on a longer sample, reported in *MNB* [2008], showed that the smoothing of consumption after the fiscal restriction in 2006 could be interpreted as a boom in consumption but the credit growth still didn't get off from the equilibrium path.

[79] The same result, about the effect of the eligibility criteria can also be found in *Vadas* [2007], *Bethlendi et al.* [2005], *Basso et al.* [2007], *Brzoza et al.* [2010] and *Csajbók et al.* [2010].

As mentioned before *Basso et al.* [2007] explains the propensity to take credit in foreign currency with the foreign ownership of the banks. This argument is also valid for Hungary as the major part of the Hungarian banks is owned by foreign banks, which grants them easy access to cheap foreign currency funding.

To sum up households' higher consumption is accompanied by an indebtedness process, which from 2003, as a result of various factors[80] shifted the loan demand towards foreign currency lending, resulting in a large negative net exchange rate position, see *Figure 3.4* which by 2008q3 reached 15% of the GDP.

***Figure 3.4.* Households' net foreign currency position between 1995q1 and 2008q3**



Source of data: MNB

3.2.2. Methodology

The transmission of the monetary policy is typically investigated with a linear vector autoregression (VAR) methodology, but an impulse response function (IRF), arising from a VAR model, measures the average response to an impulse and so is history independent. In this paper it is not sufficient as my aim is to compare the reaction of households' consumption to the same shock once with small amount of foreign currency debt and with the large amount from 2008q3.

[80] Tightening housing mortgage subsidies, interest rate differences, unperceived/neglected exchange rate risk, foreign owned banks easy access to cheap foreign currency funding etc.

The one solution could be to split the sample into two sub-samples, estimate two separate VARs, and then compare the resulting impulse responses. This solution is not adviseable here as the sample is too short (from 1996q1 to 2008q3 mere 51 data points).[81] Another solution could be to build a system that results impulse response functions that are conditional on the amount of foreign currency debt. There are several methodologies that lead to conditional IRFs (e.g. VAR with time varying coefficients), but also here the short sample limits the options. So it is not enough to get conditional IRFs but one needs a methodology that handles degrees of freedom parsimoniously.

For this purpose I run a non-linear VAR with 5 endogenous variables (output, price level, consumption, households' foreign currency debt denominated in foreign currency, and exchange rate) and with cross products of the foreign currency denominated debt and the exchange rate. These cross products serve as a measure of wealth effect that amplifies the changes in the exchange rate (or stock of debt), and through this the IRFs will become conditional on the amount of foreign currency debt. The estimated equation system is:

$$x_t = A_t + \sum_{i=1}^{l} B_i x_{t-i} + C_0 f_t e_t + \sum_{i=1}^{l} C_i f_{t-i} e_{t-i} + u_t \qquad (3.1)$$

where $x_t = (y_t, p_t, c_t, f_t, e_t)'$ is the vector of endogenous variables, y_t is the output, p_t is the price level, c_t stands for consumption, e_t is the exchange rate and u_t is the vector of residuals. The best way to bring the foreign currency debt into the equation would be the repayment of the given period, but no such data is available. The nearest available proxy could be the stock of foreign currency debt[82] (f_t), which leads to the problem of the timing of the stock variable (start vs. end of period). The system above suggests that the best solution is that stock is taken at the beginning of each period; otherwise one would have to calculate for the interaction/endogeneity between the consumption and the debt during the period as well. A, B, C_i are vectors and matrices of constants and coefficients. Vector C_0 contains the coefficients of the cross product, and has the form $C_0 = (c_{0,y}, c_{0,p}, c_{0,c}, 0, 0)'$ which means that the contemporaneous cross product is also among the independent variables in the first three equations,

[81] Quarterly data is available from 1995q1, but as the logarithm of the variables is used in the model, the sub sample with zero amount of debt denominated in foreign currency had to be dropped from the sample.

[82] It was suggested that the model would be better specified if instead of the stock of liabilities its ratio to consumption would be introduced into the model. However the ratio's movement is driven by the accumulation of the foreign currency denominated debt, so a model with the ratio of foreign currency debt and consumption wouldn't be better specified than the model above.

because in these cases it is probable that the stock of households' debt denominated in HUF would affect the variables in question.[83] As these equations can only be estimated ineffectively with the least squares method, I use the two-stage least squares method with an instrumental variable euro-dollar exchange rate.[84] The fourth and fifth equations were estimated with ordinary least squares, as no contemporaneous forint debt was added to these equations. There are two reasons for this; on the one hand because of the identification, the effect of a forint debt shock could work through the mainly affected consumption, and on the other hand in this way a recursive solution is possible. To keep the identification as simple as possible, a lower triangular identification was considered[85], with the ordering of the endogenous variables: output, price level, consumption, foreign currency debt, and exchange rate[86].

As can be seen, the methodology above is only appropriate for experimenting with the effect of an exchange rate shock given the different balance sheet positions of the households. To be able to speak about changes in the transmission of monetary policy, one needs interest rate in the model and a method to identify monetary policy.

So short-term interest rate (i_t) is added to the endogenous variables and x_t changes to $x_t = (y_t, p_t, c_t, f_t, i_t, e_t)'$ in the equation system (3.1). In this case $C_0 = (c_{0,y}, c_{0,p}, c_{0,c}, 0, c_{0,i}, 0)'$ and so because of the contemporaneous cross products the first, second, third and fifth equations had to be estimated with the two-stage least square method, with the instrumental variable as before.

With interest rate among the endogenous variables the identification is a little more complicated, and the main task after estimating the equations is to decompose residuals u_t into structural shocks ε_t ($u_t = D^{-1}\varepsilon_t$). Again my identification here follows *Smets* [1997] and *Smets and Wouters* [1999]. In the main part of the matrix D recursive

[83] The contemporaneous coefficients are significantly different from zero (at 10%) in the output and in the consumption equations.

[84] Because the foreign currency stock is from the start of the period (so flows of the given period do no affect it) one only needs an instrument for the exchange rate.

[85] The fact that the amount of debt is from the beginning of the period suggests that consumption cannot affect the stocks within the period, but the shock to the debt can affect the consumption, so an identification like $\begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ d_{21} & 1 & 0 & 0 & 0 \\ d_{31} & d_{32} & 1 & d_{34} & 0 \\ d_{41} & d_{42} & 0 & 1 & 0 \\ d_{51} & d_{52} & d_{53} & d_{54} & 1 \end{pmatrix}$ with the same ordering of the variables as above, would suit this idea more; however using the simple lower triangle identification does not affect the results.

[86] This ordering would not be appropriate if anything other than the effect of the exchange rate shock were being investigated.

identification is used (with the ordering as in vector x_t), but the weight how the policy shock affects the interest rate and the exchange rate simultaneously can be calculated as shown in Chapter 2 subsection 2.2.1 from the estimated equation:

$$u_{t,si} = -\omega/(1-\omega)u_{t,ex}, \tag{3.2}$$

using the two stages least squares method with various instrumental variables to tackle the endogeneity problems. The next step is the estimation of the equation (3.2) using the residuals of the fifth and sixth equation from system (3.1). The calculated weights can easily be built into the identification:

$$D = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ \delta_{21} & 1 & 0 & 0 & 0 & 0 \\ \delta_{31} & \delta_{32} & 1 & 0 & 0 & 0 \\ \delta_{41} & \delta_{42} & \delta_{43} & 1 & 0 & 0 \\ \delta_{51} & \delta_{52} & \delta_{53} & \delta_{54} & 1-\omega & \omega \\ \delta_{61} & \delta_{62} & \delta_{63} & \delta_{64} & \delta_{65} & 1 \end{pmatrix}. \tag{3.3}$$

So in this case the effects of the identified monetary policy shock are featured in the figures.

3.2.3. Results

For the estimation quarterly data is used with a sample length from 1996q1 to 2008q3. Real output is the seasonally adjusted GDP, with calendar effects taken into consideration, at average prices of 2000 from the Hungarian Statistical Office. Quarterly inflation from the Statistical Office is used to calculate the price level (1994q4=100), but as this variable is seasonally unadjusted in this case seasonal dummies were also added to the price level equations. Consumption is at average prices for the year 2000, adjusted and reconciled for seasonal and calendar effects. Households' foreign currency denominated debt is from the Hungarian National Bank's financial accounts (and converted into euros) together with quarterly euro exchange rates and 3 month market interest rates. In all cases except for the interest rate, the logarithms of the variables are used in the estimations. Two is the minimum number of lags that solve most of the autocorrelation problem and leave enough degree of freedom; so $l = 2$ in system (3.1). The residual of euro short term interest (regressed on its own lags) used as instrumental variable in case of equation (3.2).

In this section I present the impulse response functions resulting from equation (3.1). Because the impulse response functions are conditional on the amount of foreign

currency it is important from which point the IRFs starts. To show how the change in the balance sheet position of the households affects the monetary transmission two starting points are considered: 2002q1 and 2008q3. The two periods differ in the amount of foreign currency debt, because in 2002 the foreign currency debt accumulation boom had not yet started (see Figure 3.4), but other important parameters, such as the exchange rate and monetary policy regime, are not fundamentally different between the two periods.[87] The confidence intervals in the figures contain 60% (approx. one standard deviation on each side) and 90% (approx. two standard deviations on each side) of the 10000 Monte Carlo simulations.[88], but was adequately modified to fit the two-stage least square estimation procedure.

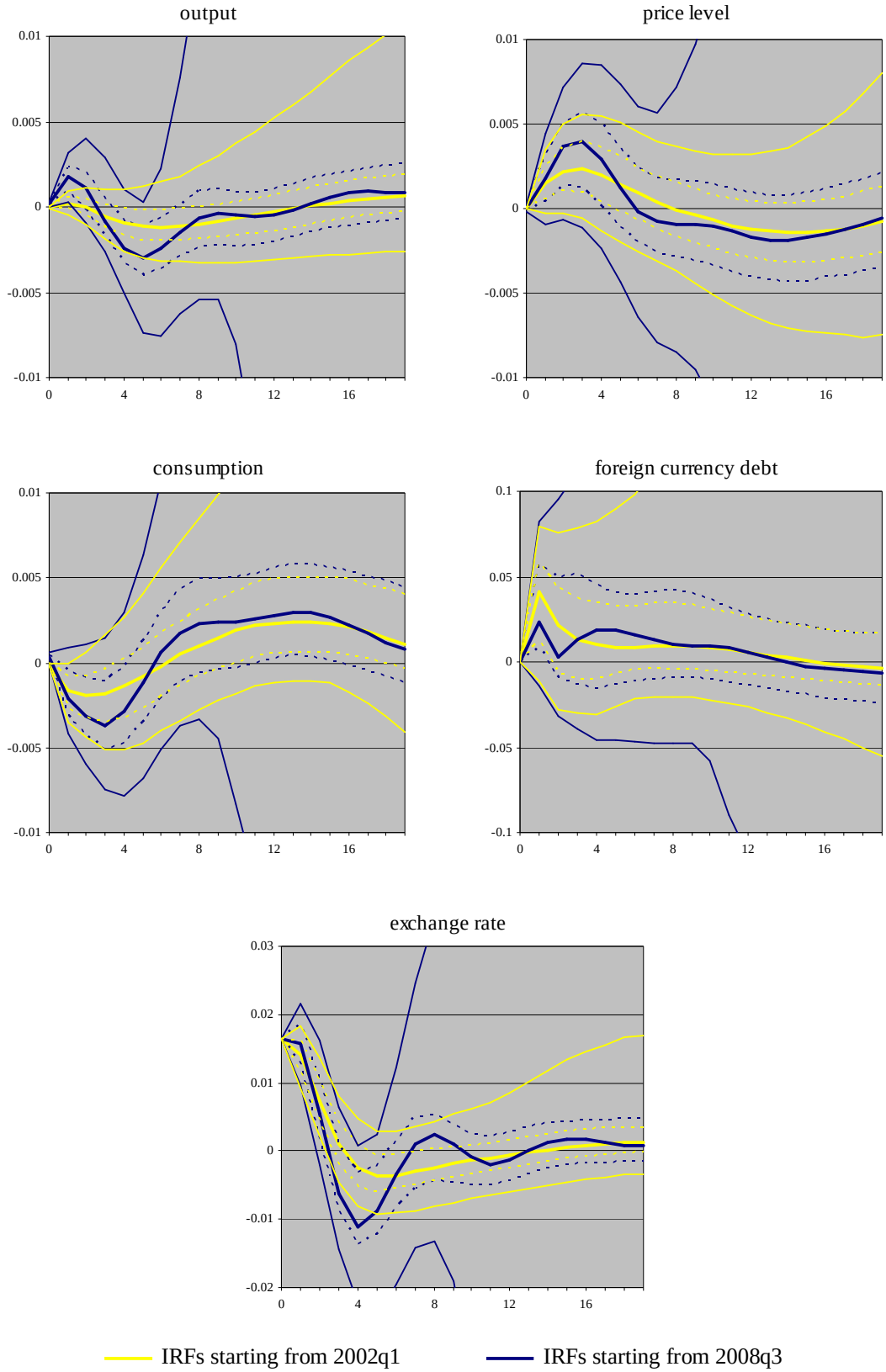
There is a common expectation in the academic literature how the variables of the economy should respond to an unexpected positive exchange rate shock, as already shown in Chapter 2. In the absence of foreign currency denominated debt, the responses to an unexpected monetary shock commonly found in the transmission literature could be described as following. The depreciation decreases the relative price of the export, and increases the relative price of import, creating competitive advantage for domestic exporters. At the same time the decreasing interest rate would make incentive for more investments. So the output should be increased through the rising net export and rising investment, and consumption should slowly move along with the output. Prices should rise because of exchange rate pass-through and because of the inflation pressure caused by the increased the output.

In *Figure 3.5.a* the IRF-s based on the 2002 amounts tell a little bit different story: the exchange rate depreciation caused a significant rise in prices and a significant decline in consumption at a significance level of 60%; these together leading to the decline of output. It is interesting, that even in the absence of foreign currency debt, the output and consumption declines after the initial depreciation of exchange rate. The reaction of the consumption could be explained with the earlier findings of *Jakab et al.* [2006], who found that an interest rate increase causes a consumption increase, because the slowing inflation increases real wages, and through this, consumption. In this case the reversed explanation can be used: the increasing price level decreases the real wages and consumption.

[87] The exchange rate regime changed on the 26th February 2008, as the pegged exchange rate with ±15% band around it, was replaced by a floating exchange rate system. But this change isn't really taken up by the model, as only the last three data points are affected.

[88] The method used here is based on *Hamilton* [1994] p. 337.

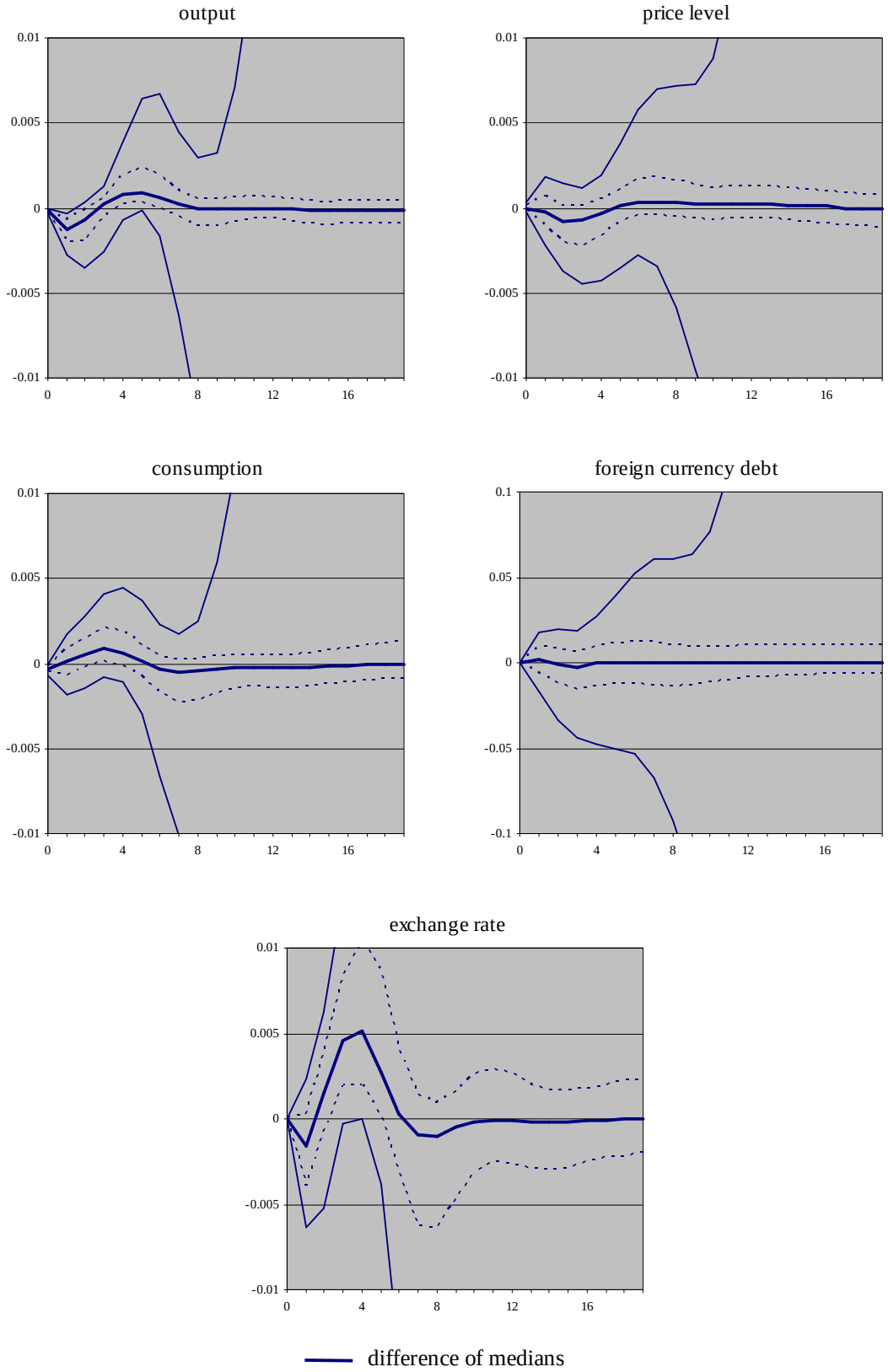
Figure 3.5.a. **Impulse response functions from the 5-variable model (starting from 2002q1 and 2008q3)**



Source: own calculations

Note: thin continuous lines represent 90%, dashed lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

Figure 3.5.b. **Differences of impulse response functions (2002q1 minus 2008q3) from the 5-variable model**



Source: own calculations

Note: continuous bold lines represent difference of the medians, thin continuous lines represent 90%, dashed lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

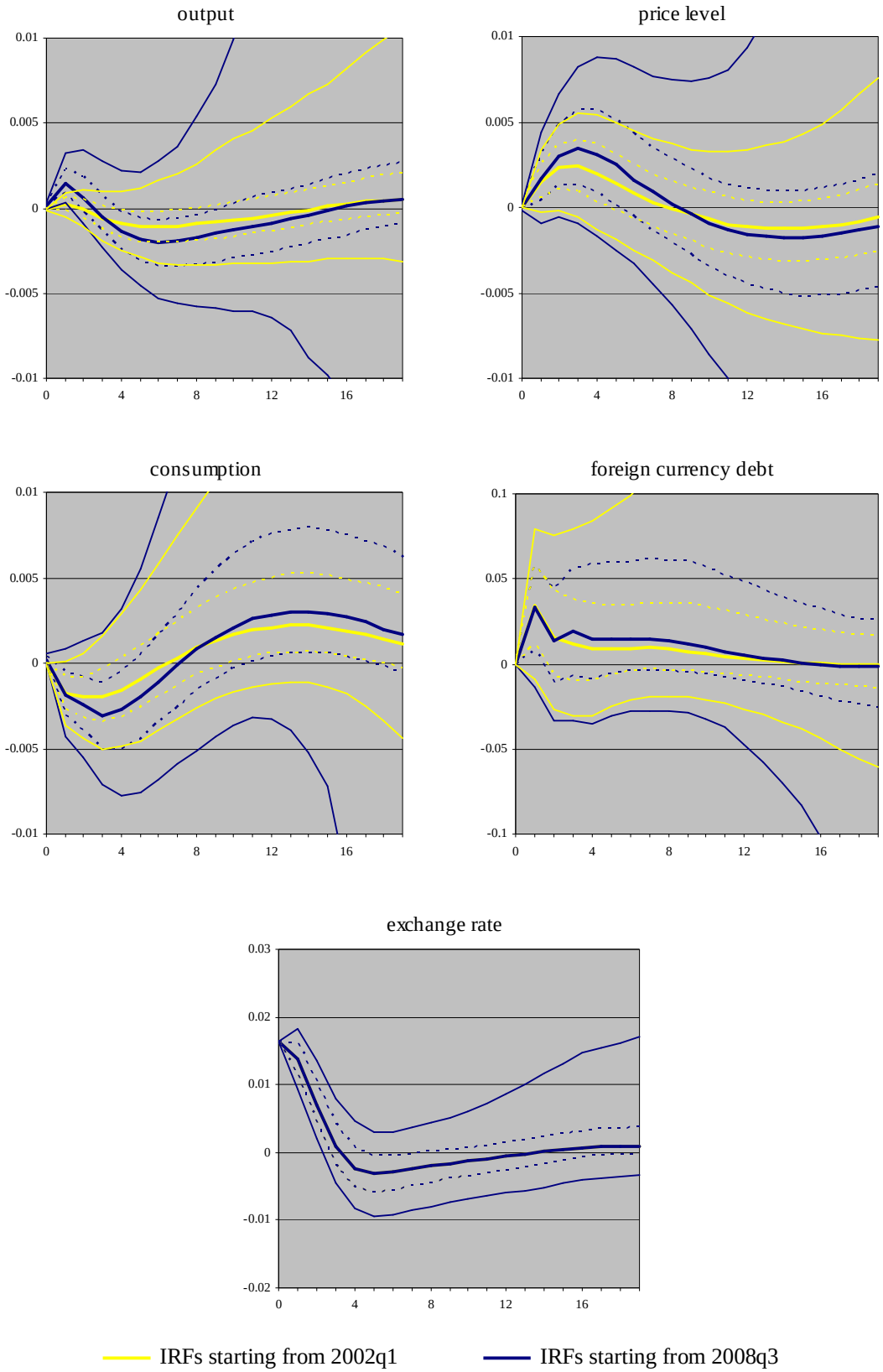
It is also interesting to notice how the foreign currency debt rises sharply just after the shock, probably as households (still without greater amounts of debt) try to smooth their consumption. In case of the IRF-s based on 2008q3 the story is even less straightforward. The decline in consumption and the moderate rise of foreign currency debt are in line with households heavily indebted in foreign currency. The initial rise in output can be explained by the effect of depreciated exchange rate on the net export, but after a while the output declines because of the decline in consumption. The presence of an additional fluctuation can also be observed in the reaction of the exchange rate.

The two sets of IRFs above are created from the same estimation and only launched from two different points of time. The same is true for the confidence intervals, each draw from the Monte Carlo simulation is used twice (launched from 2002 and 2008). So the above IRF-s are not independent of each other, and their differences can be interpreted. *Figure 3.5.b* shows the differences of the IRF-s calculated from the Monte Carlo simulations. The bold blue line is the difference in the medians of the 10000 Monte Carlo simulations, thin lines represent the 90% confidence interval, while dashed lines represent the 60% confidence interval.

As can be seen in *Figure 3.5.b* the consumption shows a significant difference at 60%, which means that the sharper decline with relatively high amount of debt denominated in foreign currency differs from the reaction of consumption with lower level of debt, but the significance level of the difference is rather low. The significant difference between the reaction function of the output is caused by the initial rise and the greater decline[89]. The difference between reactions in the stock of the foreign denominated debt does not differ from zero. There is also a significant difference in the reaction of prices, which could be explained by the greater openness in the same period. The excess volatility in the reaction of the exchange rate from the impulse response function starting from 2008q3 values causes significant differences.

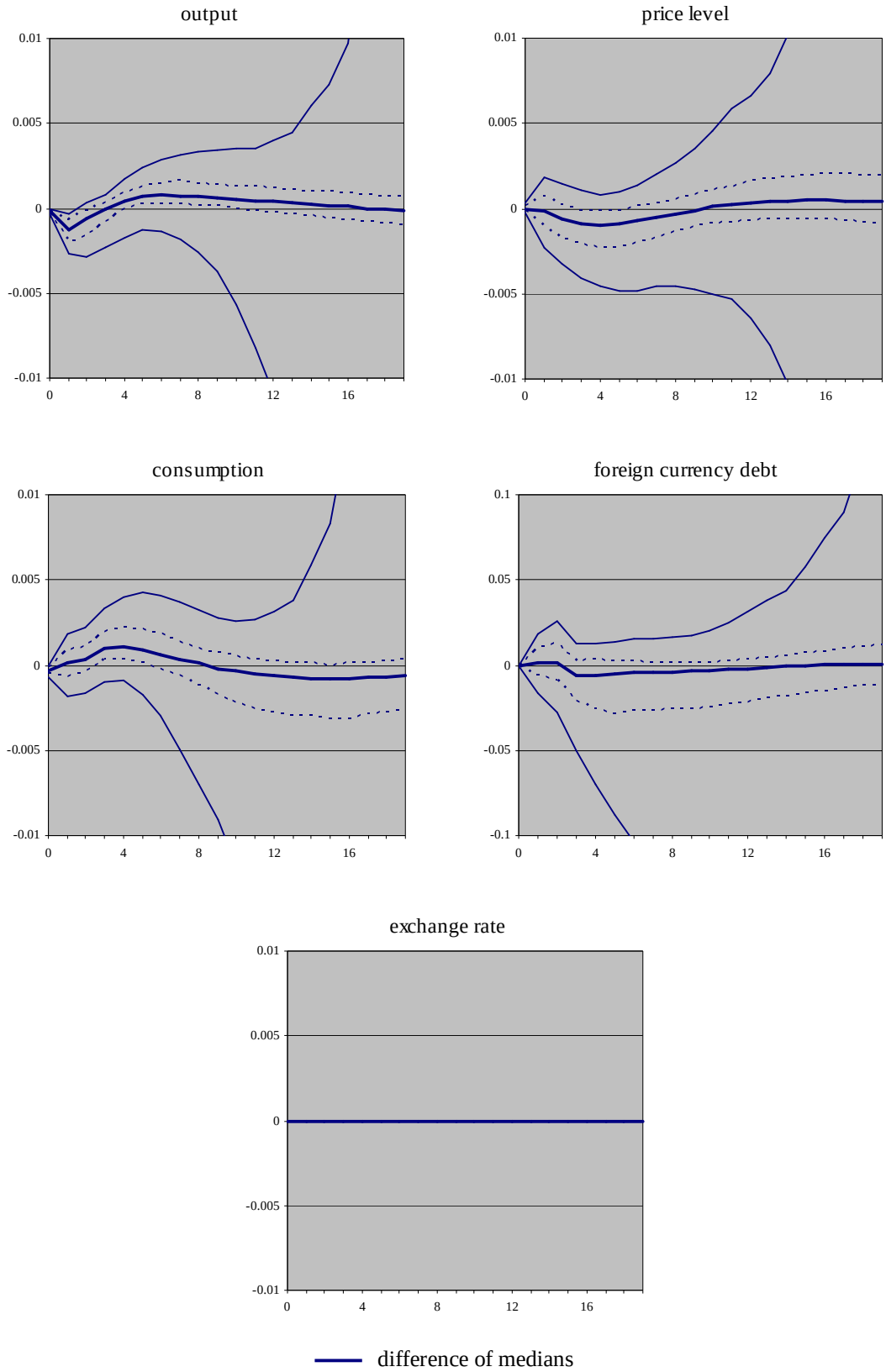
[89] *Krekó and Endrész* [2010] found that in case of a sudden depreciation (exchange rate crises) if the banks crunch their credit supply the balance sheet effect of the foreign currency denominated debt is almost equivalent with the competitiveness effect of the depreciation. In this case the sign of the depreciation's real economic effect is uncertain (it's positive without the credit crunch). Despite the obvious differences (depreciation is not a crises in my model) the two results can be brought in line as the more indebted households cannot increase their foreign currency debt, making the decline of their consumption more sever in both cases.

Figure 3.6.a. **Impulse response functions from the 5-varibale model, with additional exchange rate shocks (starting from 2002q1 and 2008q3)**



Source: own calculations
Note: thin continuous lines represent 90%, dashed lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

Figure 3.6.b. **Differences of impulse response functions (2002q1 minus 2008q3) from the 5-variable model, with additional exchange rate shocks**



Source: own calculations

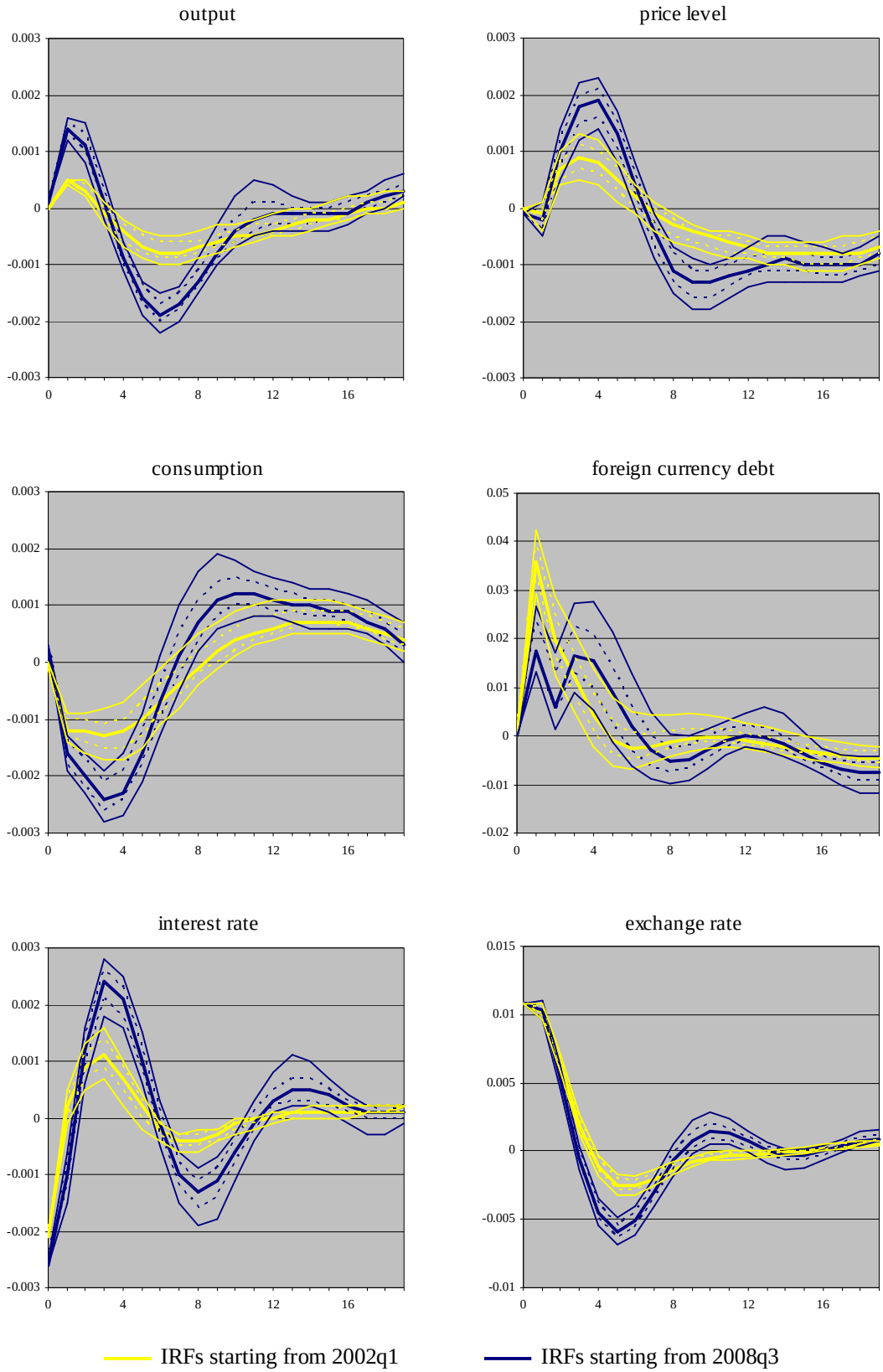
Note: continuous bold lines represent difference of the median, thin continuous lines represent 90%, dashed lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

As could be seen in *Figure 3.5.a* and *Figure 3.5.b*, the volatile reaction of the exchange rate from 2008 differs significantly from the reaction in 2002, but what if these differences caused the different reaction of the consumption and not the difference in the accumulated debt? One must filter out the differences of the exchange rate responses to be able to answer this question. For this exercise the response functions starting from 2008 were simulated with a series of additional exchange rate shocks, so the reaction of the exchange rate is the same as the one based on values from 2002.[90] The series of additional exchange rate shocks were obtained in repetitive manner, where in step n the difference of the reactions in period n was added to the series of additional exchange rate shocks as a new shock, and the whole model was simulated again with the additional shocks.

The result of this experiment is shown in *Figure 3.6.a* and *Figure 3.6.b*. The addition of shocks to the exchange rate caused almost no difference. The general movements of the variables are the same, and the significant differences (at a 60% significance level) in the reactions of consumption is still present, even after the volatility of the exchange rate is taken care of (*Figure 3.6.b*).

[90] In this case the movements of the exchange rate from 2008 are not impulse responses any more but actually pre-set, to follow the dynamics of the exchange rate from 2002.

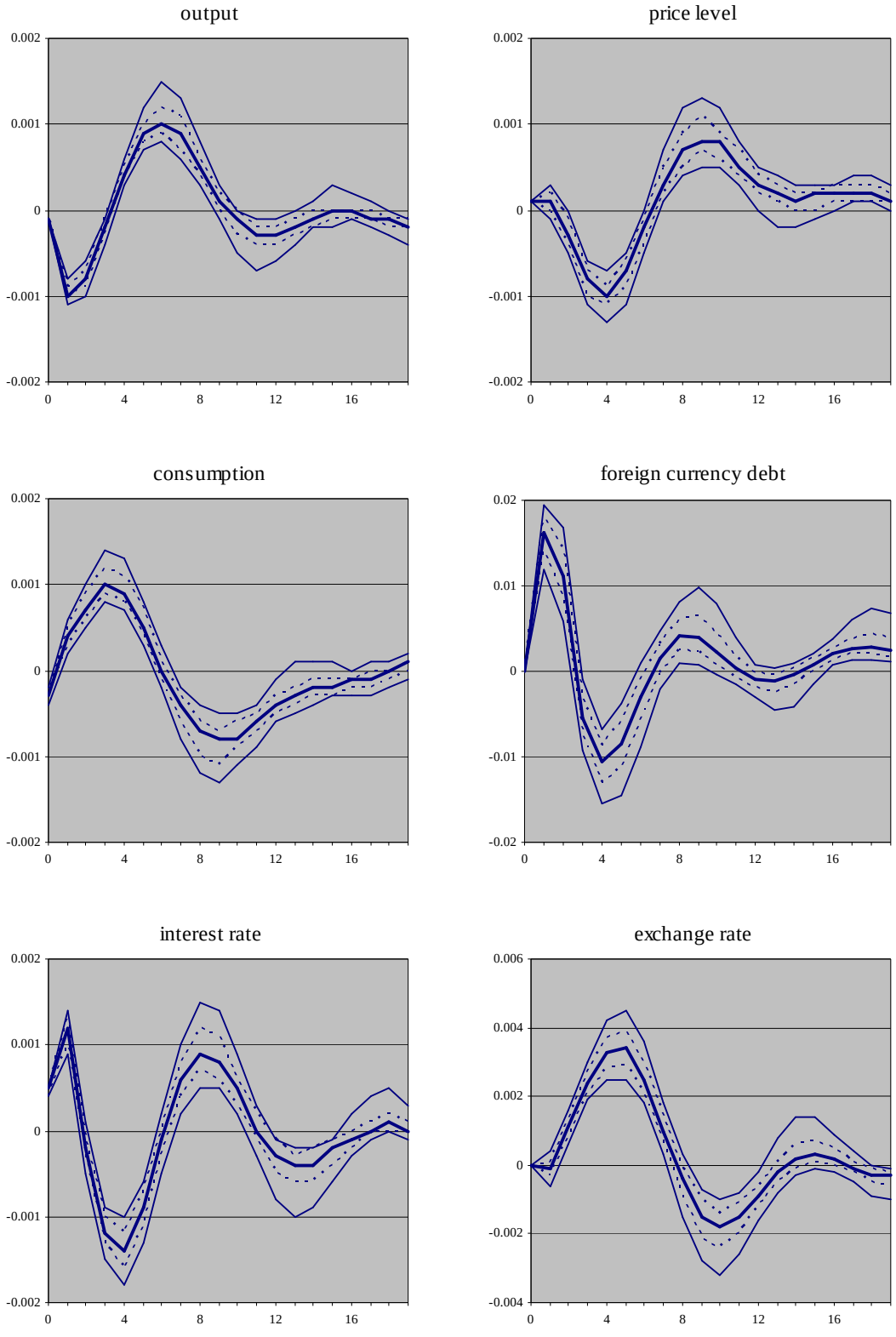
Figure 3.7.a. **Impulse response functions from the 6-variable model (starting from 2002q1 and 2008q3)**



Source: own calculations

Note: thin continuous lines represent 90%, dashed lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

Figure 3.7.b. **Differences of impulse response functions (2002q1 minus 2008q3) from the 6-variable model**



Source: own calculations

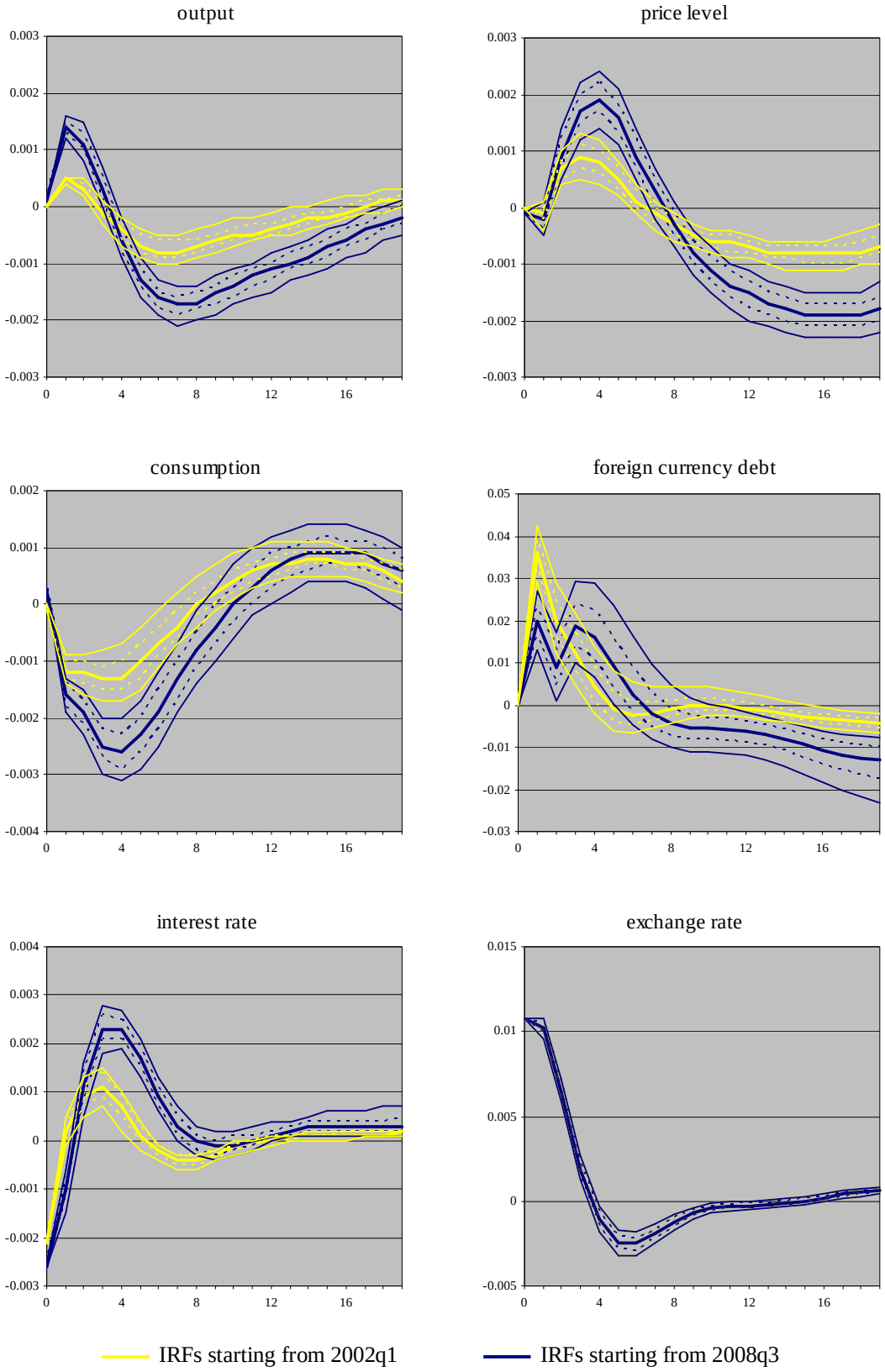
Note: continuous bold lines represent difference of the median, thin continuous lines represent 90%, dashed lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

Figure 3.7.a shows the IRF from the 6 variable SVAR, where the monetary policy shock is identified as shown in Chapter 2. The 2002 case is the following: the simultaneous drop in the interest rate and rise in the exchange rate causes the drop in consumption, and a sharp rise in the foreign currency debt is consistent with the need to smooth consumption. The significant increase at the beginning of the output's reaction is in line with increasing net export and the following decline is in line with the drop of the consumption. The rise in the price level is also significant.

The picture from 2008 is no clearer; there is a significant initial rise in output, followed by a faster and deeper decline compared to the reaction of the output in 2002. The increase in the price level is also bigger. Consumption shows a great decline, which lasts 6 quarters, accompanied by a modest increase in debt. After the initial negative shock the interest rate recovers very rapidly. As in case of the mere exchange rate shock in previous figures, the reactions show additional fluctuations.

According to *Figure 3.7.b* there is a significant difference between the reaction functions of output, consumption, and price level and even the interest rate at a 90% confidence level. The foreign debt stock shows the same behaviour as in the previous scenarios, and the significant difference between the reactions of exchange rates is due to the fluctuation.

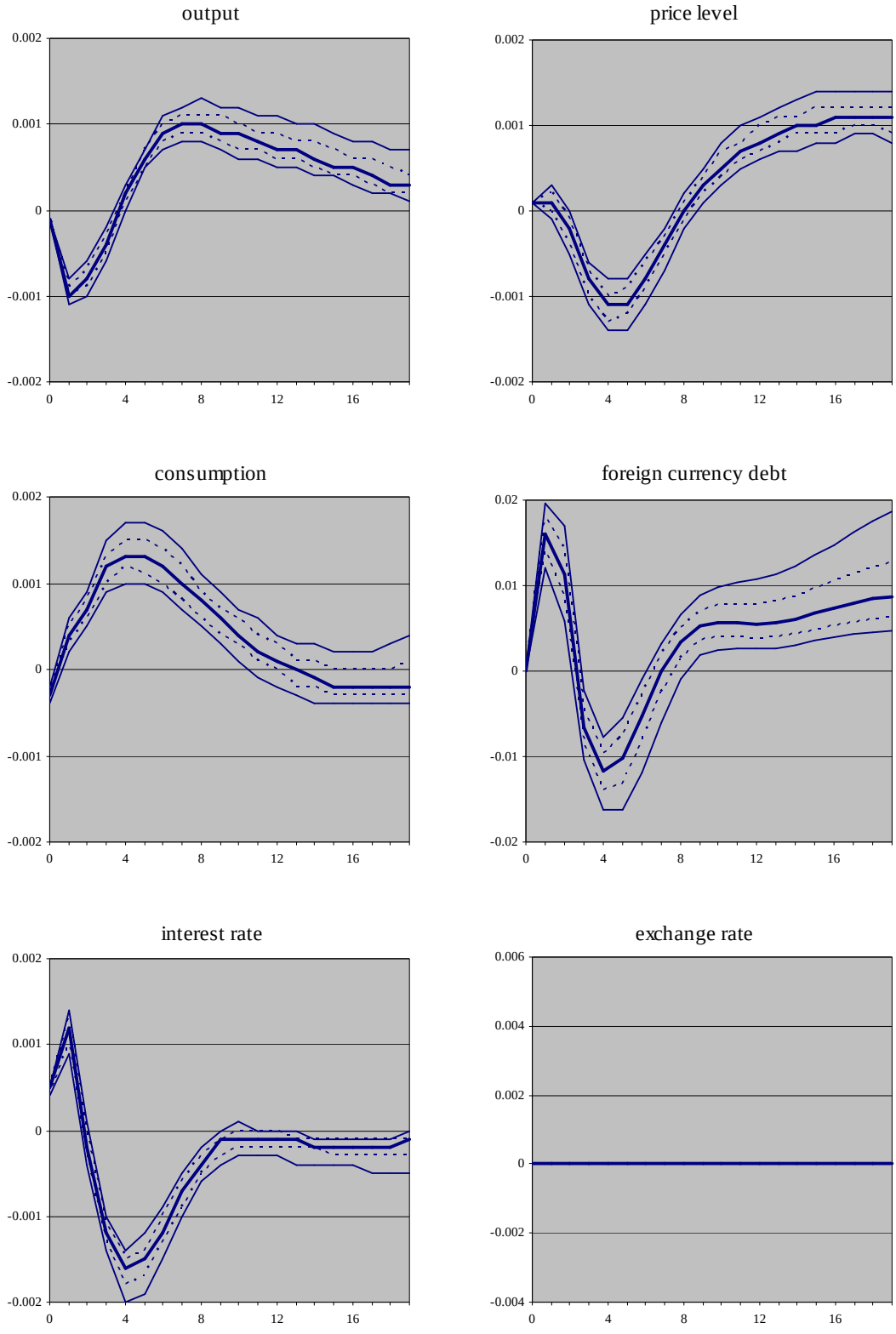
Figure 3.8.a. **Impulse response functions from the 6-variable model, with additional exchange rate shocks (starting from 2002q1 and 2008q3)**



Source: own calculations

Note: thin continuous lines represent 90%, dashed lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

Figure 3.8.b. **Differences of impulse response functions (2002q1 minus 2008q3) from the 6-variable model, with additional exchange rate shocks**



Source: own calculations

Note: continuous bold lines represent difference of the median, thin continuous lines represent 90%, dashed lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

Again additional exchange rate shocks were added to the impulse response functions launched from the 2008q3 data, to eliminate the differences in the reaction of the exchange rate, as can be seen in *Figure 3.8.a* and *Figure 3.8.b*. The addition of shocks to the exchange rate caused almost no difference to the previous results. The general movement of the variables is the same, and the significant differences in the reactions of endogenous variables are still present.

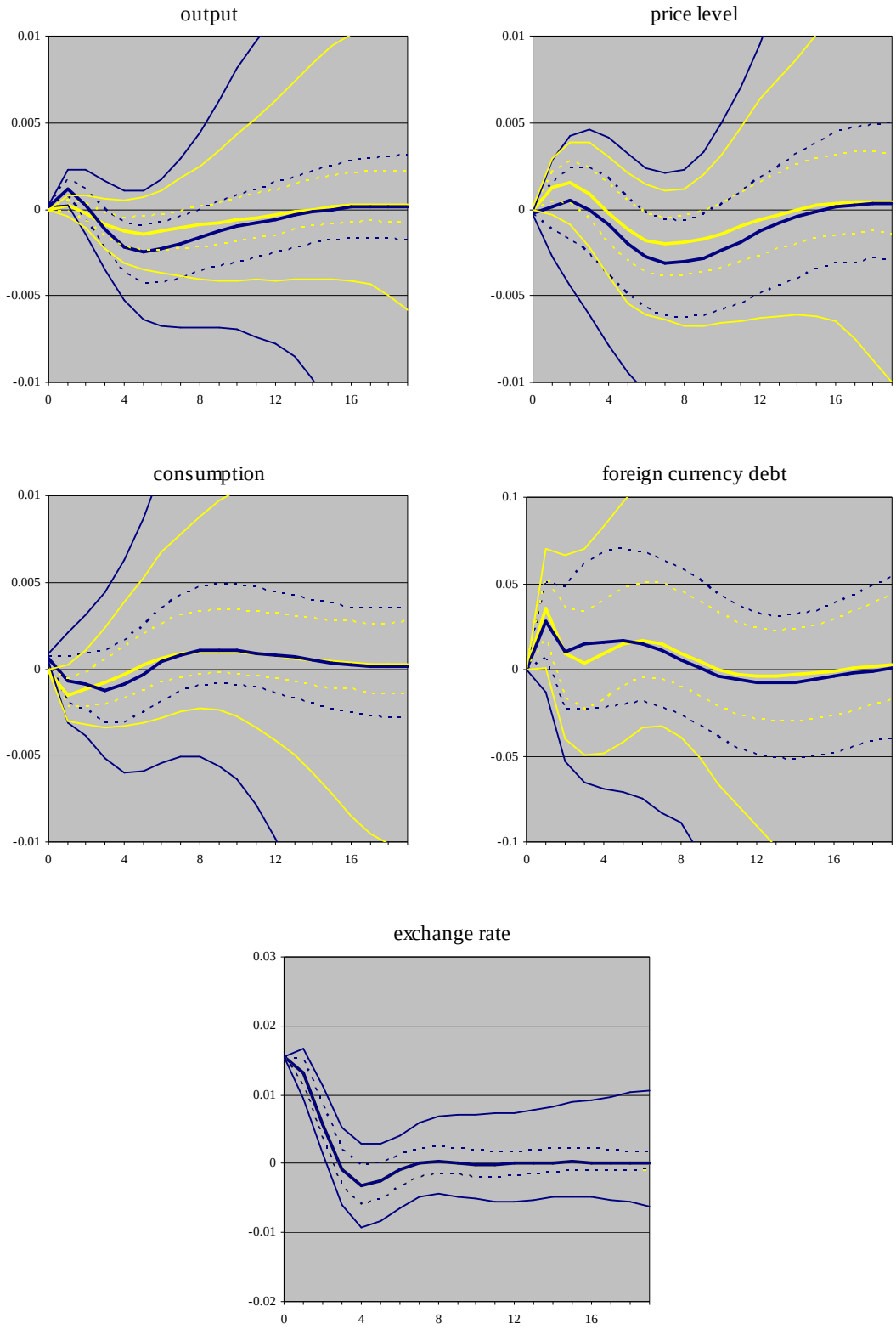
3.2.4. Robustness checks

As mentioned previously one of the main driving forces of the increasing indebtedness in foreign currency is the difference in interest rates. This could cause omitted variable problem in some of the equations in system (3.1), so one of the experiment was to include the short term Swiss interest rate in the equations as an exogenous interest rate.[91]

In *Figure 3.9.a* and *Figure 3.9.b*, the same experiment is shown as in *Figure 3.6.a* and *Figure 3.6.b* augmented with an exogenous 3-month Swiss interest rate. The most important differences are following: 2008 price response becomes smaller in case of an exchange rate shock, than the one launched from 2002 values (their difference is almost significantly different at 60%). The stronger decline in the consumption is still there but the difference became insignificant. The initial response of the output from 2008 is smaller, but the decline after the initial rise became larger, both movements are significantly different from the 2002 response.

[91] As the exogenous foreign interest rate interfered with the identification of monetary policy shock, so only results with the exchange rate shock are shown here.

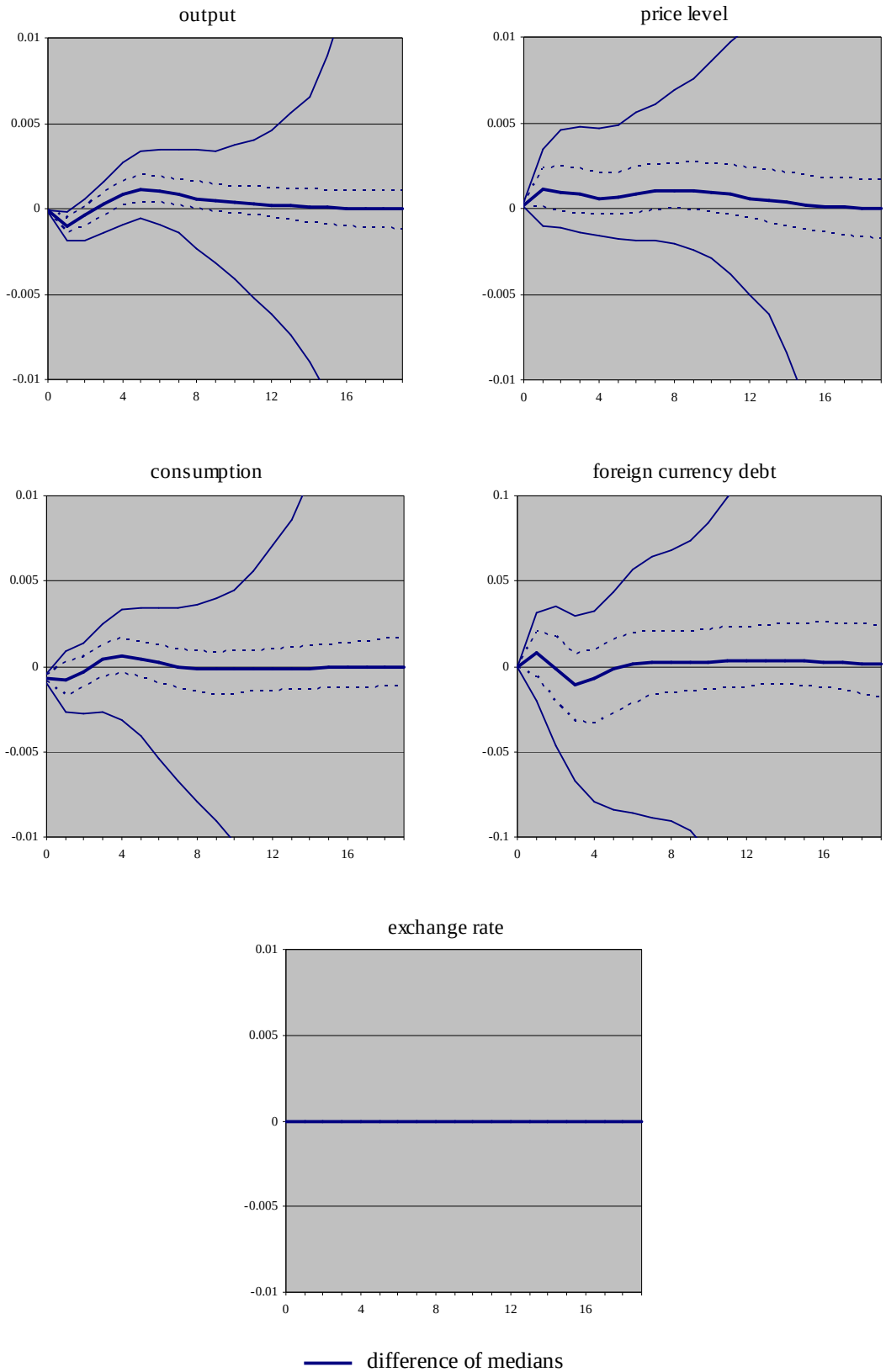
Figure 3.9.a. **Impulse response functions from the 5-variable model, with additional exchange rate shocks and foreign interest rate as exogenous variable (starting from 2002q1 and 2008q3)**



Source: own calculations

Note: thin continuous lines represent 90%, dashed lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

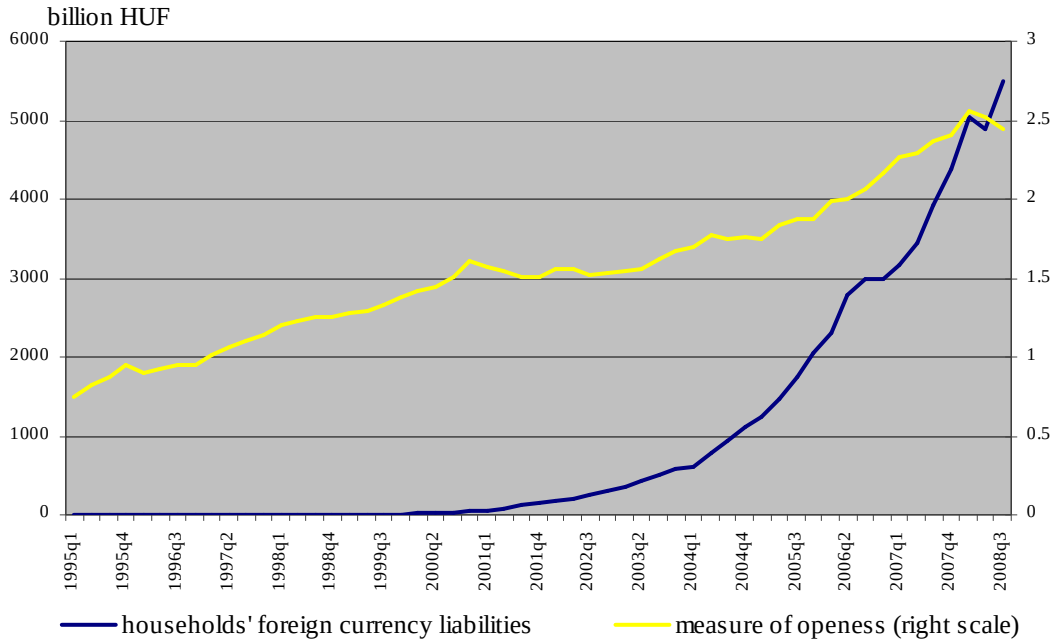
Figure 3.9.b. **Differences of impulse response functions (2002q1 minus 2008q3) from the 5-variable model, with additional exchange rate shocks and foreign interest rate as exogenous variable**



Source: own calculations
Note: continuous bold lines represent difference of the median, thin continuous lines represent 90%, dashed lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

The next robustness check is based on the fact that the trend of accumulated foreign currency denominated debt may take up the effect of other variables with similar trend. Furthermore, as mentioned above, the changes in the reaction of the price level and output hint to the role of trade openness (export and import as a fraction of the GDP), which also doubled during the period examined, see *Figure 3.10*.

***Figure 3.10.* Households' foreign currency liabilities and the measure of openness**

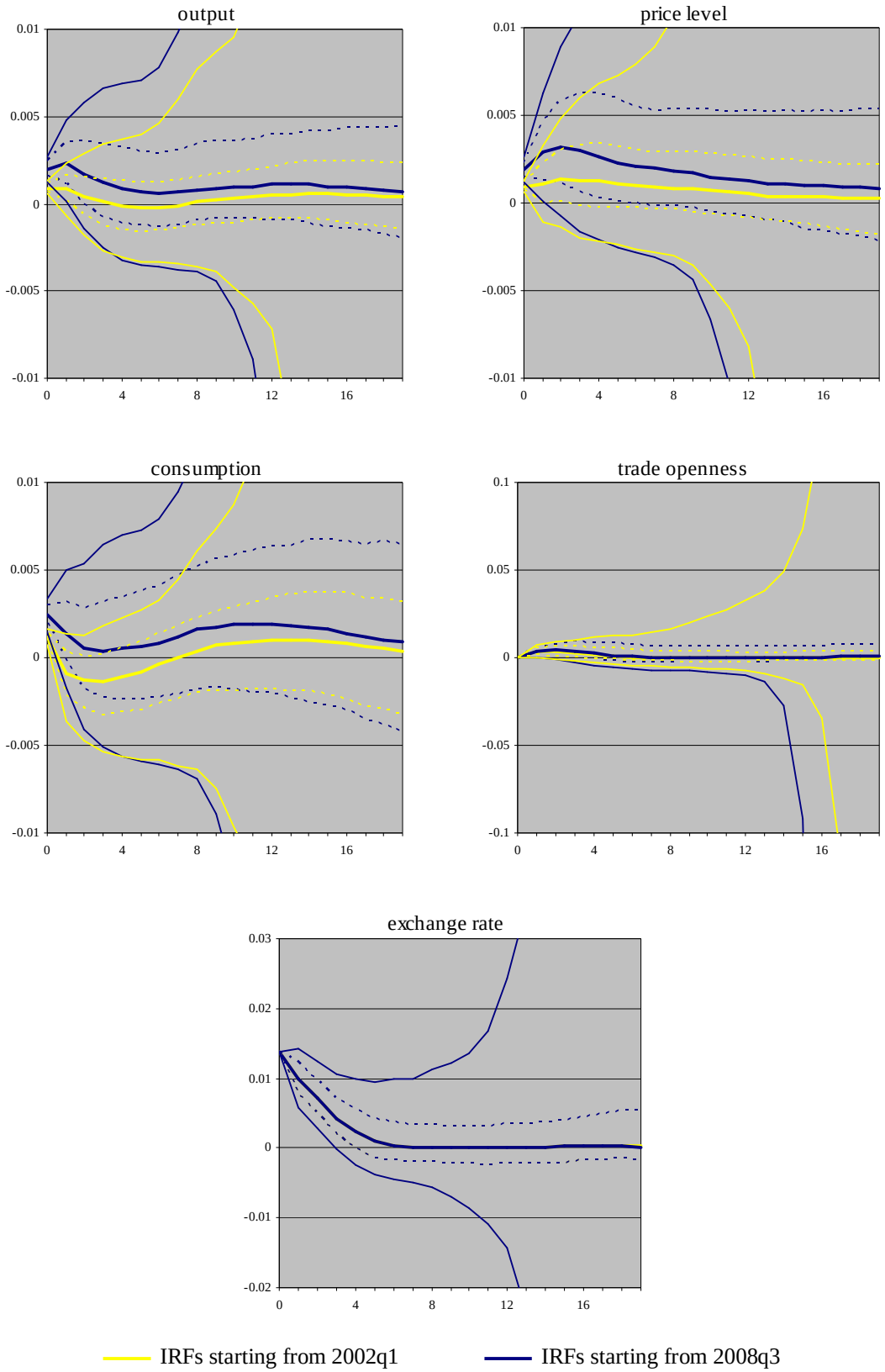


Source: MNB and KSH

To test whether this is the case or not, in the model (3.1) the variable f_t is replaced with the openness of trade measure (to_t), and everything else is kept the same for the sake of comparability. Certainly this model is not ideal, and the interpretability of the cross products is also lost, but as the effect of the exchange rate is strengthened by the trade openness, it seems to me a valid way to think about the effect of trade openness. However, these results should be handled with care, as they serve only for comparison.

The IRF-s in *Figure 3.11.a* and *Figure 3.11.b* show the effect of an exchange rate shock. Because of the fluctuations in the exchange rate, additional shocks were added, so the reaction of exchange rate based on values from 2002 and from 2008 do not differ from each other. The positive reaction of the output and consumption and the rise of price level are larger in the case with greater openness and differ significantly from the lower openness scenario.

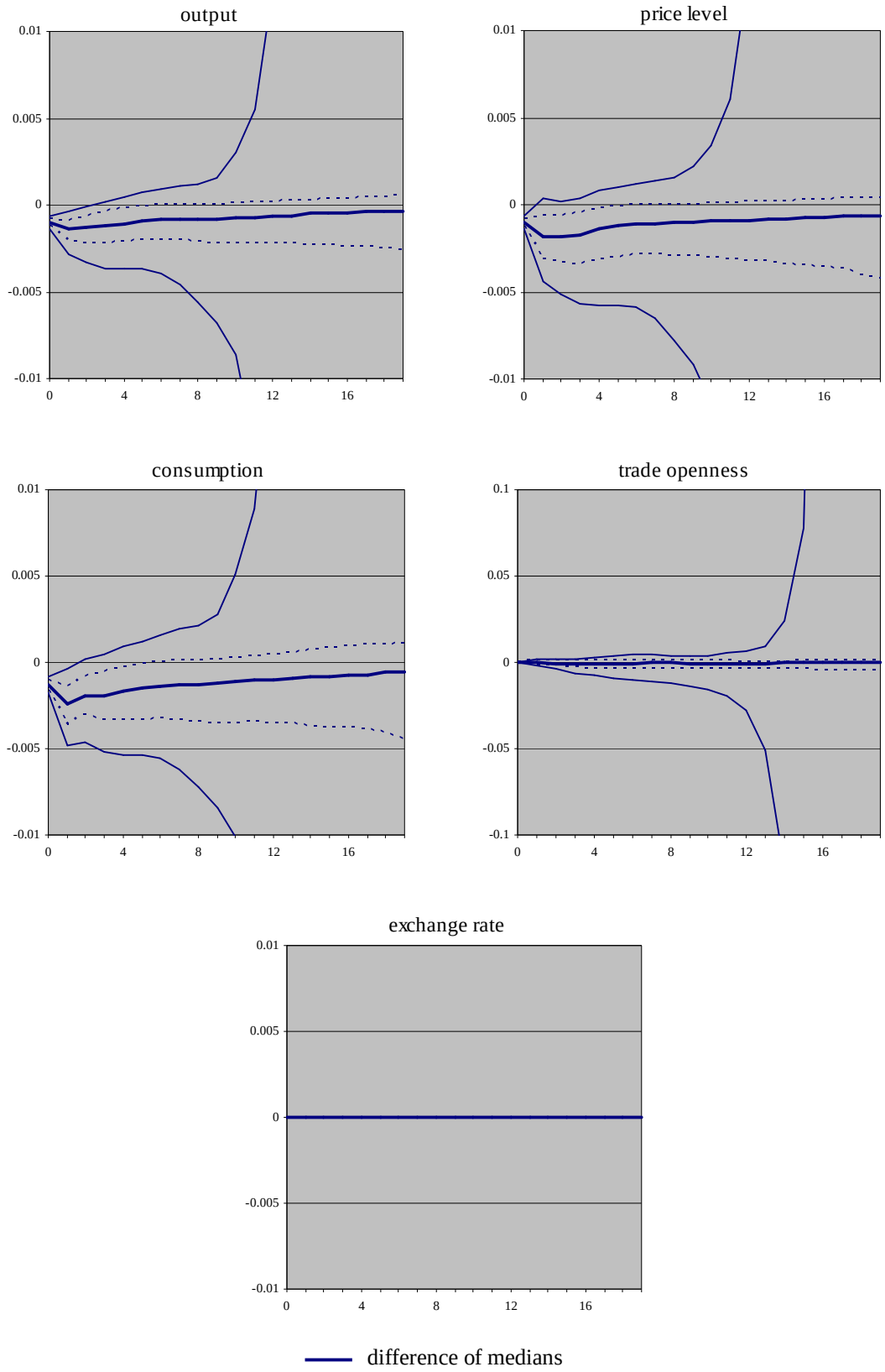
Figure 3.11.a. **Impulse response functions from the 5-variable model, with additional exchange rate shocks and trade openness instead of foreign currency debt (starting from 2002q1 and 2008q3)**



Source: own calculations

Note: thin continuous lines represent 90%, dashed lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

Figure 3.11.b. **Differences of impulse response functions (2002q1 minus 2008q3) from the 5-variable model, with additional exchange rate shocks and trade openness instead of foreign debt**



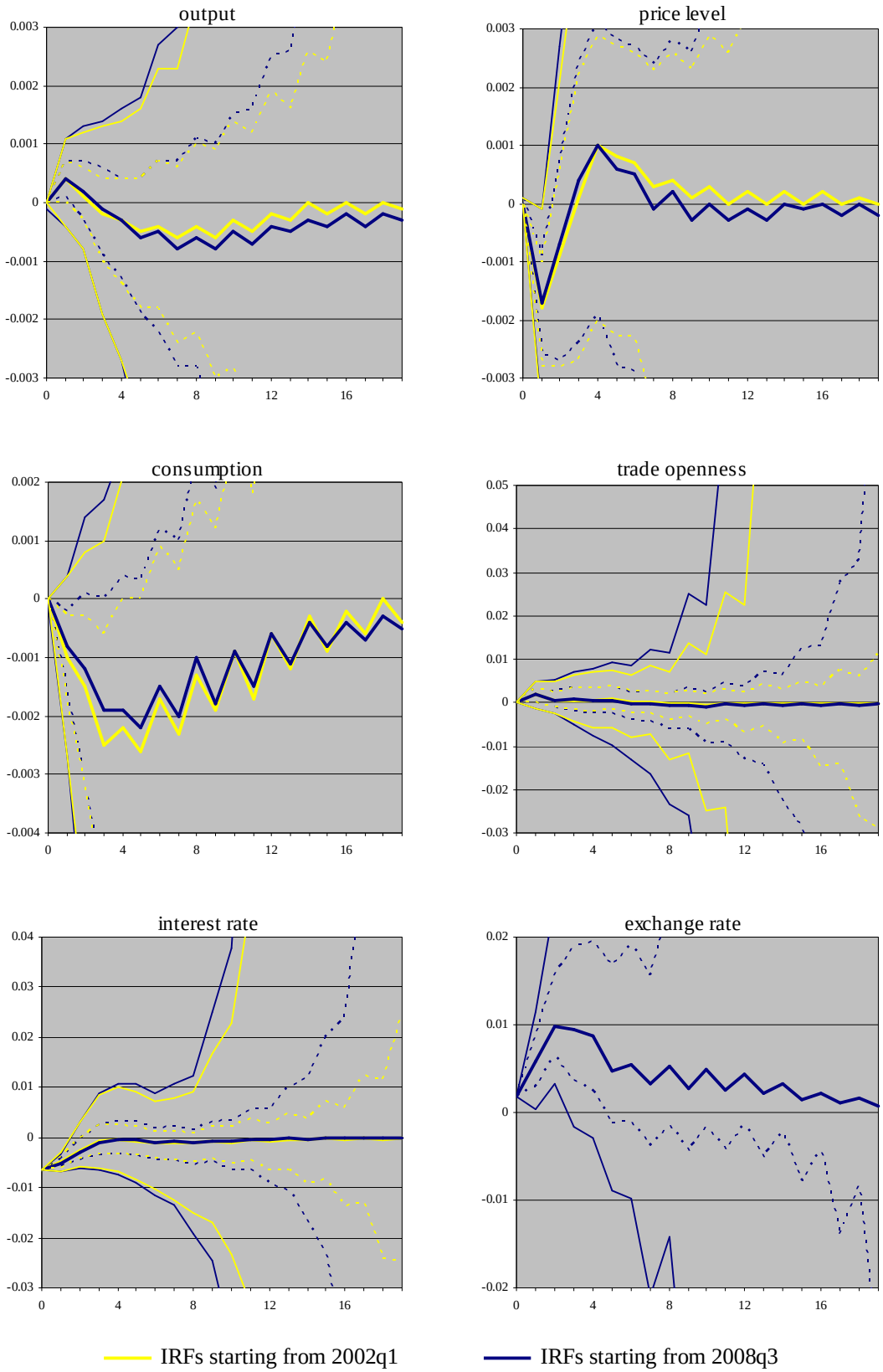
Source: own calculations

Note: continuous bold lines represent difference of the median, thin continuous lines represent 90%, dashed lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

The IRF-s from the six-variable version of model (3.1) are shown in *Figure 3.12.a* and *Figure 3.12.b*. Again the difference of the reaction of exchange rate is minimized with additional exchange rate shocks, although the reaction of the exchange rate is difficult to interpret, because it further depreciates after the shock. Even after the addition of interest rates the greater initial rise in the output is significantly different from the lower openness scenario, as well as the more intensive and rapid exchange rate pass-through. In this experiment the consumption declines both in presence of lower and higher openness, but in the latter case the decline is smaller, and the difference seems to be significantly different from zero on a 60% significance level.

The conclusion of the experiments with trade openness is, that the stronger negative reaction of the consumption to an exchange rate shock was probably caused by the accumulation of foreign currency denominated debt, so the reactions above are not the result from spurious regressions.

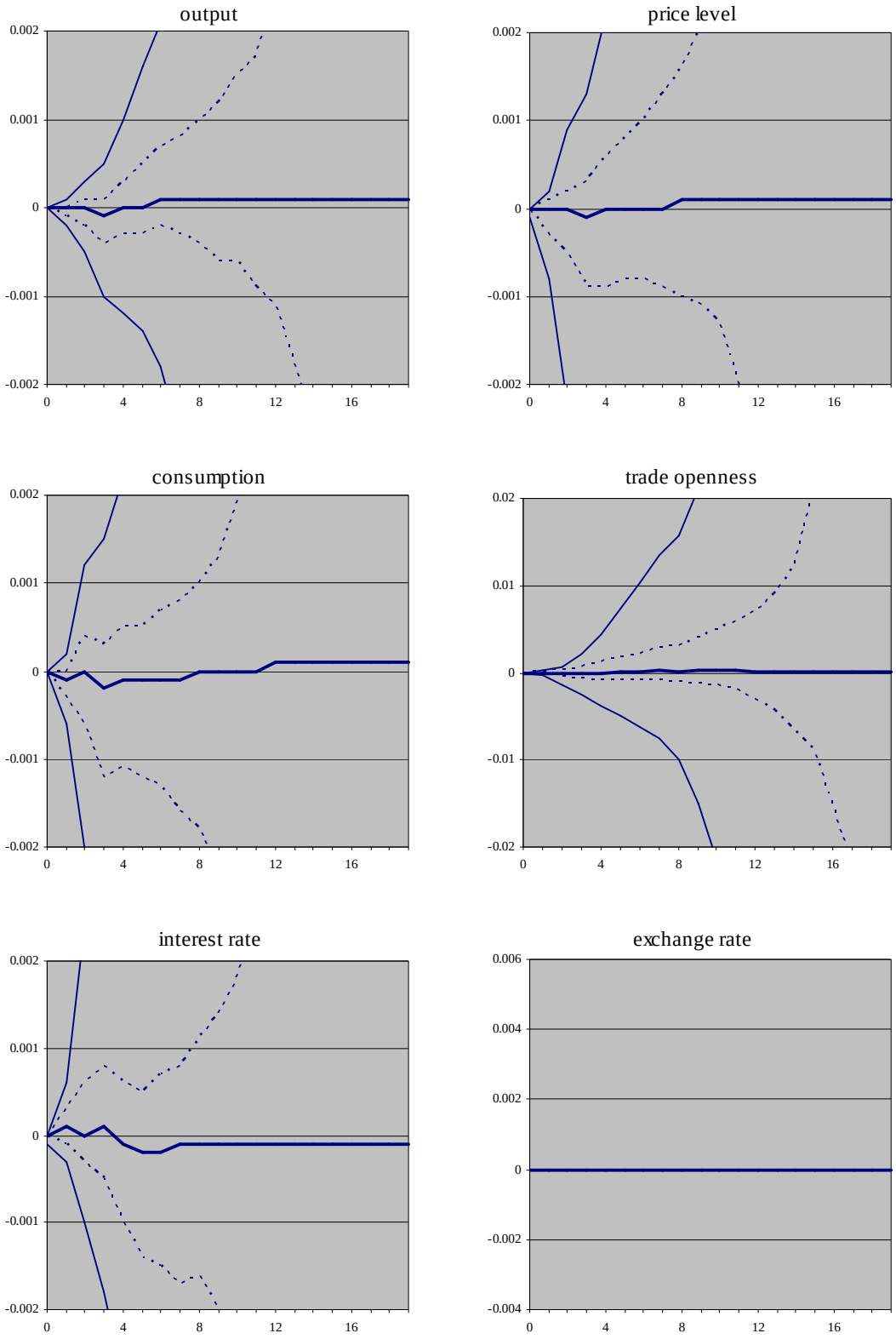
Figure 3.12.a. **Impulse response functions from the 6-variable model, with additional exchange rate shocks and trade openness instead of foreign currency debt (starting from 2002q1 and 2008q3)**



Source: own calculations

Note: thin continuous lines represent 90%, dashed lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

Figure 3.12.b. **Differences of impulse response functions (2002q1 minus 2008q3) from the 5-variable model, with additional exchange rate shocks and trade openness instead of foreign debt**



Source: own calculations

Note: continuous bold lines represent difference of the median, thin continuous lines represent 90%, dashed lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

3.2.5. Conclusion

The aim of the section above was to search for differences in the transmission of monetary policy caused by the Hungarian households' indebtedness in foreign currency. As the rapid foreign currency debt accumulation, driven by interest rate differentials, neglected exchange rate risks in the light of the expected adoption of the euro, making household consumption more sensitive to exchange rate depreciation, the hypothesis was drawn that the exchange rate channel of monetary policy should be weakened or even inverted.

To be able to compare the transmission of monetary policy in case of low and high amount of foreign currency denominated debt, a non-linear VAR model was used to make the resulting impulse response functions conditional on the accumulated debt, which made it possible to compare the reaction of the economy in two scenarios. In the first case the IRF-s were launched from 2002q1, when household foreign currency debt was still negligible, the second case is from 2008q3 where the ratio of household debt denominated in foreign currency reached 64% of households' liabilities. A further advantage of these two dates is that neither the exchange rate nor monetary policy regime changed significantly between these two points in time, keeping regime changes to the minimum.

The results show significant differences of the reaction of consumption in the presence of more foreign currency denominated debt in every scenario, but several counterintuitive movements were found in the case of other variables, which makes the results less solid. On the other hand robustness checks showed that the results were not caused by specification problems, and were robust among specifications.

Summary of the chapter

Aim of this chapter was to show how a change in the environment, namely the increased integration of the financial and other markets influences the monetary policy's ability to affect different variables of the economy to pursue its goal of price stability. After a detailed literature survey the hypothesis was formed that the globalization made the connections that add up the monetary transmission mechanism more uncertain, and that it strengthened some of the channels of monetary transmission (interest channel and wealth channel) while weakened others (broad credit channels).

These hypotheses were tested in a case study. The case study tried to measure if the foreign currency denominated debt accumulated by the Hungarian household changed

the Hungarian monetary policy's main transmission channel, the exchange rate channel. I found that the change in the amount of debt made household more sensitive towards exchange rate shocks. This way a positive shock in the exchange rate (caused by monetary policy or not) caused larger drop in the consumption with more debt accumulated, which after a while dragged the output and price level with it. Admittedly the Hungarian case is a rather extreme one, so it is not sure that the effect of a milder increase in the integration could be detected empirically (see *Kohn* [2006] and *Boivin and Giannoni* [2008a]).

In the next chapter another change in the environment of the monetary policy is investigated, the introduction of the common currency.

Chapter 4. Monetary Transmission and Optimal Currency Areas – The Endogeneity of Monetary Transmission

"In that regard, we believe that countries of the E[uro] *A*[rea]*, and their move toward a common currency, provide a unique experiment for monetary economics."* (*Boivin et al.* [2008] p. 9)

Introduction

The subject of this chapter is the interaction of the common monetary policy of a currency area and the transmission mechanism of the monetary policy. The idea is that the common monetary policy could change the financial environment and, through this slowly change the effect of monetary policy in the member economies of the currency area.

Three questions are investigated in this Chapter:

- Do the differences in the monetary transmission act in the same way as the other criteria in the Optimal Currency Area literature?
- Were there differences in the monetary transmission mechanism among the members of the European Monetary Union in 1999?
- Do the differences from the beginning of the EMU change due to the endogeneity of transmission mechanism?

The remainder of the chapter is built up as follows: as a first step the optimal currency area literature is introduced to serve as a framework for the investigation of differences in the monetary transmission (4.1). The next step is to use the euro area as an example, in which the differences of transmission are examined using various methods and results from the literature (4.2). I then ask the question what happened to these differences after the introduction of the common currency, and try to answer it first with the help of a literature review (4.3) and by estimating a vector autoregression model for the five largest EU countries (4.4). Summary closes the chapter.

4.1. Literature of the optimal currency area and the monetary transmission mechanism

After the decision in 1992 to establish the European Monetary Union (EMU), the criteria, drawn from the optimal currency area (henceforth OCA) literature, were often referred to for help in deciding whether the advantages of a single currency[92] used by multiple countries outweigh its drawbacks.

The advantages of a single currency are mainly on the micro level[93]; by making prices more comparable it can help to integrate the market and intensify competition. The macro level costs linked to the use of a single currency mostly arise from the loss of an independent monetary policy which could be used as a tool by the economic policy for adjustment. This could cause problems in cases when an asymmetric shock affects different countries using the single currency, and the common monetary policy cannot or will not react in the way the independent monetary policies would have done. So one way to answer the question, whether the loss of an independent monetary policy created disadvantages, is to measure the probability of asymmetric shocks. This could be done using mainly real variables, such as the synchronisation of business cycles or the degree of trade openness towards third (non currency area) countries. So the first criterion for an optimal currency area is the need for symmetric, common shocks (*Kouparitsas* [1999]).

The other criteria from the OCA literature try to measure the other means of adaptation to an asymmetric shock (other than the country's own monetary policy); candidates here are the internal factor mobility (within the area, between the member countries) and the flexibility of prices and wages, to make a quick symmetric adjustment possible (*Kouparitsas* [1999]).

After reviewing the traditional criteria of the OCA literature, in this section I argue for the inclusion of another kind of criterion - the difference in the monetary transmission mechanism. This new-old[94] criterion could be grouped to the sources of asymmetric shocks, because if the timing or the strength of monetary transmission differs among

[92] One should not forget that the origins of the OCA literature lie back in the Bretton Woods era, so the original idea is about fixed exchange rate systems, and not a common currency. This also explains the strong belief in monetary policy as tool of adaptation (stable short-term Phillips curve).

[93] There can be macro level advantages as well, for example if the credibility of the common monetary policy exceeds that of the country's own previous monetary policy (see *Tavlas* [1993], *Bofinger* [1994]).

[94] On one hand this is a new idea because the basic OCA literature never mentions the monetary transmission as a possible source of asymmetric shocks (e.g. *Bonfinger* [1994] introduces asymmetric monetary shocks, but in his definition this means sudden exchange rate devaluations). On the other hand this is old news, because there are many articles and papers (see section 4.3 for the review) which try to measure the differences in the transmission mechanism for the evaluation of currency unions' sustainability.

countries, then the countries would react differently (different changes in the aggregate demand or in the inflation itself) to the same interest rate change, making the common monetary policy steps a source of asymmetric shocks. This would cause the same problem for the monetary policy as a car would for the driver given that the different wheels of the car would accelerate (or decelerate) differently in response to a movement of the accelerator (or brake) pedal. It definitely wouldn't be easy to steer such a vehicle. If there are such differences in monetary transmission, then either it is not a good idea to introduce a single currency together with a common monetary policy at all, or there is a need for an even more flexible economy to be able to adapt to the asymmetric shocks caused by monetary policy as well.

4.1.1. Review of the Optimal Currency Area literature

The purpose of this subsection is to show the logic of the original OCA criteria[95], so I will not review the literature that investigated the readiness of the European countries for monetary unification[96], I just focus on the different criteria. The OCA literature can be divided into two parts, the first tries to measure the probability of an asymmetric shock within the currency area; the second investigates the possible adaptation mechanism in absence of a country's own monetary policy.

Avoiding asymmetric shocks

Mundell [1961]'s starting point is that the flexible exchange rates can only play their role as a stabilizer, thus decreasing unemployment with depreciation and helping fight inflation with appreciation, if the given currency with a flexible exchange rate belongs to an economic region. In Mundell's region there is a homogenous group of suppliers, who use the same technology and face the same demand function, so they "*suffer and prosper together*" (*Kenen* [1969] p. 42.). If the currency does not belong to such an economic region, or if two areas fix their exchange rate without forming an economic region, then a shock would cause inflation or unemployment, which cannot be avoided by the use of monetary assets.

I use the example from *Mundell* [1961] to illustrate this. Let us assume two countries (A and B[97]) with equilibrium employment and balance of payments, and with sticky prices and wages. The two countries maintain a flexible exchange rate system with each other. Let us assume that both countries contain the two cross-border regions C and D. In C the timber industry is important; in D the automotive industry is predominant. If the

[95] For a more thorough review see *Horvath* [2003]
[96] See, just for an example: *Bayoumi and Eichengreen* [1992], [1994], [1997], *Alesina et al.* [2002].
[97] The USA and Canada in the original version.

demand for timber increases, then inflation rises in region C and unemployment rises in region D. So there is inflation in one part of both countries and unemployment in the other part. The flexible exchange rate that tries to bring into balance the accounts of countries A and B can not help in such a situation; however if there were regional currencies connected by a flexible exchange rate, then C's currency would appreciate against that of D. This movement in the exchange rate would at the same time help the inflation in C and the unemployment in D. *Mundell's* example shows that a flexible exchange rate can only stabilize if it connects regional currencies. A fixed exchange rate between regional currencies would generate the same problem, inflation in C and unemployment in D. In case of fixed exchange rates the monetary policy can let prices rise in C, to ease the unemployment pressure in D, as the inflation in C would make the cars in relative terms cheaper against timber products. Would C and D use the same currency, then the common monetary policy would have to decide whether to tolerate inflation in the hope of reducing unemployment. In all the examples above stabilization could have been achieved with unemployed workers migrating from D to C, solving the unemployment problem in D and, through increased labour supply, reducing the inflation pressure in C, the same solution could be achieved even by partial migration. Next to the homogenous production structure this is the other part of *Mundell's* definition of the economic region, a more flexible flow of factors inside the region compared to the flow among the regions. An economic region would constitute an optimal currency area, and should use one currency[98] or fix the exchange rates inside the area.

Kenen [1969] added another condition. In his case diversified production is needed for a region to become an optimal currency region. In his definition the optimal currency area contains a region with diversified production structure or many one-product regions. This would help to limit the effect of technical or terms of trade shocks to smaller parts of the region, keeping exports stable and making adjustment less costly. The flexibility of the economy to absorb the workers laid off from the sector affected by the shock is also a requirement. This happens more easily if the sectors and workers are not heavily specialised, which also means that shocks affecting multiple sectors are more common. If the sectors use specialized workers then it is harder for the other sectors to absorb the unemployed workforce, but the shocks would be more independent as well. *"Again, a*

[98] Mundell held that it was impossible for a country to give up its own currency for a common currency. *"It might seem at first that the question is purely academic since it hardly appears in the realm of political feasibility that national currencies would ever be abandoned in favour of any other arrangement."* (*Mundell* [1961], p. 657.)

major caveat: My argument does not apply when changes in export demand arise from business-cycle swings. When those occur, the whole range of exports will be hit, and export diversification cannot forestall 'imported' instability." (*Kenen* [1969] p. 53.) But such a shock would hit the whole economy, making it a symmetric shock.

Following *Frankel and Rose* [1996] the best way to avoid asymmetric shocks, or to achieve the synchronization of business cycles, is the introduction of a common currency. A common currency reduces transaction costs and through this it raises the level of commercial activity. A higher level of commercial activity makes the connection between the economies tighter, leading to the synchronization of the business cycles. So the best way to avoid the costs of losing the possibilities provided by one's own monetary policy after the introduction the common currency is to introduce a common currency, because readiness for a common currency is an endogenous process[99]. The key momentum in the argument for endogeneity is that a currency union tightens commercial relations, which again makes the business cycles more harmonized. The original estimates of *Rose* [2000] resulted in the famous 300% increase in trade between two countries that share the same currency. However his sample contained small and poor countries, *"(t)hus any extrapolation of my results to EMU may be inappropriate since most currency union observations are for countries unlike those in Euroland."* (*Rose* [2000], p. 15). *Rose* [2002] reviews (with meta analysis) the empirical evidence concerning the effect of currency unions on trade volume; he finds that although the findings are heterogeneous, the common currency at least doubles the trade volume.[100,101] These results seem to be rather optimistic, and it is not clear what degree of harmonization is needed for an area to become an optimal currency area, or for the endogeneity process to operate (the question is, can any two countries form a successful currency union?). *Krugman* [1993] debates whether the increase in the level of trade would lead to the synchronization of the business cycle, and predicts the opposite - that the high level of trade leads to regional specialization, which increases the probability of asymmetric shocks.

[99] The Lucas critique (*Lucas* [1976]) says that it is not possible to decide, on the basis of historical data, whether the common currency is advisable for a country or not. As the introduction of common currency would change the institutional environment, which would change the behaviour of the agents in the economy, so their behaviour can't be forecasted.

[100] *Rose* [2002] found that if he was a co-author of a given paper, than the results were significantly higher.

[101] As could be expected, Rose's results launched a separate branch in the literature; for further meta-analysis see *Rose and Stanley* [2005] and *Havránek* [2009]. For the trade increase among EA countries, see subsection 4.3.3 below.

Adjustment

Returning to *Mundell's* definition, the flow of factors inside an optimal currency area should be greater than between the economic regions. Such flexibilities as migration or flexible prices and wages can help to decrease the effect of an asymmetric shock even if it hits some parts of the given region.

"I think the efficacy of a currency area depends on policy positions taken by governments and on the firmness of their commitment to them, on attitudes of the population toward the adjustment processes involved, on the nature of financial and other institutions, and on some economic considerations that are largely omitted from much present analysis." (*Ingram* [1969] p. 97) *Ingram* [1969] questions whether on this high level of abstraction, leaving out adjustment mechanism and government, can lead to any useful insights. *Mintz* [1970] also emphasizes the political willingness of governments to pursue monetary unions as the most important factor for forming currency areas. *Mussa* [1997] reasons along the same line, and emphasizes the importance of the political aspects of the question, leading him to the political theory of currency areas. He distinguishes between currency areas, in which countries fix their exchange rate and show a relatively low level of political commitment, and currency unions, in which countries show a relatively high level of political commitment by irreversibly fixing their exchange rate through the introduction of a common currency. If the introduction of the common currency has political aspects, then an asymmetric shock also has political significance, since the asymmetric shock and the following policies can endanger political cooperation, because countries often blame the currency union for the problems which arise.

If asymmetric shocks can cause political problems, then members must be prepared for political solutions as well. *Kenen* [1969] thinks that monetary and fiscal policy should work together to find the right solution. For this to work the fiscal and monetary policy should be defined for the same region. The fiscal area cannot exceed in size the monetary/currency area because this would raise the question of which currency to collect tax in, and which currency to issue debt in. If the fiscal area contains several regions with only one product then it is able *"to offset or compensate for regional differences, whether in earned income or in unemployment rates."* (*Kenen* [1969] p. 47) After all, most transfers are interregional in nature and are connected to social issues or unemployment problems. So *"the budget can still combat localized recession"* (*Kenen* [1969] p. 47.). *Buiter* [2000] also thinks that "[b]*ecause monetary union is not just a*

technical monetary, financial and economic issue, but also an important political and constitutional arrangement, monetary union can only survive when a minimal degree of political integration is present." (*Buiter* [2000] p. 215.)

McKinnon [1963] defines an optimal currency area as an area where an optimal mixture of fiscal and monetary policy, together with flexible exchange rates can achieve internal and external equilibrium with stable price level[102]. Given the problems of his time *McKinnon* [1963] also thought in terms of fixed exchange rates rather than common currencies.

His argument is that the flexible exchange rate makes the domestic price level unpredictable in small open economies, where the prices of many products depend on the import prices and the exchange rate. A fixed exchange rate would decrease this uncertainty, making the economy more predictable. According to *McKinnon* [1963] fixed exchange rate in a small open economy decreases the cost of policy steps because an income decrease would decrease the domestic consumption of the exported products, leaving a larger amount for foreign consumption. At the same time a drop in the households' income would also lower the domestic consumption of imported products and the products of the home country's non-tradable sector. As a result the current account deficit would decrease and unemployment in the domestic non-tradable sector would increase, which is relatively small compared to other sectors in a small open economy. In a large closed economy the argument would be turned upside-down; the non-tradable sector is important, that's why the flexible exchange rate would have a smaller effect on the price level. Would the domestic fiscal or monetary policy try to fix the current account deficit, than it would produce higher domestic unemployment than letting the flexible exchange rate solve the problem. To sum up, for a small open economy it is much easier to maintain its internal and external stability if its exchange rate can be credibly fixed. *Ricci* [1997] showed in his model that the effect of openness is not so straightforward; on the one hand it is true that openness reduces the cost of fixed exchange rates for reasons given by *McKinnon* [1963], but on the other hand openness also increases the probability of asymmetric terms of trade shocks, which again raises the cost of a fixed exchange rate or common currency.

Tavlas [1993] studies monetary integration, which includes fixed exchange rates, integrated financial markets, free capital movement and coordinated monetary policy,

[102] This third factor is important, because *"any capitalist economy requires a stable valued liquid currency to insure efficient resource allocation"* (*McKinnon* [1963] pp. 717.)

but not necessarily the introduction of the common currency, which he calls monetary unification. Such an integration could stabilize the exchange rate, creating an environment which could help trade and financial markets to develop, leading to better resource allocation. The downside is that influence over the exchange rate is given up, thus losing a tool for fixing terms of trade shocks. But what if, the exchange rate is not a tool of adjustment, but more a source of shocks in the era of integrated capital markets as in *Buiter* [2000]. In that case it is probably better to get rid of them, and introduce a common currency.

Summary

To sum up, according to the OCA literature it is desirable to introduce a common currency (or fix the exchange rate) if the probability of an asymmetric shock is small, which could be achieved with either a similar or well diversified production structure inside the area adopting the common currency. Paradoxically, already using the common currency might in some cases endogenously decrease the chance of an asymmetric shock, making the common currency more desirable. Aside from asymmetric shocks the ability to adapt to shocks could also be necessary. This includes flexible factor movement, flexible prices and wages, and also the political commitment towards the currency union, leading to an increased fiscal integration. The effect of openness is not clear, because on the one hand it makes a fixed exchange system more desirable for small economies, while on the other it increases the probability of asymmetric terms of trade shocks, which are usually better absorbed by a flexible exchange rate.

4.1.2. Monetary policy as a source of asymmetric shocks

"If the consequences of, for instance, a monetary contraction were different from one country to another – both in terms of timing and the magnitude of responses of relevant variables – the output cost of maintaining price stability could be quite unevenly distributed across EMU." (*Favero and Giavazzi* [1999] p. 1.)

In this section I show that a difference in monetary transmission mechanisms between two countries can serve as an important condition for a common currency. This is the first step towards handling the changes of monetary transmission caused by the currency union inside the optimal currency union. To be able to fit this new criterion into the OCA literature, first I show that differences in monetary transmission mechanisms can cause asymmetric shocks.

Let us assume two countries (again A and B) with a common currency.[103] The common monetary policy is responsible for the inflation in the currency area, defined by the price changes of an average consumer basket. Let us assume that the monetary transmission is stronger and quicker in country A. There can be several reasons why the economy is more sensitive to an interest rate change. Looking again at *Figure 2.1*, there could be differences at any stage. The interest rate pass-through could be stronger, the non-financial firms and households could react more intensively to changes in the financial environment, or the pricing behaviour could differ between the two countries. What happens in the case of inflationary pressure (caused by, say, a beneficial terms of trade shock)? The monetary policy raises the interest rate in accordance with its aim, to avoid causing the divergence of the area wide inflation rate from its target, i.e. to maintain price stability.[104] But this step causes a bigger contraction in country A than in country B, meaning higher unemployment and lower inflation rates. In country B, the rise in the interest rate was not high enough, so it suffers a higher inflation than the desired level. In the end neither of the countries achieves the target inflation rate, and again there is increased unemployment in one of countries and increased inflation in the other one, just as in Mundell's example above.

The problem with a difference in the timing and strength of the reaction to a monetary policy impulse is that even if the economies' business cycles are synchronized, so that the common monetary policy shock comes at the right time in all the member countries, the different economies would react differently, so their business cycles would be thrown out of synchronization. This effect would endanger the survival of the currency area, even if one accepts that political will is the most important factor for the maintenance of a common currency. It is harder to ensure political backing in the presence of economic losses (inflation, unemployment).

The other reason this criterion should be treated within the OCA literature is that the same adaptation mechanism can ease the problem as was previously the case. A greater factor flow among member countries (labour or capital), flexible adaptation of wages and prices or fiscal transfers can help to cushion the economic losses.

[103] The story would be almost the same with a fixed exchange rate between the two countries. Both exchange rate regimes means that there is one real monetary authority in the two countries. However there is one crucial difference between the two cases: with a common currency the monetary authority is responsible for the monetary processes of the whole currency area; with fixed exchange rates the leading central bank focuses on its own country's economy.

[104] Some kind of inflation targeting framework is presumed in this step.

4.1.3. Conclusion

As *Bofinger* [1994] states: OCA theory *"seems to be almost generally accepted as the main touchstone of the advantages of EMU and as the theoretical basis for all empirical tests in this area."* (*Bofinger* [1994] p. 1.) I reasoned in the section above that the common monetary policy can be seen as a source of asymmetric shocks, in case the monetary transmission mechanism differs in different member countries. If this was the case then the differences in transmission should be treated within the OCA literature, using the same processes for adaptation. After establishing the place of differences in the monetary transmission inside the optimal currency area literature, further questions arise. The question of endogeneity is a popular notion, since *Frankel and Rose* [1996], in the literature, so the possibility that monetary transmission changed because of the introduction of common currency is worth investigating.

In the next sections I start this investigation. As a first step I show whether there were differences in the monetary transmission mechanism of the countries that later introduced euro. This is followed by the question, how the introduction of euro changed the transmission.

4.2. Differences in the monetary transmission mechanism before the EMU

> *"The existing empirical evidence does not give a clear picture of how important these differences actually are, or if they even exist."* (*Elbourne and de Haan* [2004] p. 1.)

In this section I will summarise the various empirical papers reasoning in favour of or against the "dangerous" differences in the monetary transmission mechanism, thus revealing the source of the puzzle lying behind the quote at the beginning of the section. I summarize the parts of those papers that concentrate on the state of transmission based on data gathered before or shortly after the start of EMU's the third stage But one must keep in mind, that the introduction of a common currency together with a common monetary policy acts as a 'regime change', and since the Lucas' critique (*Lucas* [1976]) it has been recognized that such a change can affect the relationships within an economy. So pre-EMU differences do not automatically also indicate post-EMU differences. I will turn to post-EMU differences later in section 4.3. Various methods were used by the authors, so the papers are grouped according to the methods they adopt and, if possible, by transmission channels.

During the literature review I only concentrate on the countries, who were first to introduce the euro, so I will not include Slovenia, Cyprus, Malta or Slovakia. The reason for this is that changes in the transmission mechanism may take time, so I focus on countries that spent the longest time inside the monetary union.

4.2.1. Key variables

A fairly big strand of the literature relies on structural differences to show the differences in monetary transmission. This method is favoured for two reasons; first the collected key variables are supposed to be connected to one of the channels of transmission and in this way the authors try to establish the strength of the different channels. The second reason, expressed by *Guiso et al.* [2000], is that it is believed that these key variables refer to real micro level relationships (behavioural responses) that could survive a regime change owing to their longer accommodation time, and in this way they expose more about the true structural relationships of the monetary transmission than the other methods (VARs etc.).

This method also has a clear drawback, mentioned by *Suardi* [2001], because it only allows the strength of a channel to be compared relative to the same channel in another country, and nothing can be revealed about the varying importance of channels within a given country. In this way the method cannot show the differences in the strength of the complete transmission. Nevertheless *Guiso et al.* [2000] consider this even as an advantage, because they intended to look only at the channels to avoid an aggregation bias, as the micro data can also help to decide whether the differences are caused by agents behaving differently in the different countries or whether it is just a composition effect. In the next paragraphs I will proceed channel-by-channel.

From changes in instrumental variables to changes in the price of other financial assets (interest rate pass-through)

There could be differences in the degree to which the changes in the official interest rate can affect the interest rates in the capital market or that of bank loans and deposits. In this sense *Mojon* [2000] finds that the response of short-term credit rates to money market rates is significantly smaller in Italy, Germany and Spain, than in Belgium, France and the Netherlands. These results are almost in line with that of *Heinemann and Schüler* [2002] who find differences in pass-through, especially in retail interest rates; the differences in the reaction after 3 months to a 100 basis points market rate decrease are shown in the last columns of *Table 4.1*. As can be seen, the pass-through is slowest

in Austria and Portugal, which coincides with the degree of competition according to the average Boone indicator calculated by *van Leuvensteijn et al* [2008] for the period 1993-1998. In the case of Belgium and the Netherlands the two measures (competition and interest rate pass-through) are also as expected, as a fast pass-through (at least for mortgage loans) goes hand in hand with intensive competition. The picture is not so clear in the case of Germany, Italy and Spain as the intensive competition showed by the Boone indicator accelerates the pass-through in only one of the markets (mortgage loans in Germany, enterprise loans in Italy and Spain).

Table 4.1. **Measures of interest rate pass-through**

	competition among banks		3 month decrease in retail rates after a one percentage point fall in market rates (in basis points) [a,]		
	HHI [c,]	Boone index [b,]	mortgage loans	consumer loans (short)	enterprise loans (short)
Austria	0.0515	1.62	-14	-60	-44
Belgium	0.0909	-1.81	-107	-98	-83
Finland	0.2324	n/a	n/a	n/a	n/a
France	0.0485	n/a	n/a	n/a	-45
Germany	0.0133	-3.09	-99	23	-13
Greece	0.1165	n/a	n/a	n/a	n/a
Ireland	0.0470	n/a	-56	n/a	3
Italy	0.0210	-5.62	-47	n/a	-167
Luxembourg	0.0222	n/a	n/a	n/a	n/a
Netherlands	0.1802	-2.19	-97	n/a	-62
Portugal	0.0600	0.22	-11	-32	-53
Spain	0.0488	-5.60	-35	-46	-75
Denmark	0.1442	n/a	n/a	n/a	n/a
Sweden	0.2010	n/a	n/a	n/a	n/a
United Kingdom	0.0216	n/a	-62	-73	n/a

[a,] *Heinemann and Schüler* [2002]
[b,] *van Leuvensteijn et al* [2008] p. 38. – average of 1993-1998
[c,] *ECB* [2002], the Herfindahl index is on a non-consolidated basis for total assets of credit institutions in the year 1998. The Herfindahl index is calculated as the sum of the squares of all the credit institutions' market shares, according to total assets. *ECB* [2006]

From changes in the price of other financial assets to changes in the behaviour of households and firms (aggregate demand)

The exchange rate channel

Changes in interest rates tends to influence the exchange rate, and through this the international trade and the output of the given country. As the common currency replaced national currencies, most of what was previously international trade became in this sense domestic, which changed this channel significantly. One way to see how this channel differed among member countries pre-1999 is to show how large a share of their trade went to countries outside the EMU.

Suardi [2001] finds that exports to third countries outside the Euro Area (EA) compared to GDP are proportionally larger in the smaller economies. As can be seen in *Table 4.2* it is 42% in Ireland, 25% in Belgium and 22% in Austria. In Germany it is 13% of GDP, 14% in the Netherlands; in France and Italy it is about 10%, in Spain and Portugal 7%, and just 1% in Greece according to data from Eurostat (which includes imports and exports of goods, but not of services). On the other hand the extra EA-12 import also tends to be bigger in the smaller economies (26% and 22% in Belgium and the Netherlands, 10% in Germany, 8% in Spain, 6% in France and 7.5% in Italy), which means that there are smaller differences in the net exports. Altogether these findings do not indicate that the differences in the exchange rate channel should be large after the introduction of the euro. As shown later these findings do not help to explain the macro results of *van Els et al.* [2001], who found - using other methodology – that this exchange rate channel is important in Germany, Austria and Spain.

Table 4.2. **Measures of the exchange rate channel**

	Extra EA-12 exports of goods as share of GDP (1998)	Extra EA-12 exports of goods as share of exports (1998)	Extra EA-12 imports of goods as share of GDP (1998)	Extra EA-12 imports of goods as share of imports (1998)
Austria	0.126	0.420	0.100	0.295
Belgium	0.254	0.268	0.265	0.323
Finland	0.219	0.658	0.143	0.606
France	0.095	0.466	0.067	0.362
Germany	0.136	0.555	0.106	0.505
Greece	0.013	0.270	0.047	0.275
Ireland	0.422	0.549	0.379	0.804
Italy	0.102	0.516	0.074	0.438
Luxembourg	n/a	n/a	n/a	n/a
Netherlands	0.145	0.297	0.220	0.503
Portugal	0.074	0.348	0.097	0.304
Spain	0.075	0.401	0.086	0.385
Denmark	0.145	0.528	0.118	0.467
Sweden	0.201	0.597	0.140	0.521
United Kingdom	0.026	0.207	0.035	0.244

Source: Eurostat

The cost of capital channel

The structure of production can shed light on the interest rate sensitivity of production. *Dedola and Lippi* [2005] find sizeable and significant differences between various industries, by running VAR models on data from 21 different manufacturing sectors in five OECD countries.[105] The differences between the industries are bigger than those between countries, which are hardly detectable. The demand for durable goods can be

[105] France, Germany, Italy, the UK and the USA

more sensitive to changes in the interest rate and capital intensive sectors (mainly heavy industries, such as machinery and transport) ought to be more affected by changes in the alternative costs of capital. *Dedola and Lippi* [2005] find that Germany is more specialised in durable goods production than Italy, France and the U.K. As can be seen in the third column of *Table 4.3*, Germany also has a bigger share of capital intensive production.

Suardi [2001] uses the level of investment as a share of output, because according to his explanation a higher level tends to come with a higher interest rate sensitivity in the six euro area countries on average in 1999-2000 (19-23% of GDP), than in Sweden and or the U.K. (16-17%), according data from Eurostat. In his opinion Italy and Germany should be more sensitive. The data in the first column of *Table 4.3* shows the investment output ratio in 1998. The picture here is almost the same as in *Suardi* [2001], with the exception that here Portugal has the highest investment compared to its GDP, making it a perfect candidate for a strong cost of capital channel based solely on this indicator. *Guiso et al.* [2000] use the ratio of fixed capital to output to reveal the need for investment; the higher this ratio is, the more investment is needed to keep it high, and the more investment is needed the more interest rate sensitive it should be (see *Table 4.3*). *Chatelain et al.* [2001] estimate a neoclassical investment equation for Germany, France, Italy and Spain on micro panel data. The different estimators produced different results, but they draw the conclusion that user costs enter the estimation significantly and in all estimations of the user cost elasticity is greater in Germany than in the other three countries.

Guiso et al. [2000] and *van Els et al.* [2001] also use the maturity structure to show the exposure of firms to interest rate changes (see *Table 4.3*). The investment needs of the German firms are balanced by a relatively small proportion of short term, interest rate sensitive financing. The Netherlands also have a low proportion of short term financing; on the other hand in Italy and Belgium short term finance accounts for half of all finance (in the case of Finland and Sweden a lack of short term loans make the ratio very low).

To summarize, according to the indicators there is reason to believe that the cost of capital channel should be strong in Germany (total capital output ratio, share of capital intensive production), in Belgium (proportion of short term financing, total capital intensive production) and Italy (proportion of short term financing, total capital intensive production). This result is in line with the result of *van Els et al.* [2001], who found a strong cost of capital channel in Italy (see *Table 4.9*).

Table 4.3. **Measures of the cost of capital channel**

	Investment/output (1998) [a,]	Total capital output ratio [b,]	Share of capital intensive production (1998) [a, c,]	Proportion of short term financing (1998) [a, d,]
Austria	0.240	n/a	0.274	0.304
Belgium	0.202	3.0	0.275	0.502
Finland	0.190	n/a	0.295	0.045 [e,]
France	0.179	3.0	n/a	0.321
Germany	0.211	4.0	0.318	0.205 [f,]
Greece	n/a	n/a	n/a	0.419
Ireland	0.214	n/a	n/a	n/a
Italy	0.193	3.2	0.269	0.509
Luxembourg	n/a	n/a	n/a	n/a
Netherlands	0.222	n/a	0.261	0.214 [f,]
Portugal	0.265	n/a	0.246	0.289
Spain	0.230	n/a	0.281	0.381
Denmark	0.204	n/a	0.212	n/a
Sweden	0.163	n/a	0.273	0.044 [e,]
United Kingdom	0.177	1.99	0.260	n/a

[a,] Eurostat
[b,] *Guiso et al.* [2000]
[c,] Capital intensive production in this sense includes: Mining and quarrying (C); Manufacture of coke, refined petroleum products and nuclear fuel (DF); Manufacture of chemicals, chemical products and man-made fibres (DG); Manufacture of basic metals and fabricated metal products (DJ); Manufacture of machinery and equipment n.e.c. (DK); Manufacture of electrical and optical equipment (DL); Manufacture of transport equipment (DM); Electricity, gas and water supply (E); Construction (F)
[d,] The proportion of short term financing is defined as the sum of short term loans (F41) and trade credits (F71) divided by financial liabilities (F_LI) minus shares and other equities (F5) as liabilities of non-financial corporations.
[e,] There is no data concerning short-term loans in Finland and Sweden
[f,] There is no data concerning trade credits in Germany and the Netherlands

Wealth and income channels

Changes in households' wealth can affect aggregated demand through their effect on consumption, as shown in Chapter 2 In this subsection I show the differences in the possible reaction of households' wealth to interest rate changes, and the differences in how consumers would have reacted to the changes in their wealth in 1998. Financial wealth and real estate wealth are treated separately.

Byrne and Davis [2002] compare the financial balance sheets of the households of the 4 biggest EU countries (Germany, France, Italy and the United Kingdom), searching for trends and signs of integration between 1980 and 2000. They find that on the asset side the deviations are not smaller in the case of the three continental economies than for all four countries (except in the case of life and pension funds, where the lesser development of the continental pension funds results in similar holdings and smaller deviations), which means that the three continental countries are no more similar to

each other than the four EU countries.[106] On the liabilities side one group consists of Germany and UK with a higher amount of debt, while Italy and France are also similar with a lower amount of debt. Looking at a wider sample of countries, one can draw the conclusion that there are fairly large differences in the level of financial assets ranging from circa 90% of GDP in Finland to 303% of GDP in the UK (see *Table 4.4*) and in the level of financial liabilities (see *Table 4.5*) as well; here Italian households are the least indebted with liabilities reaching 24% of GDP and Danish households the most indebted, having 102% of GDP as liabilities.

***Table 4.4.* Measures of wealth, income and the substitution channel**

	Financial assets	Total currency and deposits	Securities other than shares	Quoted shares	Life assurance and pension fund reserves	Net interest bearing assets [a,]	Quoted shares as a proportion of financial assets	Self-employed as a proportion of employees
	as a % of GDP							
Austria	141.9	77.0	10.8	3.89	22.9	38.6	0.03	0.059
Belgium	289.6	73.9	63.0	25.55	34.8	91.9	0.09	0.136
Finland	89.5	36.0	2.2	14.72	12.8	6.3	0.16	0.103
France	159.9	60.4	5.2	7.18	45.8	29.3	0.04	0.062
Germany	161.2	63.9	11.6	10.59	44.8	3.1	0.07	0.049
Greece	150.0	63.0	11.1	22.81	3.1	63.8	0.15	0.250
Ireland	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.128
Italy	220.9	60.8	47.8	n/a	20.8	85.1	n/a	0.120
Luxembourg	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Netherlands	290.4	54.3	7.8	n/a	152.5	-17.5	n/a	0.068
Portugal	232.8	82.8	6.8	13.73	24.8	64.9	0.06	0.197
Spain	173.1	62.0	4.3	14.76	19.4	18.6	0.09	0.147
Denmark	174.9	40.8	17.9	n/a	79.4	-34.38 [b,]	n/a	0.042
Sweden	140.8	25.5	8.5	27.89	52.6	-15.8	0.20	0.069
United Kingdom [c,]	302.6	64.7	7.2	26.90	158.5	5.0	0.09	0.090

Source: Eurostat

[a,] Financial assets that earn interest (deposits + loans + securities other than shares) minus financial liabilities with interest payment (loans + securities) as a percentage of GDP. This is a crude measure of net interest income, as it compares the interest of stocks bearing different interest rates.

[b,] There is no data on deposits in the case of Denmark, so currency and deposits are used instead.

[c,] The source of data in the case of the United Kingdom is the Office of National Statistics.

Van Els et al. [2001] tried to explain the results from central banks' models through key variables, and found that the relatively large net interest rate receivable helps to explain the relatively important income channel found in the case of Belgium. It is interesting that they did not find a similar importance for the income channel in the case of Italy where the amount of net interest bearing assets is also sizeable. *Table 4.4* shows that net interest receivables should also be high in Greece and Portugal (not covered in *van Els*

[106] *Byrne and Davis* [2002] also find that similarities are more remarkable; when they looked through institutional investors and allocated their portfolios directly to households, the resemblance between France and the UK was particularly striking. Here I cannot follow their method because of a lack of data.

et al. [2001]), but low in Germany, Finland and the UK, and even negative in Denmark, Sweden and the Netherlands. Looking exclusively at the net interest earning position is, however, not enough according to *Suardi* [2001]. On the one hand the propensity to consume can be different between debtors and savers, so even if the net interest earnings were positive, the debtors' decreasing consumption could outweigh the increase in the savers consumption in the case of a rising interest rate. Unfortunately there is no data for this. On the other hand, if the debts are mainly long term loans with fixed interest rates, then a rising interest rate would only affect the new loans granted, which would result in a very slow rising of average interest rate burden. Taking these factors into consideration the income effect should even have a stronger positive effect in the case of Italy and France, as 60% and 80% of the households' mortgages were at fixed interest rates until final maturity (see fourth column in *Table 4.5*). For the same reason Danish debtors are protected, as here again mortgages with a fixed interest rate are widespread. Sweden and the UK are more negatively affected as the mortgage interest rates are adjustable, and linked to short term market rates. According to *Mojon* [2000], taking everything together, the income effect should be similar in Germany, Spain, France and Italy.

As the size of the possible wealth effect is often explained by the size and extensiveness of stock holdings, I will focus on this measure to show the possible differences. The direct holdings of quoted shares are sizeable in Belgium, Greece, Sweden and in the United Kingdom, as here they reach 20% of GDP (see the fourth column in *Table 4.4*). Equity holdings also seem to be important in Finland, as almost 16% of households' financial assets is held in quoted shares. *IMF* [2000] cites several results indicating that stock prices have no effect on private consumption in France and Italy; for Germany, the Netherlands and the United Kingdom they find small but significant effects (smaller then the 0.03-0.07 elasticity of consumption found for the United States see Chapter 2). *IMF* [2000] explains these results by the smaller share of stock ownership relative to other financial assets, and by a more concentrated distribution of stock ownership across households in continental Europe.

Van Els et al. [2001] and *Berben et al.* [2004] found that self employment is connected to the size of the substitution effect, which is large in Greece and Portugal – see the last column in *Table 4.4* and sizeable in Italy and Ireland (in the case of Spain and Belgium

on the other hand they found no measurable substitution effect (see *Table 4.9*) despite the relatively large self employed sector).

Table 4.5. **Measures of real estate as a proportion of the wealth and income channel**

	Liabilities [a,]	Residential mortgage debt [c,]	Owner occupied (as % of housing stock) 2001 [a,]	Loan to value ratios (year) [g,]	Mortgage interest adjustment [e,]	Total transaction cost as % price [f,]
	as a % of GDP (1998)					
Austria	43.9	n/a	49	n/a	mostly N and R	n/a
Belgium	41.6	26.5	63	80% (2002)	N 75%; F 25%	n/a
Finland	32.4	n/a	63	70% (2005)	V 90%	n/a
France	44.8	20.0	55	70-80 [h,]	F 80%; V 20%	13.8
Germany	69.7	51.9	42	68% (1999)	F 20%; N 40%; R 40%	7.1
Greece	16.3	6.3	72	56% (2003)	F 30%; V 70%	n/a
Ireland	n/a	26.5	77	n/a	R 57%; F 43%	n/a
Italy	24.1	7.8	71	40 [h,]	V 40%; F 60%	7.4
Luxembourg	n/a	23.3	66	n/a	mostly R some V	n/a
Netherlands	76.1	60.8	50	52% (2006)	V 10%; N 65%; F 25%	n/a
Portugal	60.6	36.9 [d,]	75	54% (2005)	V 100%	n/a
Spain	47.1	23.9	82	65% (2004)	V 80%; F 20%	10.4
Denmark	102.4	75.0	n/a	n/a	V 10%; F 90%	n/a
Sweden	48.1	44.5	n/a	70-75 [h,]	mostly R, short-term N	n/a
United Kingdom	71.4 [b,]	50.6	68	88% (1998)	R 70%; N30%	2.0

[a,] Eurostat
[b,] Office of National Statistics
[c,] *EMF* [2008]
[d,] 1999
[e,] *Maclennan et al.* [1998] F: fixed rate until final maturity; N: renegotiable, fixed rate not over entire term, but for more than one year; V: variable; R: reviewable, rate adjustable at discretion of lender
[f,] *Maclennan et al.* [1998] on an £80,000 property
[g,] *EMF* [2009], from the earliest year available
[h,] *Lea et al* [1997] cited by *Suardi* [2001]

As shown in Chapter 2, housing wealth can work in the same way as financial wealth, so there are wealth- and income effects. This is not surprising as real estate typically becomes the largest component of household wealth, so variations in house prices may have a large impact on households' perception of their wealth and permanent income as well as on their borrowing possibilities.[107]

The effect of increase in house prices depends on the level of owner occupation. In the case of owner-occupation the wealth effect dominates, but with tenants in the market

[107] *Calza et al.* [2007] find a connection between the development of the mortgage markets and the effect of monetary policy, as in countries with a more developed mortgage market (a higher loan-to-value, mortgage to GDP ratio) the peak effect of the monetary policy is stronger.

rented sector it is unambiguously negative (because rents tend to rise with house prices (the negative income effect) and future buyers have to save more to be able to buy a home of their own). Owner occupation is traditionally high in the Mediterranean countries and Ireland, and low in Germany and Austria. So leaving everything else aside a rise in house prices should have a stronger effect on spending in Spain than in Germany.

As transaction costs influence the liquidity of real estate, these costs can also influence how easy it is to withdraw increased house value. The data here focuses on the bigger EU countries, as shown in the last column of *Table 4.5*. The transaction costs are high in France and Spain, and very low in the United Kingdom.

Loan to value ratios indicate to what extent housing is believed to be good collateral (how easy it is for example to repossess a property in the case of a loan default). The more 'spendable' a house is (the higher the proportion of the house's value can be converted into a loan), the more house prices will impact on consumer spending. The smallest loan to value measures can be found in Italy, Greece and Portugal, with the highest in Belgium and the UK.

Guiso et al. [2000] use months required to repossess and repossession cost as a percentage of house value (the estimated legal cost of enforcement) to show how easily the bank can liquidate the collateral in the case of non-performing loans, i.e. how easy it is to enforce the contract. The easier it is to enforce the contract, the easier the bank will grant mortgage loans. Both variables show that enforcement costs are high in Italy and relatively low in the UK, so it should be easier to smooth consumption in the UK than in Italy. It is also harder to enforce contracts in Spain and Belgium, which like Italy are countries with a legal system derived from French legal system (civil law).[108]

Taking the effects together and using *Peersman's* [2001] summary, the transmission effect through asset prices (other than the exchange rate) should be above average in the UK and Ireland, and below average in Austria and Germany. It is interesting that based on the indicators above Greece should also have above average sensitivity to changes in asset prices.

[108] See *Cecchetti* [1999], who argues that legal systems with different origins cause different financial systems and - through this - different transmission mechanisms, later in this Chapter.

Credit channel

Credit channels tend to amplify the asymmetric information problems in the financial system. This channel can be divided into 2 separate mechanisms. The first is the bank lending channel, where financially weak or small banks tend to decrease the amount of credit provided. In this case the size and health of the banking system can provide some information about the probability of a functioning bank lending channel. The second mechanism is the balance sheet channel where weak debtors will not receive credit after a monetary shock because of asymmetric information problems, the lack of alternatives or the devaluation of the assets that could have served as collateral.[109]

To measure the importance of small banks *Kashyap and Stein* [1997] use the ratio of assets controlled by 3, 5, and 10 of the largest institutions/commercial banks, and they point to a similar conclusion: there tend to be larger banks in a dominant position in Belgium and the Netherlands, while smaller banks control a significant proportion of the assets in Italy, Germany and Luxembourg. (see the first column in *Table 4.6*). However it is not always a good idea to use the size of the banks as a proxy for a possible credit channel. *Ehrmann and Worms* [2001] find that the German banking system as a whole attracts funds from foreign banks during monetary tightening, while smaller banks rely on their own networks. Continuing the suggestions of the previous papers both *Worms* [2001] and *Ehrmann and Worms* [2004] show on a German example that size itself provides no information about the bank lending channel in a case where the banks are organized into networks, which through intra-network liquidity management is made possible by large head institutions. So in response to a monetary tightening, funds are redistributed within the bank network, and the small banks do not reduce their lending, but make use of the liquidity buffers held with their head institutions. *Ehrmann and Worms* [2004] also state that this could be the situation in other countries, where bank networks are important, e.g. in Austria[110], Finland, Italy and Ireland, and that this is a possible cause of the contradictory result found in the

[109] In some cases there is doubt as to whether credit channels function at all. *Favero et al.* [1999] are searching for the bank lending channel, more precisely for the reaction of the credit stock on the squeeze of liquidity in 1992. They find no significant decline in credit stock across countries (France, Germany, Italy and Spain), but there are differences in the defensive measures adopted by different banks in different countries (e.g. small German, Italian and French banks use their excess reserves, bigger German banks use the strength of their balance sheets to overcome the difficulties). As the authors concentrate on the whole credit stock, they cannot answer the question of whether the shock had any effect on the composition of debtors (the lack of a bank lending channel but no results concerning a balance sheet channel).

[110] In the case of Austria *Burgstaller* [2009] also uses the role of networks (amplified with relation based lending) to explain the increase in the lending of Austrian banks in the event of a monetary tightening.

literature in the case of Europe. For a more reliable measure than the mere size of a bank *Worms* [2001] suggests a more widely usable indicator - the short term interbank assets relative to the bank's total assets. The lower this indicator is the bigger the reduction of lending will be after a shock from monetary policy, as the bank cannot protect itself from monetary activity.

As 'healthier' banks can more easily find alternative financing in the case of a monetary tightening *Kashyap and Stein* [1997] use ROA calculated from the OECD statistics to proxy for bank health. According to this measure the banks in the Netherlands and Luxemburg are in good shape, whereas the banks in France and Italy appear to be weak, with high levels of bad loans and low profit rates. *Ehrmann et al.* [2001] also find that a monetary shock can affect the behaviour of banks, as they tend to grant fewer loans in the case of a positive interest rate shock. They also find that the most sensitive banks are not small ones (in terms of size or capitalization), but the less liquid ones. Cross country differences are also found as a 100 basis point increase in the interest rates caused a 1% decline in bank loans in Germany and Italy, but an almost 2.5% decline in French and Spanish loans. *Ehrmann et al.* [2001] show that this effect of the asymmetric information (information friction) is smaller on the interbank market in the presence of bank networks, strong state influence or if the chance of bank failures is small. Deposit insurance also reduces the risks associated with small banks. *Altunbaş et al.* [2002] also find that undercapitalized banks (of any size) react more to monetary policy shocks by reducing their lending. Looking at country cases they do not find a bank lending channel in Germany and France but they do in Italy and Spain.

Smaller firms depend more on bank financing because the monitoring cost of obtaining alternative financing from the capital markets would be too high. *Kashyap and Stein* [1997] look at the distribution of the workforce between different firm sizes, and find that in Spain and Italy more than 40% of the workforce work for firms with fewer than 10 people. Small firms also seem to be relatively important employers in Greece, the Netherlands and Portugal, while Germany and Luxembourg are dominated by larger firms. *Suardi* [2001] also uses almost the same indicators with the result that Italy and Spain are more exposed to the balance sheet effect because of a greater number of smaller firms and a comparatively weaker legal system.

Interest rate fluctuation changes the balance sheet condition and the available cash flow of the firms and, through this, their investment. *Chatelain et al.* [2001] try to show whether the estimated investment functions differ according to the size of the firm, but

they only find a significant difference in the coefficients of the cash flow in Italian firms. They explain this lack of difference as an inability to identify the right indicator to separate the firms which probably are the case for asymmetric information problems. *Fountas and Papagapitos* [2001] show, using a co-integration and an error correction model, that in the case of Germany and Italy the external finance premium is a leading indicator of the real economic activity, which hints at the presence of a credit channel. On the other hand they find no evidence for this leading indicator property in the case of France and the United Kingdom.

The chance of alternative financing depends on the development of the capital markets, proxied by *Kashyap and Stein* [1997] with the size of these markets (stock and public bond markets). The availability of non-bank finance is the greatest in Belgium and Denmark; conversely Greece, Italy and Portugal appear to be the least developed according to this measure. *Guiso et al.* [2000] use the number of months needed to repossess collateral and the legal cost of repossession as a measure of the strength of financial market institutions. In Italy, Spain and Belgium[111] long periods are required to repossess a house, with high repossession costs as well, while at the other end of the spectrum is the UK together with the Netherlands and Germany.

Cecchetti [1999] also uses the lending channel to show the asymmetries in the MTMs among the EMU countries. His analysis starts at the institutional level, because he explains the differences in financial structure by the differences in legal structure (categorized by the concepts of shareholder rights, creditor rights and enforcement). According to his argument the differences caused by the different financial structures (and thus the different strength of the credit channels) ought to survive the regime change because they are rooted in the differences of the legal systems, and the changes at the institutional level of the economy occur very slowly. *"The arguments presented here suggest that unless legal structures are harmonized across Europe, financial structures will remain diverse, and so will monetary transmission mechanism. It will not be enough to make regulatory structures more similar, since such a change will not, in and of itself, alter the structure of capital markets." Cecchetti* [1999] p. 22. His comparison of the different countries also comes to the conclusion that the credit channel should be the most effective in Italy and Austria, and the least effective in Belgium, Ireland and the Netherlands. *Elbourne and de Haan* [2004] examined *Cecchetti* [1999]'s quantitative results, as *Cecchetti* shows that his VAR results are in

[111] These countries have legal systems originating from the French legal system (*La Porta et al.* [1997]).

positive correlation with the indexes made from the variables of legal environment, financial system and credit channel. *Elbourne and de Haan* [2004] found that the correlation is often negative if one looks at the components of indexes, so "that the result produced by Cecchetti may be the result of aggregating too far" *Elbourne and de Haan* [2004] p. 21.

Table 4.6. **Measures of the credit channel**

	Share of the 5 largest credit institutions in total assets (%) 1998 [a,]	Employment in firms with more than 250 employees (% of total) 2002 [b,]	Public bond market capitalisation (% of GDP) 1995 [c,]	Stock market capitalisation (% of GDP) 1998 [b,]	Months to repossess [d,]	Repossession cost as % of house value [d,]
Austria	42	45.49	n/a	16	n/a	n/a
Belgium	63	48.57	87	92	24	19.5
Finland	86	54.94	n/a	113	n/a	n/a
France	41	54.95	43	63	11	15
Germany	19	43.36	51	47	15	6
Greece	63	41.26	16	57	n/a	n/a
Ireland	40	58.18	n/a	75	n/a	n/a
Italy	26	41.91	70	44	48	19
Luxembourg	25	45.05	9	188	n/a	n/a
Netherlands	82	50.08	0	142	2.5	11
Portugal	45	31.55	n/a	50	n/a	n/a
Spain	45	41.30	5	64	36	10
Denmark	71	45.05	172	54	n/a	n/a
Sweden	86	52.32	n/a	106	n/a	n/a
United Kingdom	28	67.98	50	150	12	4.75

[a,] *ECB* [2002]
[b,] *Eurostat*
[c,] *Kashyap and Stein* [1997]
[d,] *Guiso et al.* [2000]

The overall importance of the credit channel seems to be high in Italy and Portugal (smaller unhealthy banks, bank dependent small firms), and low in Belgium and the Netherlands (large, healthy banks and large firms, with the opportunity of capital market financing). The picture is somewhat mixed in the case of Germany and Luxembourg (small but healthy banks, larger firms), and average in the case of Denmark, France, Ireland, Greece and Spain.

The spill over effect

Spill over effect describes how the shock from one member country spreads into other member countries. Like contagion of financial crises, this also moves along trade

linkages. *Van Els et al.* [2001] measure the spill over effect with the intra euro area trade, and find that it is relevant for Belgium, Luxembourg and the Netherlands.

From changes in the behaviour of households and firms (aggregated demand) to changes in inflation dynamics

As a measure of sticky prices the OECD's strictness of the employment protection legislation indicator is frequently cited by several authors (for example *Suardi* [2001], *Guiso et al.* [2000]). According to this measure job protection is lower in the UK, and fairly similar in the other countries. Slightly weaker job protection can be found in Ireland. Job protection is strict in France, Italy, Greece, Portugal, and Spain (see first column of *Table 4.7*). Another measure of wage flexibility could be the density of labour unions, in which case a higher density would mean less flexible wages. Looking at the second column in *Table 4.7*, one finds a high union density in Finland and Belgium, and a very low one in France.

Table 4.7. **Measures of price and wage flexibility**

	Strictness of employment protection [a,]	Trade union density [b,]	Short run exchange rate pass-through into import prices (%) [c,]
Austria	2.38	38.4	0.37
Belgium	2.48	54.6	0.44 [d,]
Finland	2.18	78	0.81
France	2.84	8.5	0.68
Germany	2.57	25.9	0.66
Greece	3.46	28.9	0.33
Ireland	1.17	41.5	0.38
Italy	3.06	35.7	0.74
Luxembourg	n/a	43.7	n/a
Netherlands	2.77	24.5	0.69
Portugal	3.53	21	0.73
Spain	2.96	16.3	0.98
Denmark	1.9	75.5	n/a
Sweden	2.49	81.3	n/a
United Kingdom	0.98	30.3	n/a

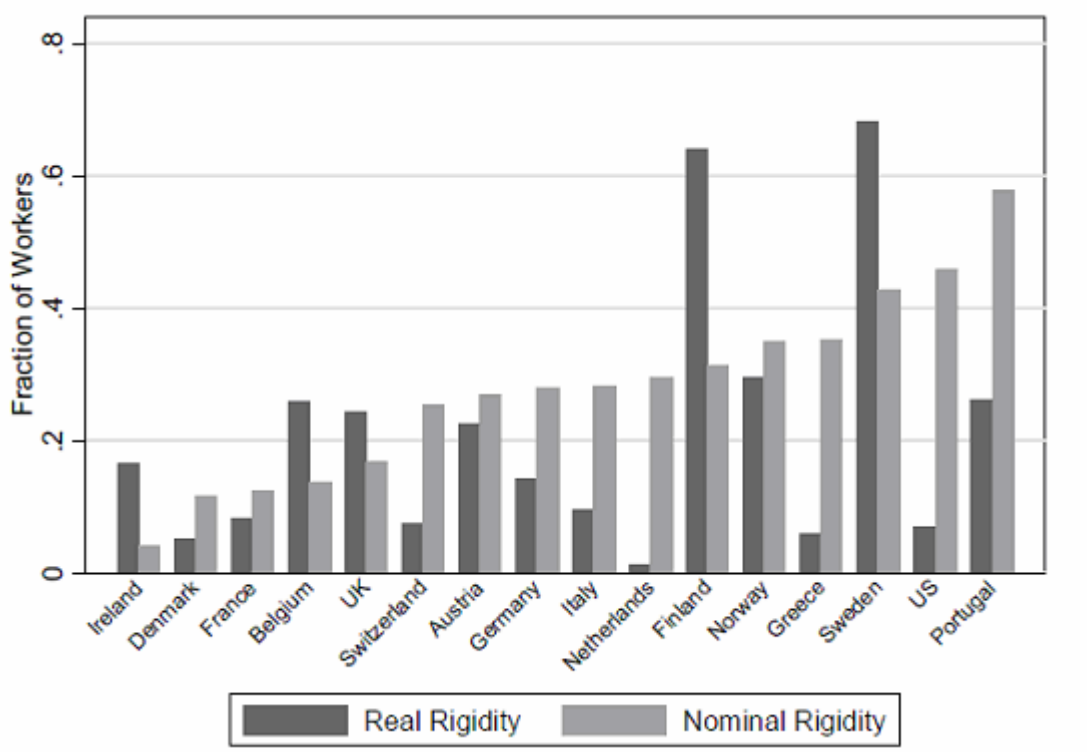
[a,] The OECD indicators of employment protection are synthetic indicators of the strictness of regulation concerning dismissals and the use of temporary contracts, version 2. The overall indicator is the weighted sum of sub-indicators for regular employment (weight of 5/12), temporary employment (5/12) and collective dismissals (2/12). It incorporates 18 data items and is available for 28 OECD member countries for 1998-2008. *Source:* OECD

[b,] Trade union density corresponds to the ratio of wage and salary earners that are trade union members, divided by the total number of wage and salary earners (OECD *Labour Force Statistics).* Density is calculated using survey data wherever possible, and otherwise using administrative data adjusted for non-active and self-employed members. *Source:* OECD.

[c,] *Campa and Minguez* [2006] p. 131, the effect of a 1% exchange rate change on import prices after the first month.

[d,] Belgium and Luxemburg are grouped together.

Figure 4.1. **Real and nominal rigidity by country (proportion of workers potentially affected).**



Source: Dickens et al. [2006] p. 28.

Dickens et al. [2006] use 31 micro datasets to examine wage changes, and finds sizeable differences in downward nominal and real rigidities across countries (see *Figure 4.1*). *Dickens et al.* [2006] explained these differences by different labour market institutions, such as employment protection legislation, corporatism and union density.

Another approach capturing price flexibility could be a measure of the exchange rate pass-through (ERPT). *Campa and Minguez* [2006] estimate different ERPT rates for different EA countries to final consumption prices (in the long run ERPT to import prices is complete, in a sense that a 1% exchange rate change changes the import prices with 1% and so is not different across countries) on a monthly sample from 1989:1 till 2001:3, and finds that the differences are best explained by different degrees of openness towards extra EA-12 imports (and as such may change in time). The estimated effects of a 1% change in the exchange rate on the import prices in the first month are shown in the last column of *Table 4.7;* the exchange rate pass-through is very high in Spain, and quite low in Greece and Austria.

Overall Greece seems to be the only country where price flexibility seems to be fairly low (with high employment protection, low ERPT, but low real wage rigidity, see *Figure 4.1*), meaning that a bigger output contraction is needed for price adjustment. At the other end of the spectrum is Spain (lower employment protection, low union density and high ERPT).

Summary

As previously mentioned, this method can't answer questions about overall effect of monetary policy, just about given channels of monetary transmission. It would be easy to draw a conclusion if all the channels were stronger in one of countries, but this is not so clearly evident: there is probably a stronger cost of capital channel in Germany, Belgium and Italy. The wealth channels are more effective in Ireland than in Germany and Austria; the credit channel should be stronger in Italy and Portugal than in Belgium. There is no easy way to add these channels together; however there are examples in the literature in which authors try to draw conclusions based on this methodology. *Suardi* [2001] came to the conclusion that the structural differences across the six euro area countries (Belgium, Germany, Spain, France, Italy, the Netherlands) are of a lesser scale than those between them and the UK or Sweden. The stress here is on difference and not on in which countries it happens to be stronger affected. *Guiso et al.* [2000] predict in their paper that the Italian economy appears to be the one in which several of the theories would predict a strong effect of monetary policy on the economy (a fairly high fixed-capital ratio, poor contractual enforcement, a large number of small firms, rigid labour markets and small banks operating in a bank dominated financial system). The UK is the opposite, while Germany is in the middle with relatively large firms, and good contract enforcement, but also has fairly rigid labour markets and a significant amount of exports outside EMU countries. France has a more concentrated lending market, but the level of French households' borrowing is lower and repossessing collateral is expensive.

4.2.2. Models using vector autoregression

The results of vector autoregression models reviewed below are hard to compare because of their different variables, identification method, shock and sample size (see in Chapter 2), so I try to show the results in their own context.

Sims [1992] used commodity price indexes to reduce, although didn't manage to eliminate completely, the price puzzle in his estimation for France and Germany. Despite the price puzzle the reduction of the industrial production is in both cases

considerable (although not significant because *Sims* [1992] did not estimate confidence intervals), in Germany almost twice as high as in France.[112]

Gerlach and Smets [1995] try to make the result for different countries comparable with each other by using a small SVAR (3 variables: output, short term interest rate and prices), estimated over the same period, and using the same identification. To identify the exogenous monetary shock from the endogenous movements of the short term interest rate *Gerlach and Smets* [1995] use the identification assumption that the monetary policy shock does not affect the output contemporaneously. The results appear similar to those in *Ehrmann* [1998] in that the French, German and Italian output show very similar reactions to a monetary policy shock both in magnitude and in timing (the reaction in France is smaller). The UK's reaction is both larger and more protracted. The difference can be found in the reaction functions of inflation, where in the UK there is an almost significant positive inflationary effect on a monetary contraction. The above results should be taken cautiously because the initial shocks differ between countries. *Dornbusch et al.* [1998] criticism is that for long run restrictions to work, the time series should be stationary, which is unlikely in this case. Further problems arise from the fact that the monetary authorities react to the same variables in every country, and if this is miss-specified then the shocks will not really be exogenous. And as there are only three variables, the exchange rate channel cannot be identified.

Grilli and Roubini [1995] use a unique exogenous monetary shock, the differential between short-term and long-term interest rates, to simulate the transmission of monetary policy. The intuition behind this method is that in this way the rise in the short-term interest rate, initiated by the monetary policy cannot be mixed with the increase caused by the rise in the expected inflation rate, because the latter raises the short and long-term interest rates simultaneously, and has no affect on their difference. This method helps to evade most puzzles, but not all; the Italian lira still depreciates in the beginning after an increase in the difference between interest rates. Despite this anomaly the biggest drop in industrial production can be observed in Italy, followed by that in France. The impulse response function (IRF) in the case of Germany does not show any significant effects (taking into account that the confidence bands are just 1 standard deviation wide on both sides), but the point estimates are positive.

[112] If this statement makes sense at all when monetary policy is not properly identified as an exogenous monetary policy action – even this result could be questioned, carrying us back to an argument over VAR; see for example *Cochrane* [1998], *Rudebush* [1998], *Sims* [1998]).

Ehrmann [1998] also tries to simulate the transmission inside the EMU, with a single monetary policy, so the shock is standardised to 10 basis points and the interest rate trajectory is constrained to that of Germany. The SVAR of each country contains an instrument variable (interest rate), industrial production, some measure for inflation, the exchange rate (except in Austria because the Austrian exchange rate is fixed in the sample period 1984-1997) and an information variable that fits to the central bank operative at the time. The results are grouped according to similarities in the impulse response, which coincide with geographical groups. The core countries - Germany and France - have very similar industrial production IRFs, as do their smaller neighbours Denmark, Belgium and Netherlands. Austria is an outlier from this group, supposedly because of the fixed exchange rate. Italy and Ireland also share similar reactions. The Southern European countries Portugal and Spain are very homogenous, as are the Scandinavian countries Finland and Sweden. The United Kingdom constitutes an outlier mostly because of timing of the reaction, but this could be a result of the regime changes during the sample period. *Ehrmann* [1998] draws the conclusion that only the UK should stay away from the currency union, because it is the only real outlier (Sweden and Denmark are apparently not).

Kieler and Saarenheimo [1998] would like to create a model in which the transmission mechanism of different countries could truly be compared (for criteria see *Dornbusch et al.* [1998] later). They use 3 endogenous variables: real GDP, the CPI index and the three month money market rate, and exogenous variables in the case of Germany. Because the results of VAR are very sensitive to the identification of the monetary policy they took the plausible identifications from all the possible identification schemes. In this case 'plausible' means that they are the same for all countries and are designed to leave a broad window to show uncertainty. In the case of output the plausible response means that the reaction x should be $-0.6 < x < 0$ within the first period, $-3.0 < x < 0$ after 2 and $-7.0 < x < 0$ after 4 years. The price response should be $-0.6 < x < 0.5$ within the period (this contradicts the fact that the presence of a price puzzle is definitely not plausible), $-3.0 < x < 0$ after 2, and $-7.0 < x < -1.0$ after 4 years. Of the 10,000 possible identification schemes 136 IRF fulfilled the plausibility criteria in the case of Germany, 445 in the case of France and 184 for the UK. From this they choose one identification scheme for each country, which resulted in similarly looking IRF-s for each country. After this they do not find statistically significant differences in the IRF-s. This method raises at least three questions: first, how did they choose the criteria for plausible reactions? Second, how did they choose the

representative IRF-s for each country? The third question is whether their conclusion concerning the lack of significant differences is a result of the identification with similar IRF-s.

Ramaswamy and Slok [1998] use a VAR model with 3 endogenous variables: GDP, price level and market interest rate. *Ramaswamy and Slok* [1998] sort the countries into two broad groups based on their output's impulse response to an interest rate shock. Austria, Belgium, Finland, Germany, the Netherlands and the United Kingdom fall into the first group; here the decline of the output reaches 0.7-0.9 percent from the baseline after 11-12 quarters, the decline being the strongest in Belgium and Finland. The other group contains France, Italy, Portugal and Spain. In this case the output decline is faster, occurring 5-6 quarters after the initial shock, but it is also shallower, with a decline of 0.3-0.6 percentage points. The interesting thing about these results is that France is not among the core countries (while the UK is).

Kim [1999] uses a five variable Structural VAR (SVAR), in which, besides more common variables such as the call money rate (interest rate), the monetary aggregate, the consumer price index and industrial production, he uses the world export commodity price index (CMPW) domestic currency equivalent to capture foreign inflationary shocks and exchange rate movements that can be important in smaller (compared to the USA) economies. *Kim* [1999] finds that monetary policy, in all G7 countries, unexpectedly increases the interest rate in the case of positive shocks of the monetary aggregate or the world export commodity price index, taking contractionary positions. The impulse response functions behave in accordance to expectations in terms of both sign and duration, with significant reactions (one exception is the reaction of the German CPI to an interest rate shock, which although declining steadily, has a very wide confidence interval including the 0 (zero) reactions as well). The industrial production response is almost identical in the three EMU countries included in the sample.

Kouparitsas [1999] uses the differences in the impulse response functions of the US regions as a measure to show how different reactions can be, and yet still form a viable OCA[113]. His conclusion is that except for two countries - Ireland and Finland - , EMU comes as close to being an OCA as the USA does. His VAR for each country has four variables: the world oil price, aggregate EMU and country income, and the EMU region

[113] In this approach he follows *Bayoumi and Eichengreen* [1992], but this approach would only be a proof if the EMU countries performed better than the U.S. regions, because the U.S. is a functioning monetary union. If the EMU performs worse, this only means that it is not as much an OCA as the U.S. but could still turn out to be a viable OCA in the end.

monetary policy (the German short term interest rate). He uses annual data and two lags, the identification is recursive with the ordering world oil price, aggregate income, indicator monetary policy and country income, which means that the monetary authority chooses the value of the monetary policy instrument after observing contemporaneous movements in oil prices and aggregate output. This system makes it possible to see how the different countries react to common shocks (monetary, oil price, aggregate income) and idiosyncratic ones (countries own income). In the case of common shocks the reaction should be similar, in the case of idiosyncratic shock the reaction should be fast, as the countries should be able to react to them flexibly. *Kouparitsas* finds a similar degree of differences among the core EMU countries, to that among the US regions (concluding that the core may be a viable currency union) and explains the different results of Ireland and Finland by their peripheral location.

Kim and Roubini [2000] do not compare the impulse response functions (IRF) of different countries. They use a 'block' identification in their 7 variable SVAR, with information variables such as oil prices and the US federal funds rate, and because they run this specification on open economies (Germany, France, Italy), they have to build in the exchange rate. In their identification, the monetary policy controls the interest rate and immediately reacts to the shocks of the monetary aggregate, the oil price and the exchange rate, and estimation results show that the monetary policy increases interest rates when it observes unexpected increases in these variables. So monetary policy is leaning against the wind and takes contractionary positions. The IRFs show that the magnitude and persistence of the interest increase and the money supply decline differs among countries, but in all of them the effects are statistically significant on impact and over the medium run. In Germany and Italy the fall in price level is persistent and significant over the full 48 months horizon, in France the price level increases insignificantly in the first few months, but after 6 months starts to fall even here, but is still not significant statistically. The output tends to fall after a few months (in Italy and Germany there is an immediate fall; in France it occurs after 4 months). With the exception of Italy this fall is statistically significant, and consistent with the transitory effects of a monetary contraction, the output level showing evidence of a mean reversion to its pre-shock level. The exchange rate significantly appreciates relative to the US dollar in all three countries following a monetary contraction. In the case of Germany the Federal Funds rate responds endogenously to the German interest rate shock, probably because it is able to influence the global interest rate. Taking care of this endogenous movement the DM/USD exchange rate response is stronger but

qualitatively similar. The impulse responses tend to be similar - no outstanding differences can be observed.

The value added by *Mojon and Peersman* [2001] is that they try to model explicitly the European Monetary System (EMS) and the countries within it. For this exercise they group the countries into three different categories: the first category is Germany itself, being the only country in the EMS period which had a truly independent monetary policy. The second group contains countries which hard pegged their exchange rate against the Deutschmark; these countries are Austria, Belgium and the Netherlands. As these countries' monetary policy maintained a hard-pegged fixed exchange rate system, there is no real exogenous monetary policy shock in these time-series, so the reaction to the German monetary policy shock is shown in the IRFs (the German interest rate is an exogenous variable for these countries). The countries in the third group had a fixed exchange rate with a narrow fluctuation band, and are modelled with autonomous monetary policy shocks and with exogenous German variables. These countries are Finland, France, Greece, Ireland, Italy and Spain. These three groups allow the authors to have a fairly similar and comparable model for each country, without the implausible uniformity often assumed. Using this concept *Mojon and Peersman* [2001] find output reactions that extend from a significant positive reaction in the case of Ireland to a -0.42 drop in Finnish output, so they also find different reactions, although this is not emphasized in their paper.

Summary

As can be seen in the summarizing table in Appendix 4A the different VAR-s mentioned above resulted in very distinct results in the ranking of the countries according to the size of their output (industrial production) reaction. *Elbourne and de Haan* [2004] searched for an answer for the cause of this phenomenon. They argue that most VARs are so different (different set of countries, different variables, different identification methods, different lag lengths etc.) that it is no wonder that they come to different conclusions. Rerunning 43 VAR/SVAR specifications they came to the conclusion that output reaction in recursive models are robust, if one also accepts results with price puzzles. *Guiso et al.* [2000] criticize this method of using different shocks (size and time paths) and different reaction functions for the monetary policy in the different countries, which makes it impossible to make legitimate comparisons among the responses. The second problem is the lack of fixed exchange rates in models dealing with countries operating a fixed exchange rate system. The third is the sensitivity of

results on the identifying restriction as already mentioned by *Kieler and Saarenheimo* [1998].

Kieler and Saarenheimo [1998] also criticize the black box nature of the VAR-s, which is why it is difficult to relate the estimated differences of the parameters and impulse response functions to structural differences in the economy. If the monetary policy is stronger in one country, one is unable to answer the question why. And because the identified monetary policy is the deviation from the estimated rule, the effect of the systematic monetary policy cannot be modelled. "*Given the complexity of the issue and the extent of identification uncertainty, we have serious doubts about whether macro-level econometrics will ever be able to resolve the issue."* (*Kieler and Saarenheimo* [1998] *p. 32.*)

4.2.3. Studies based on large-scale macroeconomic models

Using central banks' macroeconomic models to simulate the monetary transmission has the advantage that its uses 'insider wisdom', as the models are calibrated for the given economy. On the other hand one can never be sure that the differences uncovered are because of the different models (according to *Guiso et al.* [2000] different and arbitrary modelling choices) or because of the structural differences of the countries in the sample.

BIS [1995] used the central banks' macroeconomic models to see the effect of a common, standardized monetary policy shock (a 1 percentage point increase, returning to baseline after two years) in the case of fixed floating and managed exchange rates (and so according to *Guiso et al.* [2000] it complies with the two main requirements of the ideal experiment). The responses of real GDP and the GDP deflator (PGDP) to this shock are shown in *Table 4.8* as deviations from the baseline in percentage points. As stated before, the results are hard to compare, but the study finds that GDP responses are greater in the larger countries, especially in Italy, with a slightly larger and definitely longer lasting response. The price response in Germany starts only after the second year but decreases in the modelled time horizon, and there is no response in the case of Austria.

Van Els et al. [2001] report the result of the Working Group on Econometric Modelling (WGEM) co-operation which also uses the macro models of the different central banks, but tries to solve various problems of the *BIS* [1995]. Here the 100 basis point increase to the interest rate of the monetary authority is added to the same interest rate; the

handling of the long-term interest rate and the exchange rate are also uniform across models, as are the basics of the fiscal rules and the spill over effects across countries. These things help to achieve a consistent, more comparable result. The experiment is the same as in *BIS* [1995], thus between 2001q1 and 2002q4 the short term policy interest rate rises 1 percentage point, and then in 2003q1 it returns to the baseline.

Table 4.8. **The total effect on real GDP and on consumption deflator BIS (1995) versus WGEM (2001)** [a,]

			1st year	2nd year	3rd year	4th year	5th year
Germany	GDP	BIS [1995]	-0.15	-0.37	-0.30	-0.07	0.09
		WGEM	-0.26	-0.26	0.00	0.20	0.26
	consumption deflator	BIS [1995]	-0.03	-0.14	-0.31	-0.45	-0.55
		WGEM	-0.05	-0.17	-0.34	-0.50	-0.47
France	GDP	BIS [1995]	-0.18	-0.36	-0.20	0.01	0.07
		WGEM	-0.13	-0.22	-0.15	-0.07	-0.02
	consumption deflator	BIS [1995]	-0.05	-0.15	-0.25	-0.32	-0.32
		WGEM	-0.06	-0.08	-0.08	-0.09	-0.10
Italy	GDP	BIS [1995]	-0.32	-0.53	-0.22	-0.8	-0.13
		WGEM	-0.24	-0.55	-0.50	-0.16	0.10
	consumption deflator	BIS [1995]	-0.48	-0.64	-0.53	-0.17	0.10
		WGEM	-0.14	-0.29	-0.43	-0.44	-0.29
Spain	GDP	BIS [1995]	-0.05	-0.02	0.03	-0.17	-0.17
		WGEM	-0.10	-0.37	-0.51	-0.44	-0.28
	consumption deflator	BIS [1995]	-0.26	-0.54	-0.66	-0.95	-1.28
		WGEM	-0.03	-0.22	-0.39	-0.55	-0.67
Netherlands	GDP	BIS [1995]	-0.10	-0.18	-0.15	-0.09	-0.01
		WGEM	-0.17	-0.18	-0.13	-0.10	-0.08
	consumption deflator	BIS [1995]	-0.13	-0.35	-0.35	-0.23	-0.27
		WGEM	-0.10	-0.17	-0.16	-0.19	-0.21
Belgium	GDP	BIS [1995]	-0.03	-0.12	-0.23	-0.15	0.02
		WGEM	-0.10	-0.21	-0.13	-0.07	-0.08
	consumption deflator	BIS [1995]	-0.14	-0.48	-0.79	-0.81	-0.55
		WGEM	-0.02	-0.07	-0.15	-0.29	-0.44
Austria	GDP	BIS [1995]	-0.08	-0.14	-0.02	0.04	0.01
		WGEM	-0.21	-0.38	-0.37	-0.26	-0.25
	consumption deflator	BIS [1995]	-0.02	-0.04	-0.05	-0.04	-0.02
		WGEM	-0.08	-0.11	-0.09	-0.07	-0.06
Greece	GDP	WGEM	-0.37	-0.69	-0.58	-0.60	-0.64
	consumption deflator	WGEM	-0.13	-0.22	-0.2	-0.23	-0.25
Ireland	GDP	WGEM	-0.22	-0.41	-0.35	-0.31	-0.27
	consumption deflator	WGEM	-0.09	-0.14	-0.14	-0.14	-0.18
Portugal	GDP	WGEM	-0.10	-0.47	-0.67	-0.60	-0.48
	consumption deflator	WGEM	-0.06	-0.17	-0.18	-0.17	-0.23
Luxembourg	GDP	WGEM	-0.13	-0.13	-0.09	-0.06	-0.03
	consumption deflator	WGEM	-0.01	-0.03	-0.03	-0.04	-0.05
Finland	GDP	WGEM	-0.32	-0.22	-0.13	-0.21	-0.24
	consumption deflator	WGEM	-0.47	-0.41	-0.07	0.07	0.00

Source: van Els et al. [2001] p. 41-42 and 60-64.

[a] To be able to make consistent comparisons WGEM results are without spill-over effects.

As can be seen in *Table 4.8*, except in Germany and Italy the negative output effect tends to be more persistent in WGEM. The negative effect is larger in Austria and in Spain than it was in 1995 (this could be the effect of new models). The faster recovery

effect is also due to the significantly stronger impact of the monetary channel in the later model version. The consumption deflator impulse responses depend on the assumptions concerning the exchange rate movements and their pass-through into consumer prices; this explains the differences between the BIS and the WGEM result.

Table 4.9. **The effect of different channels on GDP - WGEM**

	1st year	2nd year	3rd year	4th year	5th year
exchange rate channel					
Germany	-0.21	-0.24	-0.08	0.05	0.09
France	-0.03	-0.03	0.00	0.00	0.01
Italy	-0.08	-0.10	-0.05	-0.01	0.04
Spain	-0.05	-0.13	-0.11	-0.07	-0.02
Netherlands	-0.10	-0.04	-0.02	-0.02	-0.01
Belgium	-0.04	-0.08	-0.05	-0.04	-0.07
Austria	-0.13	-0.14	-0.07	0.01	0.00
direct substitution channel					
Germany	-0.04	-0.04	0.00	0.01	0.01
France	-0.10	-0.20	-0.15	-0.07	-0.02
Italy	-0.02	-0.06	-0.06	-0.05	-0.02
Spain	-0.01	-0.04	-0.05	-0.02	0.01
Netherlands	-0.01	-0.01	-0.01	0.00	0.00
Belgium	0.01	0.01	0.00	0.01	0.01
Austria	-0.03	-0.12	-0.19	-0.19	-0.17
cost-of-capital channel					
Germany	-0.01	-0.01	0.00	0.00	0.00
France	-0.02	-0.04	-0.02	-0.01	0.00
Italy	-0.14	-0.40	-0.47	-0.33	-0.21
Spain	-0.05	-0.22	-0.35	-0.34	-0.26
Netherlands	-0.05	-0.11	-0.09	-0.06	-0.05
Belgium	-0.02	-0.03	0.00	-0.01	-0.01
Austria	-0.02	-0.02	-0.01	-0.01	-0.01
income/cash flow channel					
Germany	0.00	0.00	0.00	0.00	-0.01
France	0.01	0.02	0.01	-0.03	-0.03
Italy	0.02	0.06	0.11	0.17	0.17
Spain	0.01	0.01	0.00	-0.01	-0.01
Netherlands	0.00	0.00	0.00	-0.01	-0.02
Belgium	-0.01	0.00	0.00	-0.03	-0.04
Austria	0.00	0.00	0.00	0.00	0.00
wealth channel					
Germany	-	-	-	-	-
France	-	-	-	-	-
Italy	-0.01	-0.05	-0.07	0.01	0.07
Spain	-0.01	0.02	0.02	-0.04	-0.02
Netherlands	0.00	-0.02	-0.02	-0.01	-0.01
Belgium	0.00	0.00	0.00	0.00	0.00
Austria	-0.03	-0.10	-0.11	-0.09	-0.08

Source: van Els et al. [2001] p. 64-68.

Table 4.9 shows how the combination of the different channels of the transmission mechanism add up to the aggregated impulse response of the GDP. The exchange rate channel seems important in Germany, Austria and Spain (the big jump in the beginning was caused by the switch from a modelled exchange rate reaction - which was

backward looking by nature - to the exchange rate path agreed upon). In the case of the substitution effect the reaction in France and Austria was larger than in the other countries.

Hallett and Piscitelli [1999] use the multi-county MULTIMOD model developed by the IMF to see what effects the structural differences shown in subsection 4.2.1 cause in the transmission. After running a base specification, they alter the parameters of the models according to the differences in the structure, focusing on differences in money demand, labour and asset markets (since the money demand's interest elasticity is known to be greater in the UK, then they double the parameter). They found that the UK is more sensitive, especially if the nominal stickiness and the differences are large enough.

Röger and in't Veld [2002] use the European Commission's QUEST model to show the differences in reactions to a temporary (1 year) monetary tightening. Even though the effect of the shock on output is significant in every case, there are not great differences between the impulse response functions (the smallest effect is in the UK, the strongest is in Italy). *Kieler and Saarenheimo* [1998] note that the critique against the simulations using central bank models applies here as well, but in the opposite direction. In this case the problem is that the similar transmissions could be the result of the similar modelling methods; the similarity is, so to speak, built into the model.

Summary

To sum up, models using local wisdom and allowing for different structures (which may be better suited to the given economy or not) find differences in the monetary transmission mechanism.

4.2.4. Small scale/stylised macro models

There were other attempts that tried to measure the difference in the monetary transmission, the methodology of which cannot be included in any of the methodological groups above. This subsection is dedicated to these papers.

Britton and Whitley [1997] use a four variable four equations (aggregated demand, supply, money stock and exchange rate a la Dornbusch) basic model. This method has the advantage that the theory of the model is the same for all countries and there are statistical tests for differences, but it is also highly aggregated, so it can gloss over many important cross-country differences. *Britton and Whitley* [1997] use this estimated model to simulate output and inflation responses to the same policy experiment as BIS [1995], so they increase the nominal interest rate by one percentage point for 2 years,

then let it evolve according a common monetary policy rule. Responses show a smaller output effect in the UK and in Germany and France, and almost the same price level effect in the three countries. But the uncertainty of the parameter estimates is too high to find any significant difference. *Dornbusch et al.* [1998]'s critic is related to the use of Dornbusch's exchange rate model in a case where the spread between interest rates towards the German interest rate is positively correlated with the DM exchange rate (widening the spread together with depreciation towards the Deutschmark). *Kieler and Saarenheimo* [1998] think that this model is too highly aggregated to capture any cross-country differences.

Dornbusch et al. [1998] estimate a reaction function output function pair for Germany, France, Italy, Spain, the United Kingdom and Sweden. The output growth depends on past output growth, past output growth in the other countries, present and past values of the expected and unexpected interest rate (based on the estimated reaction function of the monetary policy), and bilateral exchange rates against the DM and the USD. Controlling for the exchange rate, the elasticities of the output to a permanent change in all expected domestic short-term interest rates show differences after two years: in the United Kingdom it is 0.9, in Germany 1.4, in France and Spain 1.54, in Italy 2.14 and in Sweden it is 2.39. However the equality of the impact effect could not be refuted statistically. *Kieler and Saarenheimo* [1998] miss the economic theory behind this exercise, which would explain why it is a good approximation to the true reduced form equation for real output growth.

Altavilla and Landolfo [2005] try to show how different the monetary transmissions can be, using a structural dynamic modelling approach with 3 equations (inflation, output and interest rate). Using different interest rate rules for different countries and building the exchange rate into the reaction function of the monetary policy (as in *Mojon and Peersman* [2001]) they find no significant difference between countries for the period between 1979q1 and 1998q4.

Clausen and Hayo [2006] estimate a 3 equations system for Germany, France and Italy, using an effective exchange rate that is calculated for extra EMU trade. They find differences in the IRF-s, but almost no difference between the coefficients. In the middle range the weakest effect is found in France, and only small differences are found between Italy and Germany. During this they search for a structural break before 1999, but could not find any according to the stability of the coefficients, which means that either the structural break can come after the introduction of the euro or the changes may be gradual. Gradual changes could mean that the differences found using pre-euro

data could be informative, and that it will take time for some differences to vanish (for example the differences noted by *Cecchetti* [1999], see above).

Ciccarelli and Rebucci [2006] search for changes in the transmission mechanism during the EMU using a 2 equation model for Germany, France, Italy and Spain with time-varying, heterogeneous coefficients. The estimated reaction function output function pairs showed that the long run cumulative impact of a common, homoskedastic monetary shock, identified with the innovation to the German reaction function, changed after 1991, decreasing by 10-20 percent in all countries due to changes in the behaviour of the monetary policy. But they also find differences in the transmission which did not decline in the same period of time.

Summary

As seen above the small aggregated models tend to find no difference in the transmission mechanism of different countries, perhaps because they are too highly aggregated for this exercise.

4.2.5. Conclusion

As has been shown in subsection 4.2.1 there were structural differences before 1998 that could have caused the different channels of monetary policy transmission to pass on different impulses in different countries. *Guiso et al.* [2000] draw the conclusion that the experiments that are nearest to the ideal one (often the experiments with central bank models) show the same result as the key variables method and point to noticeable differences in the transmission mechanism. According *Dornbusch et al.* [1998] small models are often subject to misspecification (see subsection 4.2.2 and 4.2.4), big macro models are not comparable (or too comparable), but they also state that central bank models can incorporate 'local wisdom', and prove to be helpful.

The most probable conclusion is that there were differences between the countries that introduced the common currency, differences which affected the monetary transmission mechanism as well. The different methodologies are not always adapted to show these differences: the results of indicators are frequently in accordance with the big macro models, but lack the capacity to show overall effects; it is problematic to separate the effect of the modelling technique from structural differences in the results of large-scale macro models, the high level of aggregation in the case of small macro models tends to hide the differences and in the case of VARs, much depends on the specification. In the

following sections I will use the indicators and VARs to discuss the endogeneity of the transmission mechanism.

4.3. The effect of the common currency on the economy

> *"Two questions naturally arise: what are the sources of these asymmetries, will they disappear once the union takes off, and how fast." Dornbusch et al.* [1998] p. 30.

The question I try to answer in this section is whether the common currency changes the economy of the member states in a way that MTM of the different countries became more similar, or, to use the term used by *Frankel and Rose* [1996], is the MTM 'endogenous'[114] in the EMU?[115] Or are they similar to the patterns of production in *Krugman* [1993], and integration strengthens the existing differences?

After looking at the differences found in transmission by other authors, let us turn to the changes the common monetary policy could cause. According to *Arnold and de Vries* [1999] the problem with all the literature cited above is that they concentrate on their "present" differences, and disregard the fact that the monetary policy and the inflation under its control are in interaction with the financial system. And through this interaction a change in the monetary policy regime and the inflation expectation can change distinctive features of the monetary transmission mechanism. "*Complete money market integration and the convergence of the monetary transmission mechanism will come about as a by-product of the unitary inflation regime."* (*Arnold and de Vries* [1999] p. 27) *Britton and Whitley* [1997] point to the ratio of loans with variable or fixed interest rates, a commonly cited "structural" difference resulting from the inflation history of the countries involved, which may change in response to monetary policy changes, and thus according to *Britton and Whitley* such differences should not be considered at all.

Searching for the changes the integrated monetary policy and financial system might cause, *Angeloni and Ehrmann* [2003a] stress that a change in the monetary transmission mechanism should be considered a longer and slower process, which most probably began in the early 90's (together with the Maastricht convergence), so it is not certain

[114] The term 'endogeneity' in connection with the monetary transmission mechanism was first used to my knowledge by *Arnold and de Vries* [1999]

[115] *Kouparitsas* [1999] states that if the transmission were endogenous then time elapsed since the introduction of the euro also would also become a very important factor.

that there are breakpoints that can be found precisely in 1999. *Suardi* [2001] draws attention to the fact that although the strength of different channels can change due the regime change, at the same time the composition and significance of different channels can alter as well, which makes it even harder to locate changes. Finding changes in itself is not enough because the question "Has it changed *because of* the EMU?" (*Angeloni and Ehrmann* [2003a] p. 471) also has to be answered, so there is also a need for counterfactual experiments with a control group to see if the changes found are a peculiarity of the EMU or common changes occurring around the world.

On the one hand there are characteristics that bound not to change: *Suardi* [2001] states that the varying effectiveness and efficiency of the national legal system, the differences in the institutional regulation of housing markets (and mortgage markets) and the different national choices made regarding the funding of the pension system and the role of pension funds can all present an obstacle. On the other hand there are things that are, of course, going to change too slowly to be captured in a 10 year (or 17 year, if the convergence since 1992 is also included) interval. According to *Angeloni and Ehrmann* [2003a] heterogeneity caused by different consumer preferences (time preferences for example) or differences in production[116] should change slowly if they change at all. *Suardi* [2001] and *Arnold and de Vries* [1999] add that cross country differences in labour markets and firm size are both factors which will not change rapidly.

In the following subsections I review the literature about the changes in the structure of the economy and monetary policy than could have an influence on the monetary transmission mechanism.

4.3.1. Common monetary shocks

The most striking change is the evolvement of the formation of the common monetary policy. In accordance with Article 105 of the Maastricht Treaty, the aim of the European System of Central Banks is to maintain price stability and "define and implement the monetary policy of the Community". This means that the monetary policy was given a single aim: price stability, defined by the ECB as the year-on-year increase of the Harmonized Index of Consumer Prices for the euro area, which does not exceed 2 percent in the medium term. With a harmonized instrumental framework this

[116] See for example *Krugman and Venables* [1993] for the view that the disappearance of the exchange rate risk will lead to changes in the localization of production, i.e. to specialization, through which idiosyncratic shocks can become more relevant, and can, according to the findings of *Dedola and Lippi* [2005], lead to a more differentiated transmission mechanism.

results in a single monetary shock for the whole euro area, which changes the nature of the monetary policy signal, as it has a new strategy and a new euro area orientation. If the volatility of monetary policy declines, the response of banks to a policy signal of any size is likely to have increased (*Angeloni and Ehrmann* [2003a]). In addition, *Mojon* [2000] stresses that if the volatility of the monetary policy instrument is synchronized, the pass-through should also become more synchronized, as one way the monetary regime can influence the pass-through is through the volatility of the instrument, which decreases the pass-through. To sum up, the first step of the monetary transmission mechanism was integrated institutionally.

4.3.2. Financial integration

The real question is how does the financial system react to the common monetary shocks? The integration of the financial system could be the first thoroughly endogenous response in the transmission mechanism. With the elimination of exchange rate risk the single currency removes one of the biggest sources of financial market segmentation (*Angeloni and Ehrmann* [2003a]). As the segmentation disappears the increased competition (or even the threat of contestability) can ensure a convergence in the prices of financial assets and liabilities, as inefficient banks are no longer able to pass extra costs on to customers, so eventually would be constrained to restructure or see their market share reduced.[117] So either through cross-border activity (foreign branches, mergers and acquisition) or through contestability (and even in the absence of cross border activity) the spread between the lending and inter-bank rates and between the inter-bank and deposit rate should be reduced.[118] This could mean that even in the case of an idiosyncratic shock, the agents of the economy would face the same prices, and the same instruments would be available, which could help in a more common and flexible response.

Financial integration

Let us consider what has materialized from the above expectations between 1999 and the 2008. Since 2005 the ECB has published biannual financial integration indicators,[119] mostly as defined in *Baele et al.* [2004]. Using these price (price dispersion), quantity (portfolio composition) and institutional indicators the ECB reports on the state of

[117] On the other hand *Angeloni and Ehrmann* [2003a] states that the integration of the inter-bank market allows relatively inefficient banks to access the better deposit raising technology of foreign banks, helping them to stay in competition.
[118] *Mojon* [2000] also found that competition intensifies the pass-through, as has been already cited.
[119] http://www.ecb.int/stats/finint/html/index.en.html

integration in different segments of financial intermediation. The general diagnosis is that financial integration is more advanced in those market segments that are 'closer' to the single monetary policy, so money markets are highly integrated, bond and equity markets are integrated, retail bank markets on the other hand are still segmented (*ECB* [2007]).

Cross border inter-bank activity has been rising sharply, in absolute and relative terms and relative to control cases, but *Angeloni and Ehrmann* [2003b] could not find any breakpoints in 1999. According to *ECB* [2005] measures of the money market (inter-bank short term debt and deposit) the cross country standard deviation dropped significantly. *ECB* [2006] introduced new measures in order to describe the infrastructural environment of a given market; for the inter-bank market it is the number of high-value payment systems. According to this measure, the number of payment systems decreased from 17 to 4, and yet despite this the fewer payment systems deliver a greater share of the inter-member state payments in terms of both volume and value. These changes denote greater integration in the inter-bank sector. *Angeloni and Ehrmann* [2003b] state that the banks' holdings of cross border securities almost doubled, and the growth accelerated in 1999. No similar trend is found in the control group of non-EMU countries. *ECB* [2006] shows that on the money market the cross-border holdings of short-term debt securities issued by euro area residents further increased, by more in the case of intra-euro area residents (from 7% of the portfolio in 2001 to 11% in 2006) than in the extra-euro area (from 2.8% in 2001 to 3.7% in 2006).

On the government bond market the differences in the interest rates dropped, but mostly during the convergence years (before 1999), and the yields tend to react more to common factors (EMU-wide news) rather than to local ones (*ECB* [2005]). *ECB* [2006] finds the cross-border holdings of long term debt securities issued by euro area residents increased from 11% (1997) to 57% (2006) in the intra-euro area residents' international portfolios, which compared with increase from 4% (1997) to 9% (2006) in the extra-euro area residents' international portfolios suggests increased integration. In this case the infrastructure (security settlement systems) still seems to be segmented. Next to the government bonds, the private bond markets show affects of increased cross border activity. The outstanding volume rose from 30 percent of the euro area GDP before 1999, to 74.5 percent of the euro area GDP by 2005 (*Lane* [2006b]). *Baele et al.* [2004] find a high degree of integration in the pricing of corporate bonds across the euro area; that is the pricing of corporate bonds depends almost completely on the sectoral and credit risk characteristic of issuers, with country factors playing only a trivially small

role. At the same time cross-border purchasers account for an increased proportion of the investor base, especially for the smaller member countries (*Pagano and von Thadden* [2004]).

Equity markets still react predominately to local factors; the euro area-wide factors only explain about 35% of the variance (the US or global factors accounting for about 15%), but this figure is increasing and *ECB* [2006] finds that the return dispersion between countries is declining (it is even smaller than the return dispersion between sectors), and so the diversification by country ought to be replaced by sector based strategies. In case of quantitative measures *Lane* [2006a] found 'euro bias' in both equity and bond holdings, which means that after controlling for other fundamentals, there is substantially more cross-border asset trade between members of the euro area than among other country pairings. This 'euro effect' raises the bilateral holding between member countries by 62 percent for equities and 97 percent for bonds.

Angeloni and Ehrmann [2003b] find, that despite expectations, cross border lending and deposit taking among euro area countries did not change dramatically after 1999. This is in line with the findings of *ECB* [2005], there is relatively high dispersion of interest rates on consumer credit and lending for house purchases by retail banks. Dispersion of interest rates serves as evidence for fragmentation of the retail banking sector (*ECB* [2007]), which evidence is further strengthened by the quantity based indicators as the cross border retail bank lending activity in the euro area remains at around 3.5% of the total lending. There are other facts that strengthen the case of a segmented retail banking sector:

- the infrastructure is also fragmented in the case of retail payment systems, and there is no sign for integration;
- in the retail banking sector the consolidation within countries is more important than the cross-country consolidation (cross border merger and acquisition deals are below 30% to the total value of mergers and acquisitions, the only exception being 2005 when they accounted for 62%);
- there is almost no increase in the share of assets held by branches across the euro area (from 7.3% to 10.2%), as against the share of assets held subsidiaries, which increased from 3.8% in 2001 to 8.4% in 2007. Cross border branching shows no sign of an increase in the euro area after 1999; it is very extensive in small countries and very limited in large ones, in line with the control group (especially with the pre-1994 USA) (*Angeloni and Ehrmann* [2003b]).

Consequences of integration

Looking at the effect of integration described above on the interest rate pass-through *Angeloni and Ehrmann* [2003a] investigate three aspects: the impact effect, the maximum effect and the time needed to reach the maximum effect, in two time samples: 1990-1998 and 1999-2002 (using a simple regression and VAR methodology). They find a clear upward movement of both impact and peak response (except in Germany, which could be a sign that there was no policy signal improvement in this case) and dispersion between countries declines. They use a control group comprising the UK, Sweden, Japan and the USA, where they do not find such changes. Grouped by loan and deposit type, they find that the movements of long term interest rates (mortgage loans, long term business loans and long term time deposits) shows more homogeneous reactions across countries, which implies that maturity also matters. *Angeloni and Ehrmann* [2003a] also measure the co-movements of the real interest rates (nominal interest rate co-movement is assured by the arbitrage trades) with the variance of interest differential, which shows a reduction, mostly between 1990-94 and 1995-98 (the period of convergence trades), so before the creation of the EMU, and occurring across the entire EU. According to this measure the EU has already reached the integration level of the USA (used as a control group).[120]

Sander and Kleimeier [2004] found breakpoints in the pass-through well before 1998-1999; for them this means that the integration is due more to the common institutional and legal framework, than to the common monetary policy. They also found convergence in the pass-through, but also differences driven by different legal institutions (Anglo-Saxon vs. German) and cultural differences, which mean that full integration should take more time (if it is ever achieved). These results are in line with the prediction in *Cecchetti* [1999].

Van Leuvensteijn et al [2008] measure the effect of competition on the timing and extent of the interest rate pass-through. Instead of the widely used Herfindal-Hirschmann index, where competition is defined as the lack of concentration, they use the Boone index, according to which competition is present if the company with more efficient technology (smaller marginal costs) has a larger market share (the Boone index is negative, and the greater the competition the more negative it is). According to their

[120] On euro area level data *de Bondt* [2005] finds that the sub-sample starting in 1999, i.e. since the introduction of the euro, shows qualitatively similar findings (the immediate pass-through is at most 50%, the final pass-through is close to 100%). These findings, however, are supportive of a quicker pass-through of the changes in market interest rates.

results, in the case of competition the spreads on market interest rates are smaller, and the pass through is faster and more complete. So as decreasing interest rates caused by the convergence rally, the marginal cost of lending decreases and there are signs of intensifying competition in the EMU countries (see *Table 4.10*), and these two factors together should mean a faster and more complete pass-through in the euro area.

De Bondt et al. [2005] use an error correction model based on the pricing behaviour of the retail banks, and finds that banks often use long-term bond rates besides the money market rates to determine their marginal cost of lending. The explanation for this can be the maturity mismatch, the presence of adjustment costs, uncertainty about the persistence of changes in money market rates or the future path of monetary policy. The banks use this as an indicator for future market rates. In this context a sluggish interest rate pass-through can occur as the change in the short-term interest rate slowly alters the yield curve.

Table 4.10. **Marginal cost of loans and Boone indicators over time and across various countries** [a,]

	Marginal costs of loans (in %)								**Boone indicator**							
	A	**B**	**D**	**E**	**F**	**I**	**NL**	**P**	**A**	**B**	**D**	**E**	**F**	**I**	**NL**	**P**
1992	10.3	7.1	10.2	15.9	13.8	13.2	9.2	21.3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1993	9.4	6.9	9.4	17.2	13.4	12.0	8.1	18.8	n/a	n/a	n/a	-4.2	n/a	-5.9	n/a	n/a
1994	7.1	6.4	9.2	14.3	11.9	12.2	7.4	16.6	11.2	n/a	n/a	-4.8	n/a	-7.3	-1.9	0.1
1995	7.3	5.8	8.9	15.4	11.7	11.8	7.1	15.4	-4.1	-1.5	4.5	-5.2	-1.3	-4.5	-4.4	1.6
1996	7.1	5.2	8.5	14.3	10.9	11.3	6.3	13.4	-2.3	-1.7	-7.1	-9.6	-1.3	-5.6	-2.1	0.1
1997	6.1	4.6	7.4	11.7	10.9	9.7	6.4	12.3	4.3	-2.0	-4.6	-4.4	-1.1	-5.9	-3.6	-0.0
1998	6.0	3.6	7.1	11.1	11.2	7.5	7.4	9.4	-0.9	-2.0	-5.1	-5.4	-0.8	-4.6	1.0	-0.6
1993 1998 av.	**7.6**	**5.7**	**8.7**	**14.3**	**12.0**	**11.1**	**7.4**	**15.3**	**1.6**	**-1.8**	**-3.1**	**-5.6**	**-1.1**	**-5.6**	**-2.2**	**0.2**
1999	5.5	3.2	6.4	8.8	10.0	6.7	6.4	6.1	-3.0	-2.6	-2.6	-5.5	-0.7	-4.1	-1.4	-1.5
2000	6.1	3.3	7.1	9.9	11.2	6.7	6.5	6.3	-2.3	-3.4	-2.5	-3.4	-0.5	-3.3	-3.3	-2.4
2001	6.1	3.1	7.3	9.6	11.2	6.6	6.4	5.9	-1.0	-3.0	-3.3	-4.4	-0.7	-2.7	-3.9	-1.9
2002	5.7	3.1	7.1	7.8	10.7	6.1	5.7	5.2	-1.5	-3.4	-4.5	-3.9	-0.4	-1.6	-2.5	-2.2
2003	5.5	2.7	6.4	5.9	8.9	5.3	4.9	5.3	-1.3	-2.8	-2.7	-3.4	0.3	-2.4	-2.2	-1.7
2004	5.2	2.5	6.0	4.8	7.9	4.9	4.6	5.5	-3.0	-3.1	-2.7	-2.7	0.1	-1.8	-3.1	-1.5
1999 2004 av.	**5.7**	**3.0**	**6.7**	**7.8**	**10.0**	**6.1**	**5.8**	**5.7**	**-2.0**	**-3.0**	**-3.0**	**-3.9**	**-0.3**	**-2.6**	**-2.8**	**-1.9**

Source: van Leuvensteijn et al [2008] p. 38.

[a,] where A stands for Austria, B for Belgium, D for Germany, E for Spain, F for France, I for Italy, NL for the Netherlands, P for Portugal.

De Bondt et al. [2005] also found that the pricing behaviour of the banks changed in 1999, and the weight of the long-term bond rate declined (but still remains relevant). This can be associated with the fact that banks do not need the long-term interest rate to predict future short-term rates any more, which again may indicate that the common monetary policy has gained credibility. Retail interest rates also converge faster to their 'equilibrium price of retail bank products' (the weighted short and long-term interest

rate), which leads to an increase in competition. But despite this there is no uniform increase in overall pass-through (short and long term interest rates), and heterogeneity among countries is still observable.

Spiegel [2009] sees the rise in Portugal's and Greece's indebtedness towards other member states during different phases of the EMU as a quantitative measure of financial integration. The need for financial integration as a consequence of monetary integration comes from the increasing volume of trade a la *Frankel and Rose* [1996], which also means increasing stocks of trade credits among partners, further encouraged by the lack of currency/exchange rate risk. *Spiegel* [2008] tries to disentangle this effect, and test whether it is a consequence of the changes in the trustworthiness of the borrowers (borrower effect – only pull factor $\Rightarrow$ more severe consequences of default) or changes in the position of the banks (credit effect – only push factor $\Rightarrow$ better institutional background, chance to grow) or their some sort of 'paired' effect, meaning that increased lending is occurring between lenders and debtors within the EMU (a combination of push and pull factors). *Spiegel* [2008] finds evidence for the 'paired' effect, and through this, for the increased effect of monetary integration on financial integration within the EMU.

4.3.3. Other changes

The articles I review in this subsection ask the question how the introduction of euro changed the real structure of the economy, namely the direction of trade, the structure of production, the portfolio of households, and the labour markets.

Changes in the direction of trade

The aim of this subsection is to answer the question whether there was diversion of trade from extra euro area towards intra euro area. As already shown in section 4.1 the expectation was that the elimination of exchange rate uncertainty and associated transaction costs would boost trade among member countries; moreover this was the only effect which everybody was certain about (e.g. see *Rose* [2000] above concerning the doubling of trade[121]). *Berger and Nitsch* [2005] make the point that the increase in trade volumes among euro member countries should have been stronger than for EU countries for many years, reflecting a greater commitment to integration among those

[121] As already stated above, the applicability of *Rose* [2000]'s results to the European Union was questioned by Rose himself, because the countries in his sample were small, poor countries, not like the countries in the EU. Additionally Rose's estimates could be biased upwards by reverse causality (see e.g. *Rose and Stanley* [2005]).

EU countries singing up for the single currency. So the increased trade and the introduction of the euro have a common cause, namely increased integration. This certainly does not rule out a scenario in which the introduction of the euro positively impacts trade volumes, with the euro zone countries forming the monetary union precisely as a mechanism to ensure further trade integration.

Micco et al. [2003] provided the first comprehensive study of the effects of the EMU on trade. Studying mainly members of the European Union and in an expanded specification, with a sample of 22 advanced economies, the authors used a gravity model, controlling for income, distance, free trade area, European Union membership and other variables, and find that the euro increased trade among the member countries by 8-16 percent compared to non-member countries. This increase is economically significant for a group of countries that already had strong bilateral trade linkages and a high degree of institutional integration through membership of the EU (eventually the EMU membership seems to have a comparable effect to that of EU membership). Moreover, *Rose's* [2000] work had established that the long-run impact of currency unions substantially exceeded the short term gains, so the *Micco et al.* [2003] estimate could be viewed as a plausible lower boundary for the long-term cumulative impact of the euro on intra-area trade volumes, bearing in mind that their sample only contained the first 4 years of the monetary union. Similar results were found by *Baldwin* [2006], who provides a wide-ranging review of the subsequent empirical work and concludes that a boost of 5-15 percent is a robust estimate (with 9% being the best estimate). *Chintrakarn* [2008] also found a 9-14 percentage trade increase between euro area countries. *Havránek* [2009], on the other hand, puts the effect of the euro at less than 6 per cent using simple meta-analysis techniques accounting for the publication biases.

So there is some evidence that the introduction of the euro enhanced trade growth, but one needs trade diversion, not merely trade increase to affect the exchange rate. *Micco et al.* [2003] also searched for trade diversion in their study, but found no evidence for it (neither did *Chintrakarn* [2008] or *Baldwin* [2006]): that is, trade between euro member countries and other industrial nations was also boosted by the introduction of the euro. To sum up there is significant increase in the trade of the countries using euro, but there is no evidence of changes in the trade patterns can be found, namely the countries which introduced the euro trade more with their original trading partners.

Structure of production.

Whether the EMU has changed the production structure is part of an argument already cited above in subsection 4.1.1, which is again related to the endogeneity of the currency area.

Giannone and Reichlin [2006] didn't found any visible changes in the production structure of the European Union. According to an overview published by the European Commission, there have so far been only modest changes in the pattern of industrial concentration and geographical specialisation within the euro area. While production specialisation has gradually increased since the 1970s, export specialisation appears to have decreased, which could be partly explained by the increased importance of intra-industry trade. Similarly, a study of sectoral specialisation carried out by the European System of Central Banks in 2004 (see *ECB* [2004]) found the production structure of euro area countries to be relatively similar (*Mongelli and Vega* [2006]).

However *Ezcurra et al.* [2004] find evidence for Krugman's argument, as they show that in the 90s the processes of specialisation and cluster formation accelerated in the European regions. On the other hand *Ricci* [2006] shows in his simple model that there is less incentive under a fixed exchange rate to locate firms that manufacture the same product in one region. As a flexible exchange rate absorbs some of the shocks, the best way for the firm to isolate its sales volume from volatility is to locate itself in a country which is a net exporter and is specialized in the firm's product(s).

It is possible that not enough time has elapsed to for the changes to manifest themselves.

Wealth portfolios

The financial integration caused by the introduction of the euro described above, results in the same assets and investment opportunities for households in different countries, which could lead to a convergence in portfolios. No dramatic changes are expected though, bearing in mind that on the one hand financial integration is weakest in the retail banking sector, and on the other, nobody believes that the preferences of households have become more homogenous during the past 10 years.

Byrne and Davis [2002] also investigate the convergence in households' portfolio shares in Germany, France, Italy and the United Kingdom. They find evidence for convergence in financial assets, in deposits, coins and notes, and there is convergence for money market instrument holdings. In the case of bonds and equities, the series are too volatile, so there is little evidence of consistent convergence in any of the country

groups. Both for the EMU-3 (Germany, France and Italy) and the EU-4 (Germany, France, Italy and the United Kingdom) group, the standard deviation of equity shares is comparable at 10 to 11 per cent in 2000, increasing from 4 per cent in 1980. Mutual funds were not important assets of the household sector before 1990 in most countries; hence it is interesting that since then there has been some convergence in shares in the EU-4 and EMU-3 samples. For life and pension funds the much greater divergence in the EU-4 relative to the EMU-3 reflects the more restricted development of pension funds in the continental group, as already mentioned above. Accordingly the EU-4 deviation increased up to 1998, with only a slight convergence until 2000. Finally, the assets/GDP ratios have shown increasing divergence at the EU-4 and EMU-3 levels. Current standard deviations of 30 to 50 per cent show major discrepancies in these aggregates, which is greater with the UK included (*Byrne and Davis* [2002]).

In terms of the convergence of household liabilities, according to the standard deviations, there is convergence in the relative use of consumer credit and mortgage credit by households in the EU-4 and EMU-3. On the other hand, the overall debt/GDP ratio has shown growing divergence over time, which is partly linked to lower levels in Italy and France than in the UK and Germany (*Byrne and Davis* [2002]).

As already emphasised, real estate is a very important part of households' wealth. One of the major causes of differences in the potential wealth channel of the monetary policy cited in subsection 4.2.1 is the differences in the mortgage institutions. This is one of the fields where very slow change is expected, as the observable differences are the result of differences in historical development, legal background and cultural factors etc. The differences could be further strengthened by government interventions in the housing market, prudential regulation, and the level of competition in the mortgage market. And since such factors as language, distance, consumer preferences or lender business strategies tend to change only very slowly, if they change at all, the differences will probably be long-lived (*EC* [2005], [2007]).

After all it is not surprising that - as many external sources (*LE* [2005], *MOW* [2003]) and the Commission's on-going consultation all observe - these markets are not very integrated, notably in relation to the range of available products and cross-border mortgage activity, while price differences (spreads) are already relatively low. The level of direct cross-border sales is low, less than 1% of overall residential mortgage credit

activity (*Eurobarometer* [2004])[122] and largely confined to the purchase of holiday homes or border region purchases, both niche market sectors (*EC* [2005]).[123]

MOW [2003] explains the interest differences by differences in product range. According to *LE* [2005] the nominal interest rate converged across countries, but they find no evidence of a convergence of mortgage spreads within the euro area since the adoption of the euro. *OW* [2007] reports similar findings; they updated the price measures of *MOW* [2003][124], and found that the mortgage prices have fallen in all the countries investigated due to increased competition inside the countries, but the competition between countries has not changed, which is to be expected as the regulation is still local.

Credit availability

Ciccarelli et al. [2010], using unique survey data[125] and VAR methodology on a 2002-2009 sample, find that the credit availability is quite an important for the common European monetary policy. For non-financial firms the effect works mainly through supply side effects, the banks' ability and incentive to provide credit (the bank lending channel); in the case of households the demand side effects are significant, so households' capacity to borrow due to their balance sheet position is crucial (the balance sheet effect). So the effect is present at an aggregated level, but there is no answer as to whether the heterogeneity of these channels changed after the introduction of the euro.

Despite the widespread literature on credit - and especially the bank lending channel before the introduction of the euro (see the survey in subsection 4.2.1), - hardly any attempt has been made to ask the question whether the euro and accelerated integration caused any changes. I only found the paper of *Ferreira* [2010], who concluded that the reaction of the banking institutions in the EU countries is similar to the variations of the macroeconomic conditions, in particular to the monetary policy interest rate.

[122] *Eurobarometer* [2004] found that in both 2002 and 2003 just 1% of the respondents had ever taken out a mortgage in another EU country; in 2003 Ireland (2%) and Luxemburg (4%) were both above average. No significant variations between socio-demographic categories were observed.

[123] The integration of European mortgage markets is a topic of debate within the European Commission. See *EC* [2005] and *EC* [2007].

[124] MOW [2004] and also OW [2007] use adjusted prices to account for the differences in mortgage products, (fees, maturity, country risk and prepayment options).

[125] Bank Lending Survey (BLS) also used by *de Bondt et al.* [2010], who established the property of the survey as an excellent leading indicator of credit and output growth.

Changes in flexibility of prices

Despite the fact that the advantages of introducing a common currency are connected to the development of prices (comparable prices, stable exchange rates, the possibility of a more credible monetary policy and, through this, price stability), discussion on the question of how the euro has changed price flexibility is scarce (see *Tchinkov* [2008]).

According to the models of *Devereux* [2006] and of *Senay and Sutherland* [2005] it is possible that a fixed exchange rate endogenously increases the price flexibility. In the model of *Devereux* [2006] the fixing of the exchange rate increases the volatility of monetary policy (which maintains the exchange rate peg), which in turn makes the nominal demand for firms more volatile. As a result more firms decide to bear the costs of price adjustment, also making their price more volatile. The fixed exchange rate affects the price flexibility even more if the peg is one-sided (so only one side bears the cost of maintaining it), and in this case it can even offset the volatility of an increase in output. If the peg is multi-sided the results are less unambiguous; the peg increases the flexibility of prices only in case of real shocks, while monetary shocks, on the other hand, decrease flexibility. *Senay and Sutherland* [2005] show that a fixed exchange rate can increase price flexibility in case the switching effect, so the incentive the changes in the exchange rate give to switch from home products to foreign products, is low. However, in their parameterisation the increased price flexibility cannot compensate for the loss of an independent monetary policy and fixed exchange rate scenarios tend to lead to lower welfare, compared to an inflation targeting regime with flexible exchange rate. Looking at these models it is possible that the introduction of the euro affected (even increased) the price flexibility, making it easier for member countries to adjust to asymmetric shocks.[126]

The research of *Angeloni et al.* [2006] is based on time series data aggregated for six euro countries (Austria, Belgium, France, Germany, Italy, and Spain) on the quarterly frequencies of price changes for 50 product categories. Based on time plots and summary statistics, the authors find that the euro in itself has had little impact on pricing dynamics, indicating that there was no radical change in the extent of price rigidities in 1999[127], however before 1999 inflation persistence declined homogenously throughout the countries examined. This could have been caused partly by the expectation of price

[126] This would be another channel for the endogeneity process, as in this case the flexible adjustment would be the result of the adoption of the common currency (in *Frankel and Rose* [1996]'s explanation the increased trade volume decreased the probability of asymmetric shocks).

[127] Although not in 1999, *Angeloni et al.* [2006] find effects in 2002 showing that the introduction of the euro coins and notes (change of numéraire) was often used to change/increase prices, especially in the service sector.

stability in the forthcoming EMU, but only partly, because similar trends can be observed in the UK and in the USA. But *Angeloni et al.* [2006] were criticized for not attempting to control for other factors (or model the price setting), which could influence price flexibility. Using the same data set *Tchinkov* [2008] finds a small but significant positive effect (about 5 per cent increase) of the euro on the frequency of price changes (in the case of Germany even on the frequency of price decreases). It is interesting that the estimated result is negative (but insignificant) in the case Spain, which would suggest that price flexibility decreased in the Mediterranean country. On the other hand the euro effect on the average size of price changes is estimated to be insignificant, both statistically and economically.

Labour market

The following paragraph deals with the euro's effect on the labour markets, which could affect the wage flexibility. *Calmfors* [2001] sets out three possible theoretical explanations for the fact that wages are usually rigid: long contracts, social norms of fairness, and bargaining games. The introduction of the euro and the more stable inflation environment will probably not result in shorter contracts, and the introduction of euro as a regime change is not large enough to alter social norms. As to the bargaining game, *Calmfors* thinks that the EMU will promote national coordination of wage bargaining, which again is in contrast to trends such as the decentralization of bargaining and de-unionisation. Theoretically, as in the case of price setting, the fixed exchange rate across countries without their own monetary policy could make wages more flexible, even in the presence of unions, because there are fewer other means of adaptation and the loss of competitiveness could result in higher unemployment. On the other hand, as national wage levels have much less effect on the interest rate level determined by the ECB (especially in the case of smaller member countries), there are fewer feedbacks after wage increases (Lane [2006b]).

Exchange rate pass-through

Looking at the exchange rate pass-through, and thus the effect of exchange rate movements on domestic prices *Devereux et al.* [2003] hypothesise that the pass-through should decline, and European prices should become insulated from exchange rate shocks. According to their argument the euro is becoming a vehicle currency, and because of this more and more prices will be quoted in euro, and so the exchange rate

movement will have less effect on these prices.[128] *Faruqee* [2006], using VAR methodology on a sample of euro area aggregates between 1990-2002, finds that the impulse-response patterns already suggest a high degree of local currency pricing in import prices and producer currency pricing in export prices. For the euro area this suggests that these traded goods are priced predominantly in euros, which again weakens the exchange rate pass-through. On the other hand as shown above (in subsection 4.2.1) the differences in the exchange rate pass-through estimated by *Campa and Minguez* [2006] were linked with the different degree of openness. As the openness of countries did indeed decline[129], the exchange rate pass-through should have declined as well.

4.3.4. Conclusion

As a first step in the answering of the question how the euro affected the monetary transmission I reviewed the changes in the structure of the economy caused by the introduction of the euro. At the same time these changes could also influence the differences in the transmission mechanism.

A common result in the literature is that financial integration was accelerated by the introduction of the euro, increasing competition and making reactions of interest rates and other asset prices more homogenous across countries. Other changes couldn't be linked to the homogenization of the monetary transmission across countries. The introduction of euro raised the trade among of all the EU countries, but not disproportionately among the euro area member countries. At the same time the exchange rate pass-through decreased as prices of previously imported goods aren't exposed to changes of exchange rate any more. The structure of production hasn't (yet) reacted to the introduction of common currency. Neither did labour market, price flexibility and wealth portfolios.

In the next section I test empirically if the changes (or the lack of them) summarized in the section above helped endogenously to make the monetary transmission more homogeneous.

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[128] *Devereux et al.* [2003] model the welfare consequences of a declining exchange rate pass through; on the one hand it causes more volatile macroeconomic aggregates, which decrease welfare; on the other hand through the stable import price it also raises the level of the same macroeconomic aggregates, and welfare as well. The cumulative effect of these changes according *Devereux et al.* [2003] is positive.

[129] Only 40-50% of their previous exports and imports remained exports and imports in the sense of the exchange rate after the introduction of the euro.

4.4. Quantitative results concerning the endogeneity of monetary transmission[130]

"The 'ideal' study, based on past experience, which would be informative about differences across countries in the transmission mechanism of a single monetary policy, would consider the response of the various EU economies to the same temporal sequence of monetary policy shocks, holding fixed the exchange rate among them."

Guiso et al. [2000] p. 12

In this section I try to show empirically the monetary transmission became more homogenous or heterogeneous among countries. Were the changes caused by the euro cited in the section 4.3 enough to make the differences shows in section 4.2 to disappear?

Looking at empirical evidence regarding how the monetary transmission changed to affect output after the introduction of the euro, the answer to this question is doubtful. Of course most of these results are acquired with different methodologies which make comparison of results difficult.

Clausen and Hayo [2006] searches for structural breaks before 1999, but could not find any, a result based upon the stability of the coefficients in their model (although there are differences in the impulse response functions), which means that either the structural break came after the introduction of the euro or the changes occurred very gradually.[131] Gradual changes could mean that the differences found using pre-euro data could be informative, and that it will take time for certain differences to disappear (for example the differences noted by *Cecchetti* [1999]; see above in section 4.2).

Weber et al. [2009] use VAR specification on aggregated data from 1980 to 2006, and finds two break points using the Chow break point test, the first in 1996, the second in 1999. Running the same VAR on the sub-samples they found no difference between the transmission before 1996 and that after 1999. Between these two breakpoints the effect of monetary policy should be different, but the sample was too short to run the VAR on it. The biggest problem with this method is that they treat the EA countries before 1999 as an area with already one monetary policy shock, which clearly does not reflect reality.

[130] Previous version of this subsection was presented on the International Workshop on Recent Issues in European Economic Integration and EU Enlargement, (23rd-24th June 2011. Brussels, Belgium).

[131] *Clausen and Hayo* [2006] used the sample 1979:1 1997:4, so even the period of the introduction of the euro is left out of their sample.

Boivin et al. [2008] use a factor augmented VAR model (FAVAR) to try to answer the question of whether the transmissions in different countries have changed because of the EMU. Using 245 quarterly time series they isolate common factors: an interest rate shock, an oil price shock and several other unknown factors. The aim is to see how a shock in this factor (in interaction with other factors through VAR) affects the time series, and how these affect changes in different sub-samples. They found that only Italy and Spain are outliers from the group on the 1988-2007 sample, as their long-term interest rate reacts much more to a short-term interest rate shock, resulting in a stronger reaction in other variables as well. In both cases the result is in line with the results of the WGEM experiment in *Table 4.8* and *Table 4.9*. After 1999 the picture changes; the same short term shock results in a smaller and more homogeneous long-term interest rate reaction, followed by a smaller reaction in the other variables. The homogeneity of reactions shows the same picture as the indexes of financial integration above. The reaction of short-term interest rates are identical, there is almost no difference in the reaction of the long-term (bond) rates, and small differences in the stock market indexes. The reaction of M1 and M3 is still heterogeneous, which *Boivin et al.* [2008] explain with the differences in the forms of saving in different countries. It is a justifiable question whether the smaller reaction of the economies to the same interest rate shock shows a weaker or a more stabilising monetary policy. As before[132], the authors explain decreased reactions by the changes in the systematic elements of the monetary policy, showing that an oil price shock also has a smaller effect on the consumer price index after 1999, indicating a better anchored inflation expectation and a more credible monetary policy.

One gets a mixed picture while summing the evidence in the literature: the financial integration doesn't seem to have a strong effect on other aspects of the member economies. Based on macro models the monetary transmission may or may have not changed, but there is no evidence how the differences of the transmission between the member countries changed due to the introduction of the common currency.

The reminder of the section is organized as follows: in the next subsection I show the methodology adapted, followed by the empirical results. The last section summarizes and concludes.

[132] See *Boivin and Giannoni* [2002a], [2002b], [2003]

4.4.1. Methodological concepts

Many of the empirical exercises introduced in section 4.2 were criticized on the ground shown in the citation at the beginning of this section. According to *Guiso et al*. [2000], one would only be able to show whether the differences in the transmission mechanism would cause problems for a common monetary policy, if the transmission was modelled in an environment which has the key features of the euro area: common monetary shock and irreversibly fixed exchange rates. Although I do not to wish to answer the question whether the differences found are large enough to cause concerns, *Guiso's* comment is valid for my case as well. As I try to show how the differences observable in the era of common monetary policy changed over time, the problem of regime change arises again. Because of this, the differences in monetary transmission found among the countries of the euro cannot easily be compared with the differences of previous periods, as the main features of the common monetary policy (a common monetary shock and an irreversibly fixed exchange rate) were not present before the third stage of the EMU. These characteristics have to be introduced into the models artificially, as one would ask the question of what differences would have been if there had been a common monetary policy before 1999.[133] The answer to such a question is certainly the subject of a Lucas critique, but still produces more comparable results.

In the next paragraphs I show in more detail how this methodological base concept has been implemented for the case of France, Germany, Italy, Spain and the United Kingdom.

Model

As a base I use a four-variable structural vector auto-regression model for the different countries. The reduced form of the VAR model can be written in the form:

$$x_t = A_t + \sum_{i=1}^{p} B_i x_{t-i} + \sum_{i=k}^{p} C_i y_{t-i} + M + u_t, \qquad (4.1)$$

where $B_1, ..., B_p$ are matrices of coefficients, p is the number of lags, $x_t^{'} = [ip_t \ cpi_t \ si_t \ e_t]$ is a vector of the four endogenous variables, namely: ip_t the industrial production, rpi_t the price level computed using the price index, si_t the short term interest rate and ex_t the exchange rate (in the form of the domestic currency price

[133] There is of course another way around; one could ask the question what differences could be found after 1999 if there had been independent monetary policies and flexible exchange rates, but this method would also lead to the same problems.

of one unit of foreign currency), in that order.[134] $C_0,...,C_p$ are matrices of coefficients for $y_t^{'} = \left[ip_t^f \;\; i_t^f \;\; cp_t \;\; \right]$, the vector of exogenous variables, where ip_t^f is the foreign industrial production, i_t^f is the foreign interest rate and cp_t is the commodity price index. M stands for the monthly dummies and the time trend and u_t is the vector of reduced form residuals. The models for each country in each sample (endogenous and exogenous variables, the number of lags etc.) are shown in Appendix 4B together with the source of the different time series. The model (4.1) is estimated on levels, using the logarithm of all the variables except for interest rates, which take the form $(1+i_t/100)$.

The main task after estimating the equation (4.1) is to decompose residuals u_t into structural shocks ε_t ($u_t = D^{-1}\varepsilon_t$). My identification, as already used in Chapter 3, follows *Smets* [1997] and *Smets and Wouters* [1999], and is shown in more detail in Chapter 2 This method identifies the monetary policy shock as a positive shock to the interest rate with a simultaneous negative shock to the exchange rate. Throughout this Section the shocks are calibrated to be a 25 basis point shock to the interest rate (the shock to the exchange rate depends on the weight calculated in the equation (2.16)). According to the literature summarized in Chapter 2 such a shock is expected to negatively influence the industrial production and after a time the price level as well.

Samples

"However, it is important to bear in mind that EMU is a process, *not a one time event. The transition to a new currency and monetary policy was something economic agents had time to prepare for, and adjust to, over a number of years. This complicates significantly the task of identifying casual links."* (*Angeloni and Ehrmann* [2003b] p. 6)

As the introduction of the euro was a longer process, it is not enough to split the sample in two, before and after 1999. Since the Maastricht treaty in February 1992 (or at least since its ratification in November 1993) countries had been preparing for the common currency, which means that their transmission mechanism could have changed since 1992. That is why I use three samples: a pre-Maastricht sample from 1980:1-1991:12, a post-Maastricht pre-EMU sample 1992:1-1998:12 and a post-EMU sample 1999:1-2007:12.

Several events confuse the picture, taking away observations for some countries in some samples. First there is the Volcker recession until 1982, then German unification

[134] There are no money aggregates in the model, since it was only Germany who targeted these, and the aim is to be able to estimate similar models for every country (see also *Mojon and Peersman* [2001])

between the summer of 1989 and 1990:10, another oil price crisis between 1990 and 1991, followed by Black Wednesday on September 1992 after which the United Kingdom and Italy were forced out of the narrow banded ERM. There are at least two crises in the post-EMU sample as well - the collapse of the dot-com bubble in 2001 and the prologue to the most recent recession, starting from 2007:8. As general rule if the recession is at the beginning of the sample, observations are dropped until the countries' central banks began to decrease their interest rates (see later in the chapter for each country individually).

As mentioned previously, I use 5 countries in the exercises below: Germany, France, Italy, Spain and the United Kingdom. The first four are the large countries of euro area, their GDP accounts for 80% of the euro area's GDP and, as shown in the previous section, their indicators tend to have less standard deviation than the whole euro area, which means that they tend to be more similar in the features which could influence their monetary transmission mechanism. The United Kingdom, on the other hand, serves as a control, helping to decide whether the changes in the differences were caused by the introduction of the euro or not.

Common shocks, spill over effect.

As mentioned in the introduction one way to make the impulse response functions comparable is to handle them as if the countries had a common monetary authority and fixed exchange rate before 1999. This is not so far-fetched as it seems at first sight, as the European countries operated a mechanism which produced a similar environment. The European Monetary System (EMS) was introduced in 1979 and one of its major components was the Exchange Rate Mechanism (ERM), a fixed, but adjustable exchange rate system where the participating countries maintained fixed rates against the ECU with a narrow 2.25% fluctuation band, although it soon became evident that this was effectively the same as fixing the exchange rate against the Deutschmark (DM). In this system the German central bank, the Deutsche Bundesbank, played a leading role, as being the N^{th} country, it was free to set his own monetary policy, which through the fixed exchange rates influenced the other countries (which were fond of importing the credibility of the Bundesbank - the 'warrior' for price stability - in this way). This role of the Bundesbank makes it an excellent candidate to use its shocks as common monetary policy shocks prior to the third stage of the EMU.[135]

[135] Its a common method to use the German monetary policy as a substitute for the common monetary policy prior to 1999, see also *Clements et al.* [2001], *Ciccarelli and Rebucci* [2006], *Boivin et al.* [2008]

So in the pre-Maastricht and pre-EMU samples I use German monetary policy as the common monetary policy (in the post-EMU I use the monetary policy of the ECB of course). But how does it become a common shock for all the countries? Let me explain with a concrete example. First I estimated the German model for the pre-Maastricht sample and I arrived at an impulse response function for the short term interest rate and the DM/USD exchange rate. Then I estimate the French model for the same period, and then, with the help of additional exchange rate and interest rate shocks[136], (just as in the Hungarian case study in section 3.2) I pre-set the impulse responses for the interest rate and the exchange rate to be the same as in the German case. This exercise has three consequences: first, monetary shock is truly the same in every period. Second, the impulse responses of the interest rates are the same, which again represents some kind of financial integration, just as in the case of the EMU. Third, the reaction of the DM/USD and FRF/USD is same, which means that the cross rate should be fixed.[137]

As shown in the previous section the countries inside the euro area are highly integrated and the results of *van Els et al.* [2001] cited in subsection 4.2.3 also prove that spill over effects are important factors in the monetary transmission. I also try to build in these effects through the exogenous variables. To continue the example above, let us examine the case of France again. In the pre-Maastricht sample the French model uses the German short-term interest rate and industrial production as exogenous variables (and the crude oil price, although this is not important in this case). As I already have impulse response functions for these variables (and because the shock is exactly the same because of the common shock), it is easy to manipulate the exogenous variables in order to follow the monetary shock as well. This would mean that I model what would happen in France if there were a common shock which simultaneously hit France and Germany, which is the aim of the whole exercise.[138]

4.4.2. Estimated results

In this section I show the result of the exercise described above; first I show the separate country results, then turn to the changes in the differences. As shown in Appendix 4B

[136] The series of additional exchange rate shocks were obtained in a repetitive manner, where in step n the difference of the reactions in period n was added to the series of additional exchange rate shocks as a new shock, and the whole model was simulated again with the longer series of additional shocks.

[137] Using the FRF/USD as an exchange rate in the French model is not optimal, because for French monetary policy and for the whole French economy the FRF/DM exchange rate was significantly more important; however, the common shock calls for this solution.

[138] This method is similar to that used by *Mojon and Peersman* [2001] in the models for Austria, Belgium and the Netherlands. These countries operated a fixed exchange rate system against the DM in the EMS, and for this reason they gave up their sovereign monetary policy, so the monetary policy shock in these country models came from the German monetary policy through the exogenous variables.

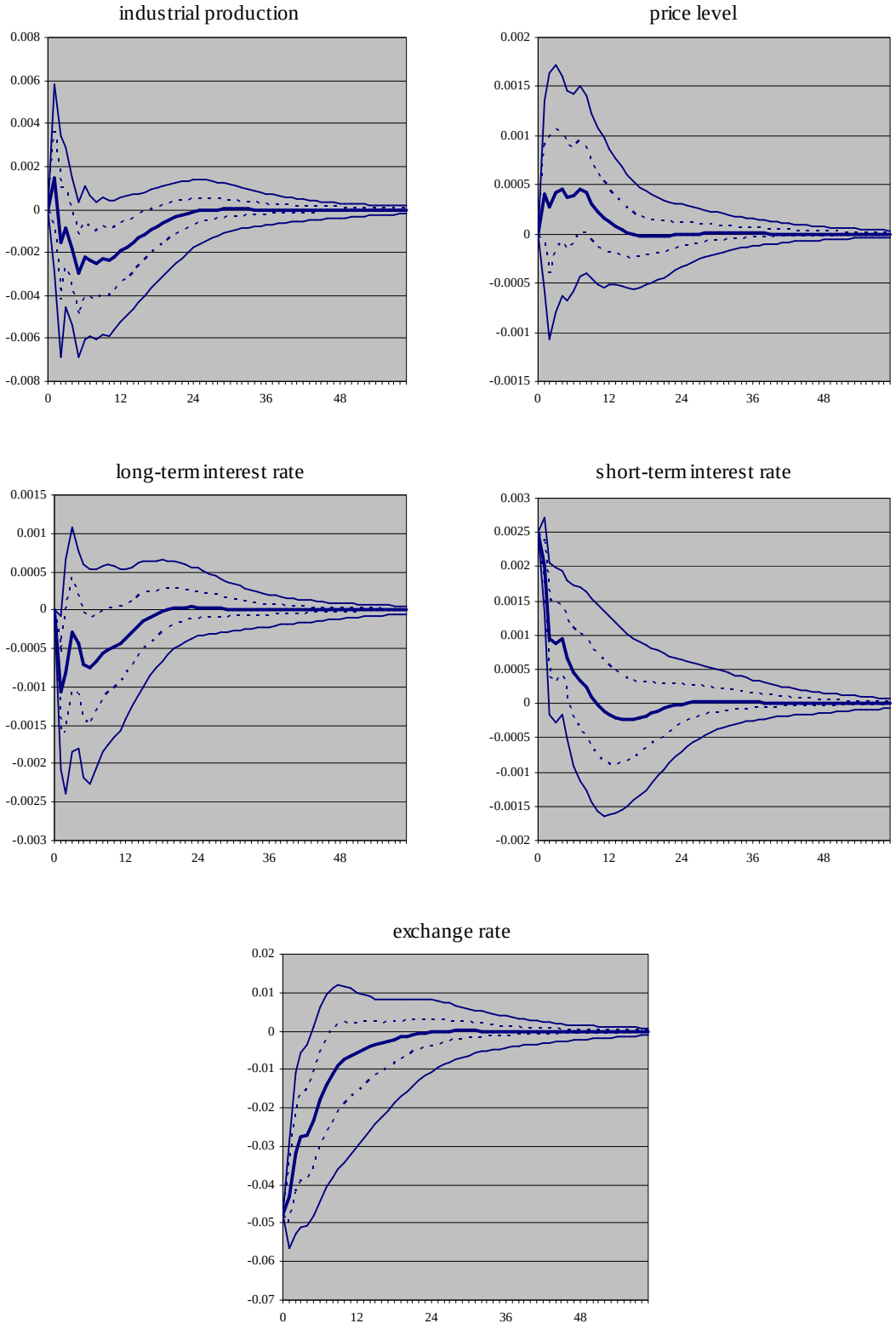
the different country models are very similar, which helps the comparison, but there are still differences which help to avoid an implausible uniformity. As the shock is different in each sub-sample I will not compare the IRF between samples.

The euro area

The first exercise is to estimate a model for the whole euro area for the post-EMU sample (1999:12 – 2007:12), because it is needed for the common shock and spill over effects. This model is somewhat different from the others because it has 5 endogenous variables, thus $x_t^{'} = \left[ip_t \; cpi_t \; li_t \; si_t \; e_t \right]$ from system (4.1), where li_t is the long-term interest rate. US short-term and long-term interest rates are used for exogenous variables, besides the IMF's commodity price index. The confidence intervals, as in all cases, are constructed from 10000 Monte Carlo draws, using the method described in *Hamilton* [1994] p. 337. In *Figure 4.2* the 60% (dashed lines) and 90% (continuous lines) confidence intervals are shown, together with the median.

Looking at the IRFs there are some unexpected movements. The fact that the price level does not decrease significantly in reaction to a monetary policy shock, means that the monetary shock is not very well identified. The reaction of the long-term interest rate is also interesting. As mentioned previously, two kinds of reaction can be expected after an increase of the short term interest rate. Given that the monetary policy increased the short-term interest due to increased inflationary pressure, the long term interest rate could either react positively if the inflation expectation increases and the short-term interest rate yield curve increases, or it can react negatively if the monetary policy is known to be capable of fighting the inflationary pressure, i.e. if it is credible. Since in this case the long term interest rate reacts negatively (which is robust across different specifications), this could mean that the monetary policy is credible, but that at the same time there is no negative reaction in the price level. These two facts contradict each other. But as I only need the reaction of the short-term interest rate and the exchange rate for the common shock and the reaction of the long-term interest rate and industrial production for the spill over effects (these IRFs appear well-behaved, even if the reaction of the exchange rate is rather strong), I leave the solution for another occasion.

Figure 4.2. **Euro area model for the sample 1999:1-2007:12**



Source: own calculation
Note: continuous bold blue lines represent the median, thin continuous blue lines represent 90%, dashed blue lines represent 60% confidence intervals from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

Germany

In the case of Germany there is no common shock or spill over effect for the first two sub-samples, as it is believed to be the country which has freedom of action.

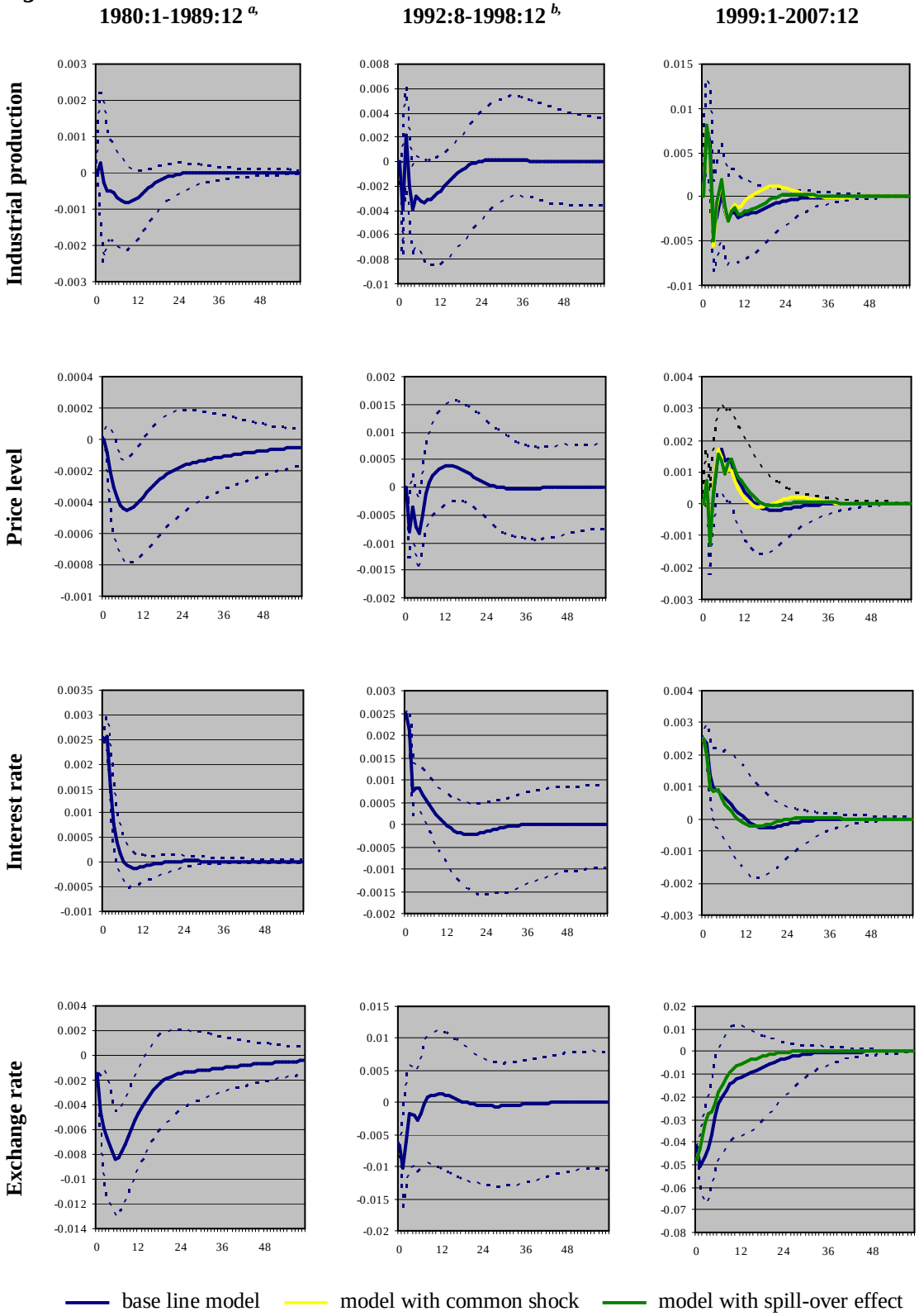
Starting with the pre-Maastricht sample, several observation had to be omitted because of German unification which started in the summer of 1989, but only came into effect in 1990, so the pre-Maastricht sample for Germany ends in 1989:12. The exogenous variables are the US short term interest rate and industrial production, together with the crude oil price index of the IMF (for other specifications see again Appendix 4B). The short term interest rate influences the exchange rate, the industrial production stands for the world demand for German exports, the commodity price represents outside inflationary pressure.[139] The impulse response functions are shown in the first column of *Figure 4.3.* The 90% confidence intervals show that the fall in industrial production is not significant, but the reduction of the price level is. The reaction of the exchange rate is somewhat unusual, because the appreciation is gradual and not immediate, but nevertheless the appreciation is significantly different from zero.

The pre-EMU sample only starts from 1992:8; from this point on the Bundesbank lowered its interest rate as a response to growing pressure, which nevertheless caused the ERM crises. If we set aside various spikes (industrial production and price level) and too rapid kick-backs (price level), the impulse response functions seem to move approximately in accordance with the literature.

Since in the post-EMU era one cannot speak of an independent German interest rate and DM/USD exchange rate, the euro interest rate and euro/USD exchange rate were incorporated into the model as endogenous variables for the last sub-sample, rather than the German interest rate and exchange rate. To enable the spill over effect the exogenous variables have to be altered as well, as in all the post-EMU sample models the exogenous variables are industrial production and the long-term interest rate of the euro area. In the last sub-sample it is possible to include the euro area common shock and spill over effects from the variables above as shown in the last column of *Figure 4.3*, where the base model is a solid black line (with 90% confidence interval as before), the dark grey solid line is the model with common shocks coming from the EMU model introduced before, and the light grey solid line is the model with the spill over effect.

[139] These are similar in *Mojon and Peersman* [2001].

Figure 4.3. **German models**



Source: own calculation

[a,] The first sub-sample ends in 1989:12 because of German unification.

[b,] The second sub-sample starts in 1992:8 because this is the peak of the German interest rate before the ERM crisis.

Note: the solid blue line is the base model, the solid yellow line is the model with common monetary shock (German in sub-sample 1980-1991 and 1992-1998, and EMU in sub-sample 1999-2007), and the solid green line is the model with a common shock and spill over effect (from Germany in sub-sample 1980-1991 and 1992-1998, and from the EA in sub-sample 1999-2007). Dashed blue lines are 90% confidence intervals for the base model from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

To avoid overcrowded figures I only show the confidence bands for the baseline model. In the case of the interest rate and exchange rate the impulse response with a common shock and 'common shock and spill over effect' are identical so only the one with the spill over effect is observable.

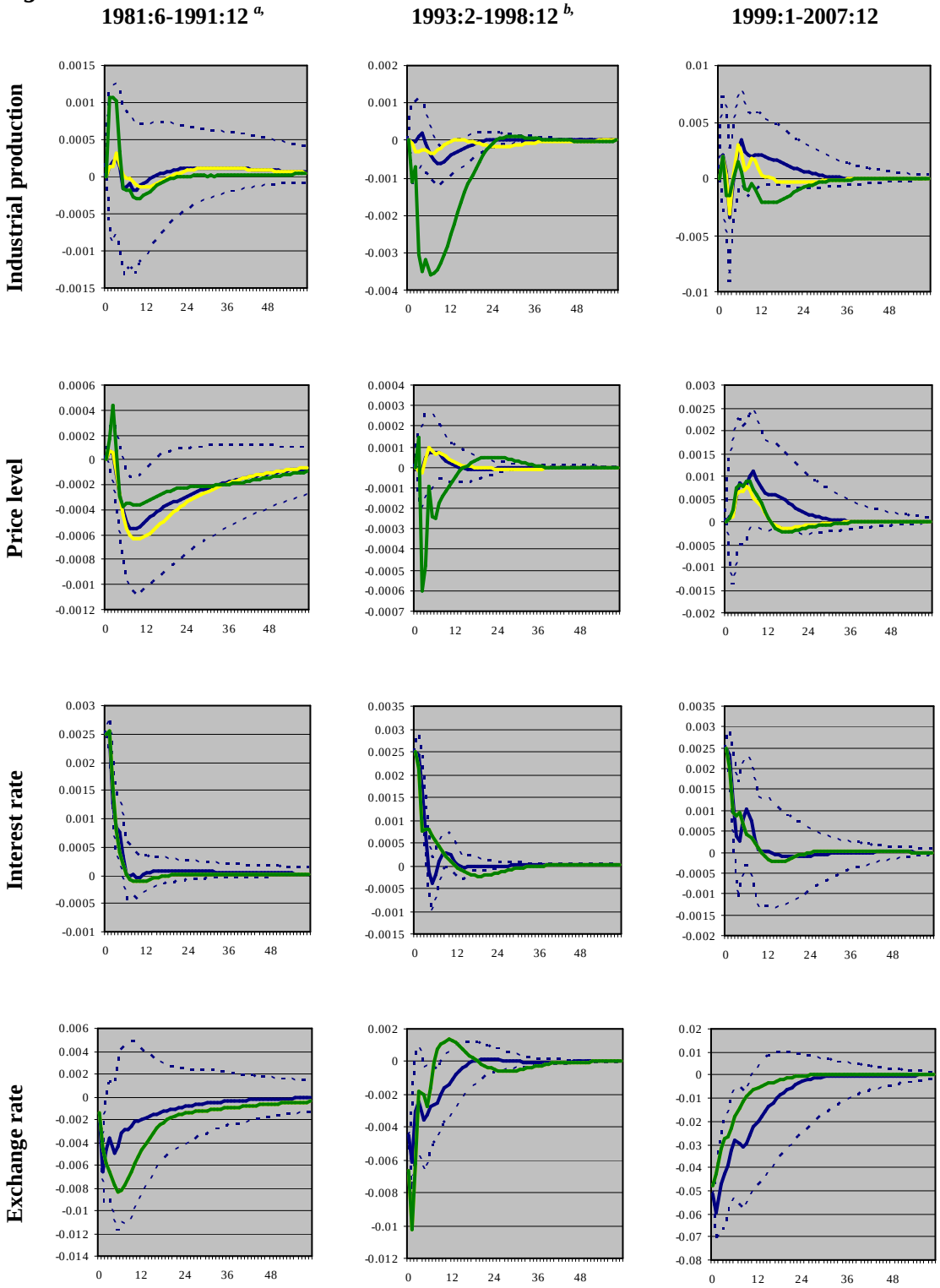
To turn to the forms of the impulse response functions one can see that there is a positive spike in the beginning of the industrial production, which does not become significantly negative after that. In the case of the price level after a negative spike, the price level rises significantly above zero. What is interesting in this case is the fact that the baseline reaction of the interest rate and exchange rate does not differ significantly from the reaction to the common shock (or spill over effect as they are identical), which could explain the lack of difference in the industrial production and price level. This means that the short-term interest rate and exchange rate react very similarly if the industrial production and the price level of the whole euro area are included in the model, and if only German factors are included. This fact also shows the weight the German economy has in the euro area.

France

The first sub-sample starts at 1981:6 to leave out the statistics related to the Volcker recession. The exogenous variables in this model - as already explained - are the German short-term interest rate, and the German industrial production and the crude oil price.[140] The German interest rate is very important for French monetary policy as it attempts to fix the exchange rate against the ECU in the ERM; the German industrial production represents the movements in the global business cycle. The crude oil price shows outside inflationary shocks. These variables make it possible to have spill over effects in addition to the common shocks, as shown in *Figure 4.4* and explained in the sub-section above. Looking at the impulse response functions, industrial production does not show a significant decline (there is even a sharp spike right after the shock with spill over effects), but the reaction of the price level seems to be significant. Neither the common shocks nor the spill over effects change the form of the IRF-s considerably.

[140] *Mojon and Peersman* [2001] use similar exogenous variables for France, Italy and Spain.

Figure 4.4. **French models**



Source: own calculation

[a,] The first sub-sample starts at 1981:6 because of the Volcker recession.

[b,] The second sub-sample starts at 1993:3 because this is the peak of the French interest rate in the ERM crisis.

Note: the solid blue line is the base model, the solid yellow line is the model with common monetary shock (German in sub-sample 1980-1991 and 1992-1998, and EMU in sub-sample 1999-2007), and the solid green line is the model with a common shock and spill over effect (from Germany in sub-sample 1980-1991 and 1992-1998, and from the EA in sub-sample 1999-2007). Dashed blue lines are 90% confidence intervals for the base model from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

The pre-EMU sample begins at 1993:2, the point at which the French central bank lowered its interest rate as an answer to the ERM crisis. The exogenous variables are the same as in the first model, the common shock and the shocks to these exogenous variables come from the German post-Maastricht model. The IRF-s are shown in the second column of *Figure 4.4*; here the spill over effect has a great influence on the drop in industrial production and the price level.

Both the endogenous and exogenous variables had to be changed in the post-EMU sample, as already explained in the German model. The fall in industrial production is deeper with spill over effects. The positive reaction of the price level is not 'textbook' either, although at least the positive reaction is smaller with common shocks and spill over effects.

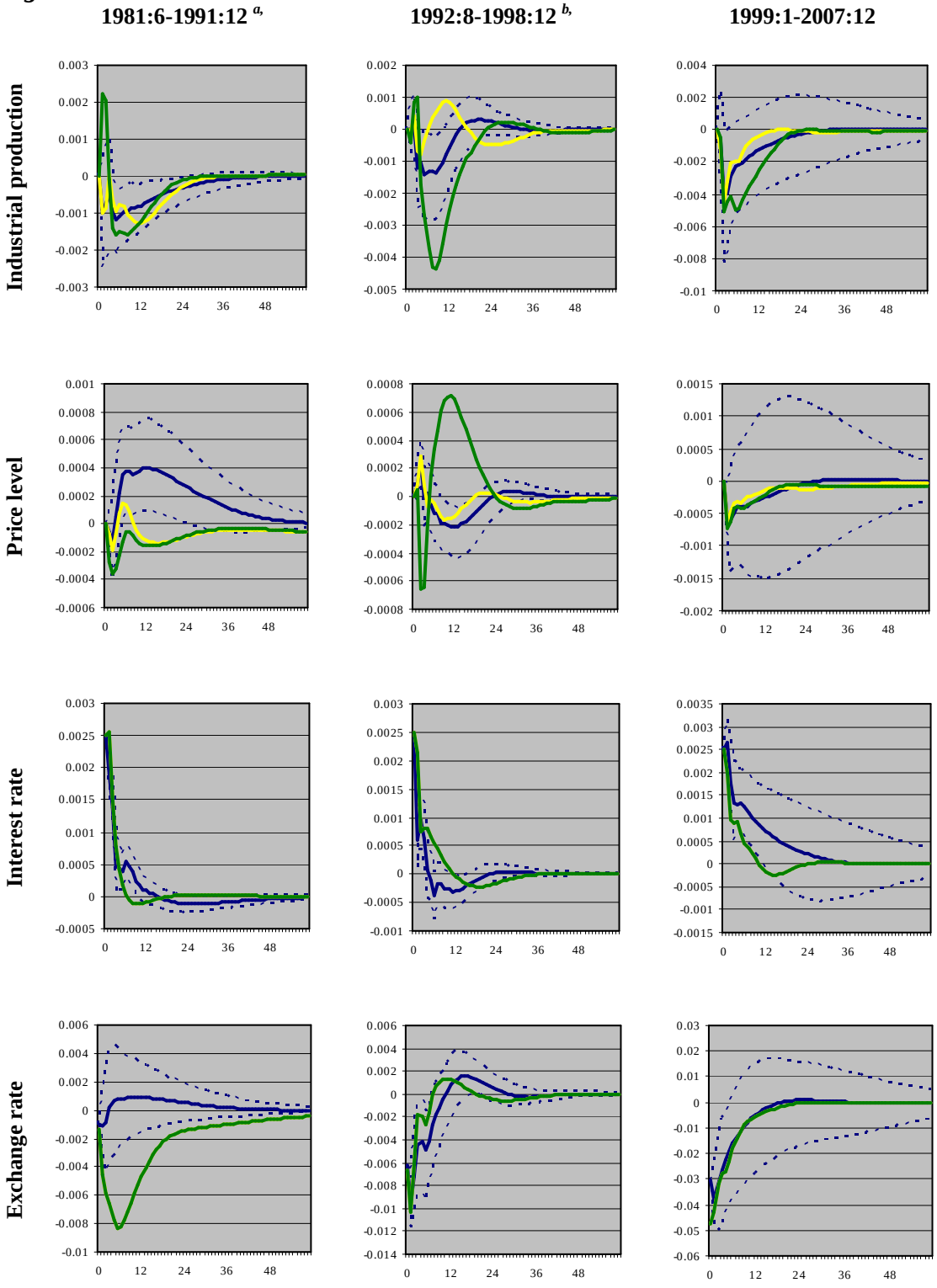
Italy

The first sub-sample for the Italian model starts at 1981:6 to avoid the turmoil caused by the Volcker recession. The exogenous variables are the same for the Italian model as for the French one. The impulse responses are depicted in the first column of *Figure 4.5*. The reaction of industrial production is negative and significantly different from zero. The picture is distorted neither by a common shock nor by spill over effects, although the positive spike right after the shock is - as in the French model for the same sub-sample - also observable in this case. The reaction of the price level is a harder question because here only the model with common shocks and spill over effect results in negative IRFs. It is also interesting how small the exchange rate shock caused by the baseline monetary shock is.

In the Italian case the start of the second sub-sample is at 1992:8 as the Italian lira was forced out of the narrow ±2.25% band around the ECU during the ERM crisis. The decrease in both the industrial production and the price level was significantly negative. But the most interesting thing is that here again it is the second sub-sample where the spill over effects cause the most differences, a deeper fall in the industrial production and a negative spike followed by sizeable kick-back in the price level.

In the third sub-sample in the case of industrial production the spill over effect makes the fall more lasting. The price level also decreases but in the base model it has a very wide confidence band, so the fall cannot be considered significantly different from zero.

Figure 4.5. **Italian models**



Source: own calculation

[a,] The first sub-sample starts at 1981:6 because of the Volcker recession.

[b,] The second sub-sample starts at 1992:8 as the Italian Lira was forced out from the narrower band against the ECU.

Note: the solid blue line is the base model, the solid yellow line is the model with common monetary shock (German in sub-sample 1980-1991 and 1992-1998, and EMU in sub-sample 1999-2007), and the solid green line is the model with a common shock and spill over effect (from Germany in sub-sample 1980-1991 and 1992-1998, and from the EA in sub-sample 1999-2007). Dashed blue lines are 90% confidence intervals for the base model from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

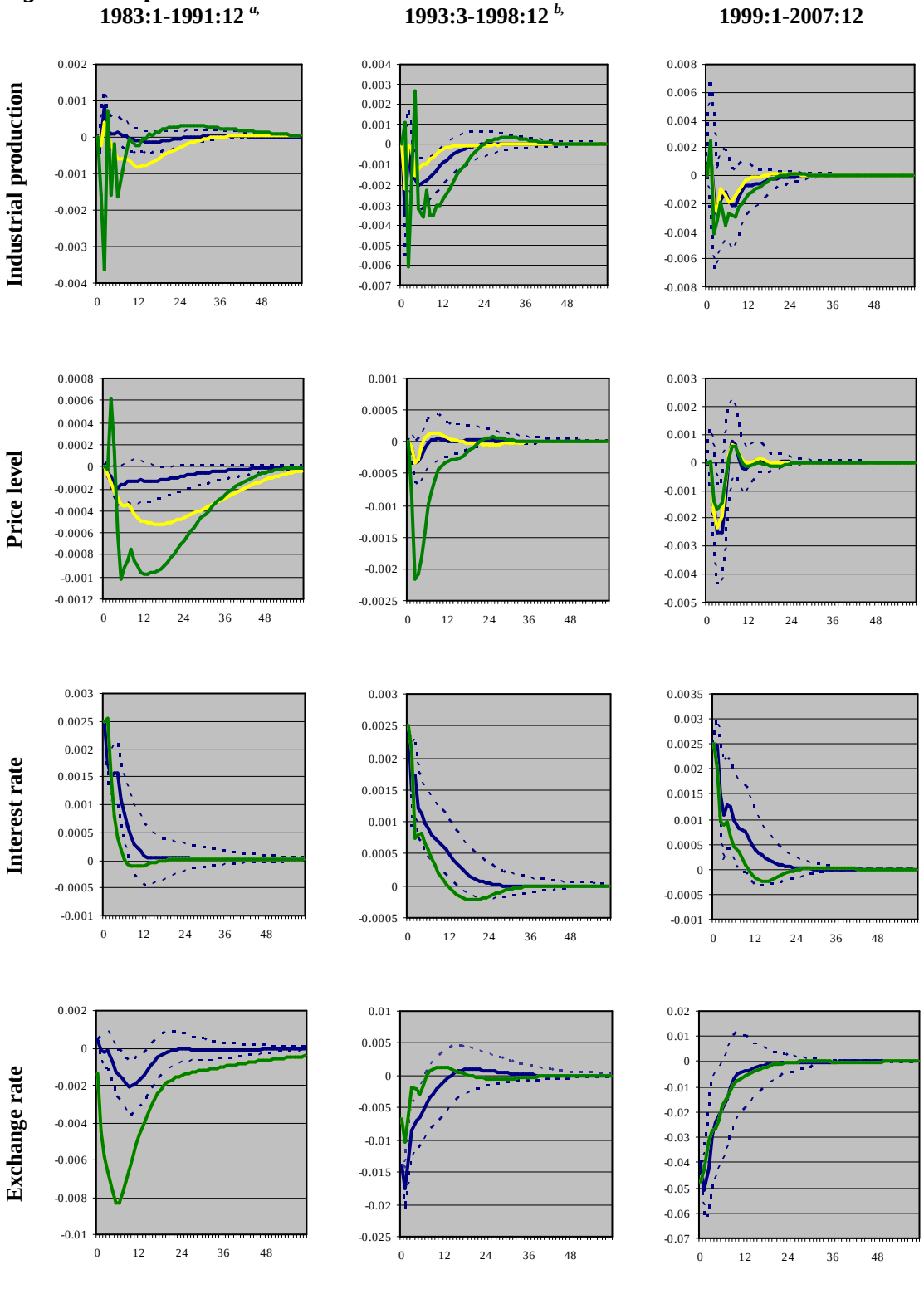
Spain

The pre-Maastricht sample in the Spanish case begins in 1983:1, again because of the Volcker recession. As in the previous cases the exogenous variables are the German short-term interest rate and the German industrial production, which make it possible to model spill over effects, through these variables. The impulse responses in the first column of *Figure 4.6* show that again the spill over effects are needed to make the reactions bigger. In the case of industrial production this larger reaction is just a dramatic spike right after the shock. The fall in the price level also becomes larger with a common shock and with a common shock and spill over effect, except for the positive spike at the beginning of the latter. As in the Italian case the exchange rate reaction is also small in the baseline model.

The interest rate peak was in 1993:3; after that the central bank decreased its interest rate as an answer to the ERM crisis. In this sub-sample the industrial production seems a little volatile (positive and negative spikes), but the spill over effect increases the drop (which was already significantly different from zero in the baseline scenario). The spill over effect also increases the effect of the common shock on the price level. One interesting thing is that unlike the previous sub-sample here the reaction of the exchange rate is even bigger than the common shock.

In the last sub-sample industrial production reacts in the expected way, and the spill over increases the reaction. But with the price level it is reversed; the initial negative shift is smaller with spill over effects, but the positive kick-back is the same in all cases.

***Figure 4.6.* Spanish models**



Source: own calculation

[a,] The first sub-sample starts at 1981:6 because of the Volcker recession.

[b,] The second sub-sample starts at 1993:3 because this is the peak of the Spanish interest rate in the ERM crisis

Note: the solid blue line is the base model, the solid yellow line is the model with common monetary shock (German in sub-sample 1980-1991 and 1992-1998, and EMU in sub-sample 1999-2007), and the solid green line is the model with a common shock and spill over effect (from Germany in sub-sample 1980-1991 and 1992-1998, and from the EA in sub-sample 1999-2007). Dashed blue lines are 90% confidence intervals for the base model from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

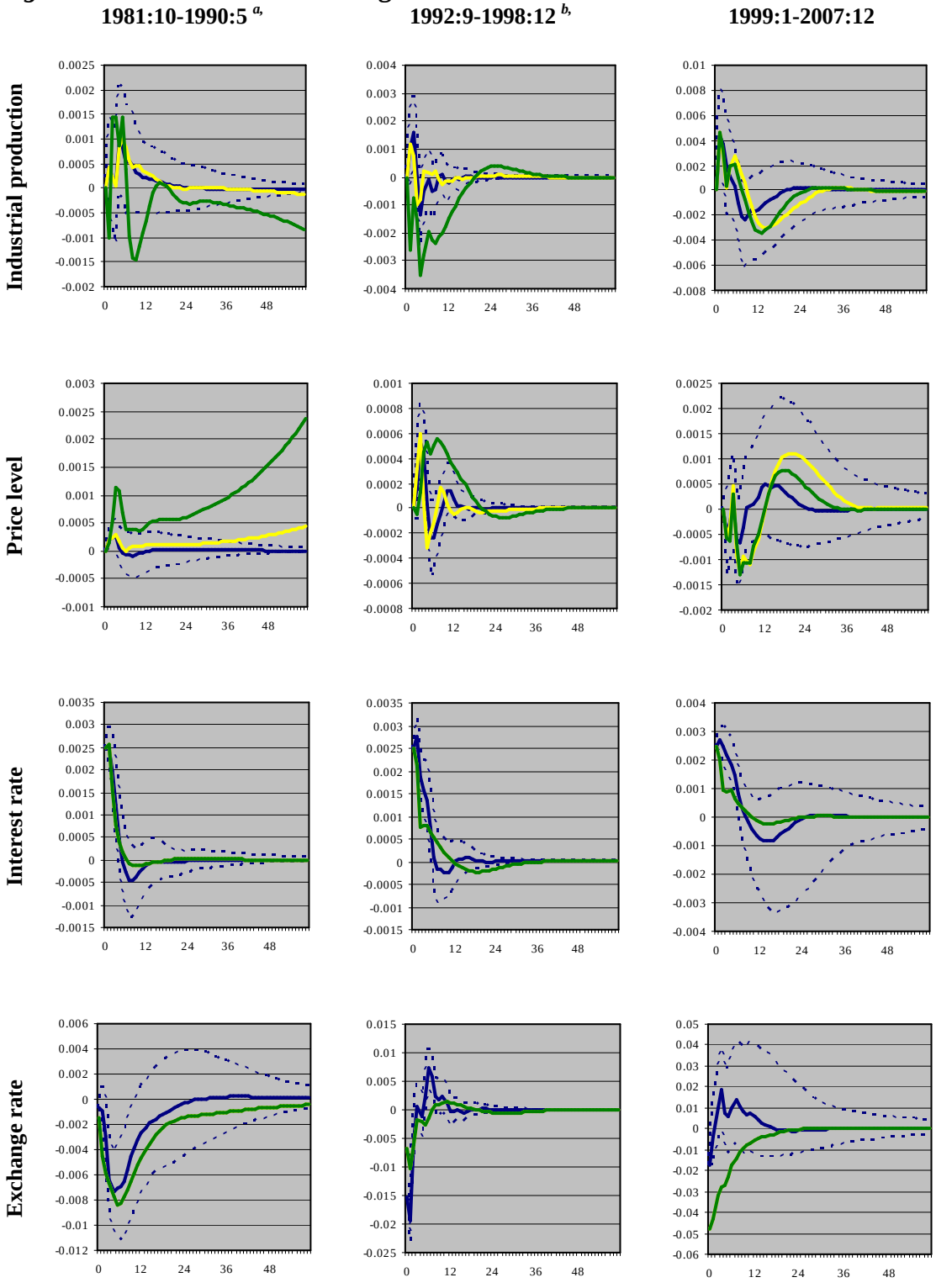
United Kingdom

The United Kingdom is needed as a one-man control group, a country which is part of the EU and highly integrated with it through trade and other links, but did not introduce the euro. In short, it helps to decide whether there is a euro effect or not.

The first sub-sample is messy, starting in 1981:10 because the Volcker recession hit the UK hard, and ending in 1990:5 when the oil crisis caused by the first Gulf war reached the country. The exogenous variables are the same as in the other models to make spill over effects possible just as for the other countries (the common shock, defined as the German monetary shock, and the spill over from the German short term interest-rate and industrial production). Impulse response functions are shown in *Figure 4.7*; there is a positive reaction in industrial production, and is not solved by the spill over effect which only makes the volatility greater and in the end the industrial production converges to negative infinity. The same is true for the price level, where the spill over effect only causes the price level to explode toward positive infinity.

The post-Maastricht sample starts at 1992:9; this is the date when the pressure caused by German unification and the fixed exchange rate system led to the exchange rate crises. As already shown in Section 3.2, there is no clear evidence that the transmission in the UK changed during this time. As previously mentioned it would be more favourable to end this sub-period in 1997:12, as from 1998:1 the monetary policy in the UK really became independent, but for the sake of comparability this sub-sample also ends in 1998:12. The results are ambivalent. The industrial production seems to move as expected after the spill over effect is added, but the price level increases, which is not in accordance with the literature. Here again, the baseline reaction of the exchange rate after the shock is larger as in the case of the common shock.

Figure 4.7. **Models of United Kingdom**



Source: own calculation

[a,] The first sample starts at 1981:10 because of the Volcker recession, and ends at 1990:5 because of the oil crisis

[b,] The second sample starts at 1992:9 because of the ERM crisis

Note: the solid blue line is the base model, the solid yellow line is the model with common monetary shock (German in sub-sample 1980-1991 and 1992-1998, and EMU in sub-sample 1999-2007), and the solid green line is the model with a common shock and spill over effect (from Germany in sub-sample 1980-1991 and 1992-1998, and from the EA in sub-sample 1999-2007). Dashed blue lines are 90% confidence intervals for the base model from 10000 Monte Carlo simulations, based on Hamilton [1994] p. 337.

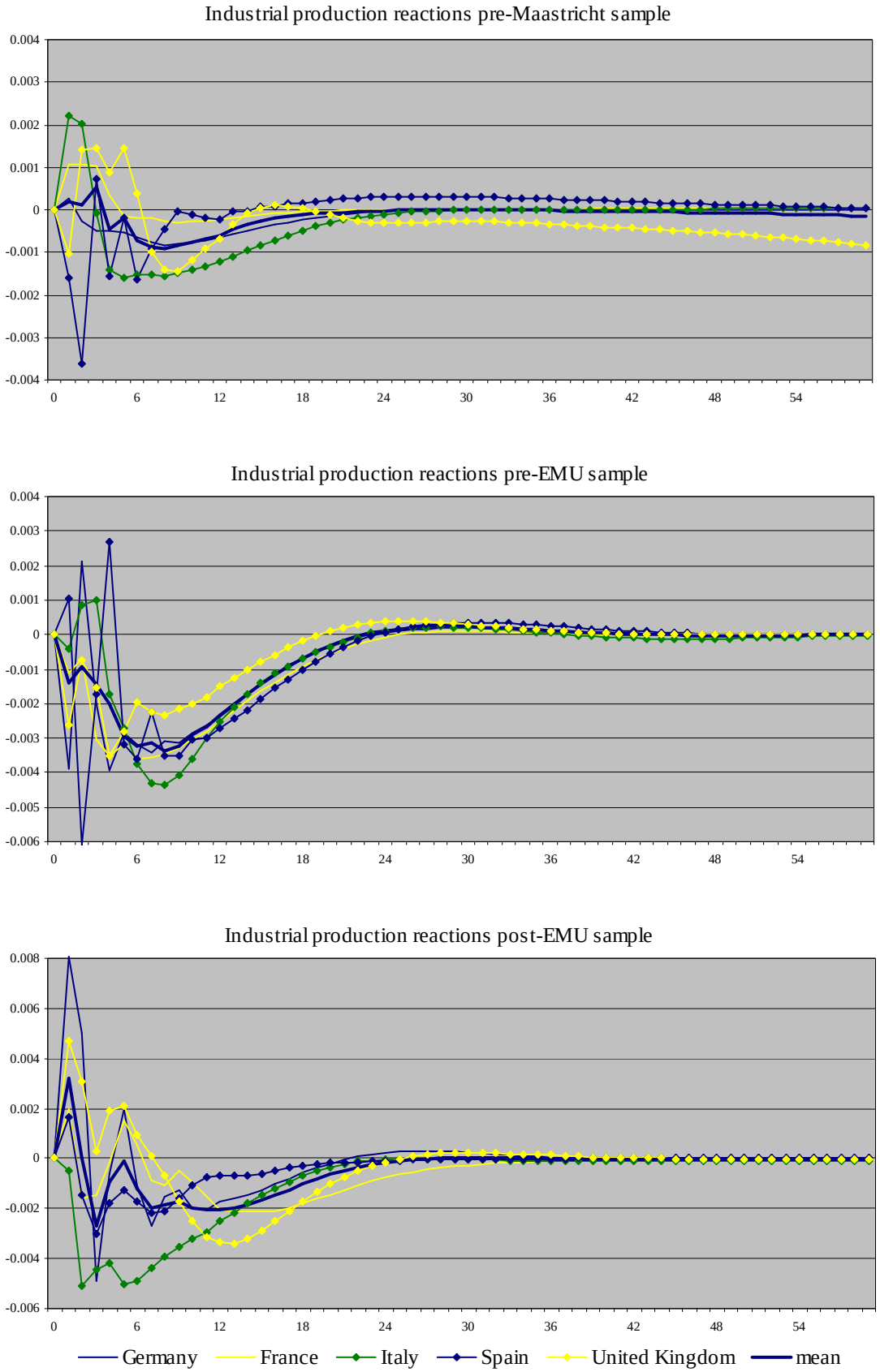
The post-EMU sample is prepared with the common shock estimated for the euro area, with spill over effects from the euro area long-term interest rate and industrial production. As the United Kingdom still has an independent short term interest rate and GBP/USD exchange rate, these are used in the model as endogenous variables; the exogenous variables are the same as in the other countries (again see Appendix 4B, for more detail). In the last column of *Figure 4.7* the impulse response of industrial production starts with positive shifts, but after a period it becomes negative, and this drop is strengthened by the common shock and the spill over effect. The price level also has a volatile start; after the initial negative start there is positive spike, followed by a lasting drop, which after a time turns positive again. In this case the common shock and the spill over effect strengthened the volatile movements.

4.4.3. Comparison

As already explained above I will not compare the impulse responses of a given country between different samples, because the shock is different in the different samples and so there is no way of establishing whether the differences were caused by the different shocks or by something structural. But it can be interesting to see how the different countries reacted to the same shock in a given sample and the see how these differences changed. I use the IRFs with common shock and spill over effects for this exercise, because these impulse responses have the most in common with the ideal experiment cited in the introduction to this Section.

But what could the measure of convergence be? A rough indicator could be the standard deviation of the impulse responses in a given sample in a given period of time. There is one drawback - after all standard deviations are functions of the absolute size of the deviations and not the relative size. Hence, whereas there may be greater deviation relative to the mean for a series with a small mean than for one with a large mean, the standard deviation may show greater divergence in the large mean series. It might be a better solution to use relative standard deviations, but after a time the mean of the responses become quite small (IRFs tend to converge back to zero), and the standard deviations are not large either, resulting in quite volatile series, which makes them hard to interpret. I report the standard deviation here.

Figure 4.8. **Impulse responses of industrial production with common shock and spill over effect**



Source: own calculation
Note: the five country means are plotted.

To see whether there is convergence or not, one can look at the changes in these series of standard deviations between different samples. Looking at the standard deviations of different groups of countries, one can try to answer the question of whether the changes were caused by the introduction of the euro or not. I present the result for three groups: the first is for all five countries in the sample labelled EU, the second is for those countries that became part of the euro area; the third group contains Germany, France and the United Kingdom, the non-Mediterranean countries. The reason for the latter group is that in some cases a similarity in the reaction of the Spanish and Italian variables is observable.[141] The euro effect would mean that there are distinctive changes in the EA sample but which is not observable in the other samples containing the impulse response of the United Kingdom.

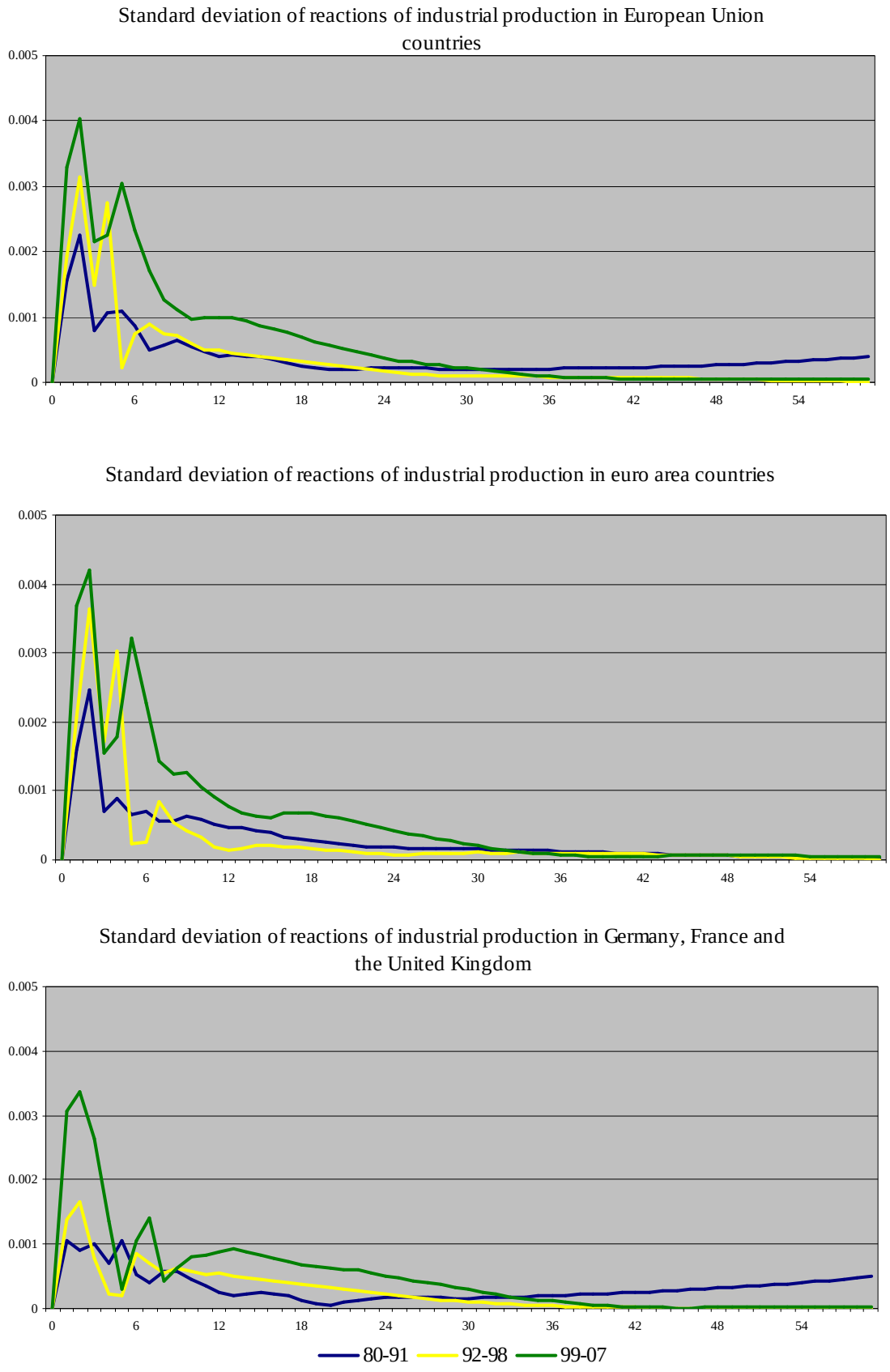
Industrial production

Copying the impulse response functions of the different countries into one illustration (see *Figure 4.8*), the first thing that is observable is that the mean decrease in industrial production is much smaller in the pre-Maastricht sample. Comparing the two latter samples, the mean reaction of industrial production is larger in the pre-EMU sample. This fact is only interesting because it influences my chosen measure of differences in the standard deviation. A smaller mean indicates a smaller absolute deviation even if the relative deviation is the same.

In *Figure 4.9* the above-mentioned series of standard deviations are depicted. In the case of all three groups the standard deviation seems to be smallest in the pre-Maastricht sample and largest in the post-EMU sample. The first tendency could be explained by saying that with a smaller mean this could indicate an even larger relative standard deviation. However, the drop in the mean industrial production is smaller in the post-EMU sample than in the pre-EMU sample, which means that the relative standard deviation would be even larger in the post-EMU sample. What is more the standard deviation of impulse responses in the post-EMU sample converges more slowly to zero, meaning that it takes more time for the impulse responses to move together. To summarise, there is no trace of convergence, or of a change to a more homogenous reaction of industrial production to the monetary shock.

[141] *Boivin et al.* [2008] also found that these two countries react similarly and that their reaction stands apart from that of other countries.

Figure 4.9. **Convergence in the reactions of industrial production**



Source: own calculation

Looking at the difference between the country groups, one can observe that the standard deviation of the EU and EA group are almost identical, the only major difference being that in the pre-Maastricht sample the standard deviation of the EU countries rises at the end, which is due to the reaction of the United Kingdom. One other interesting fact is that standard deviation in the non-Mediterranean group is smaller in every sample. Looking at this result shows that the inclusion of the United Kingdom did not change anything, so no 'euro effect' can be identified.

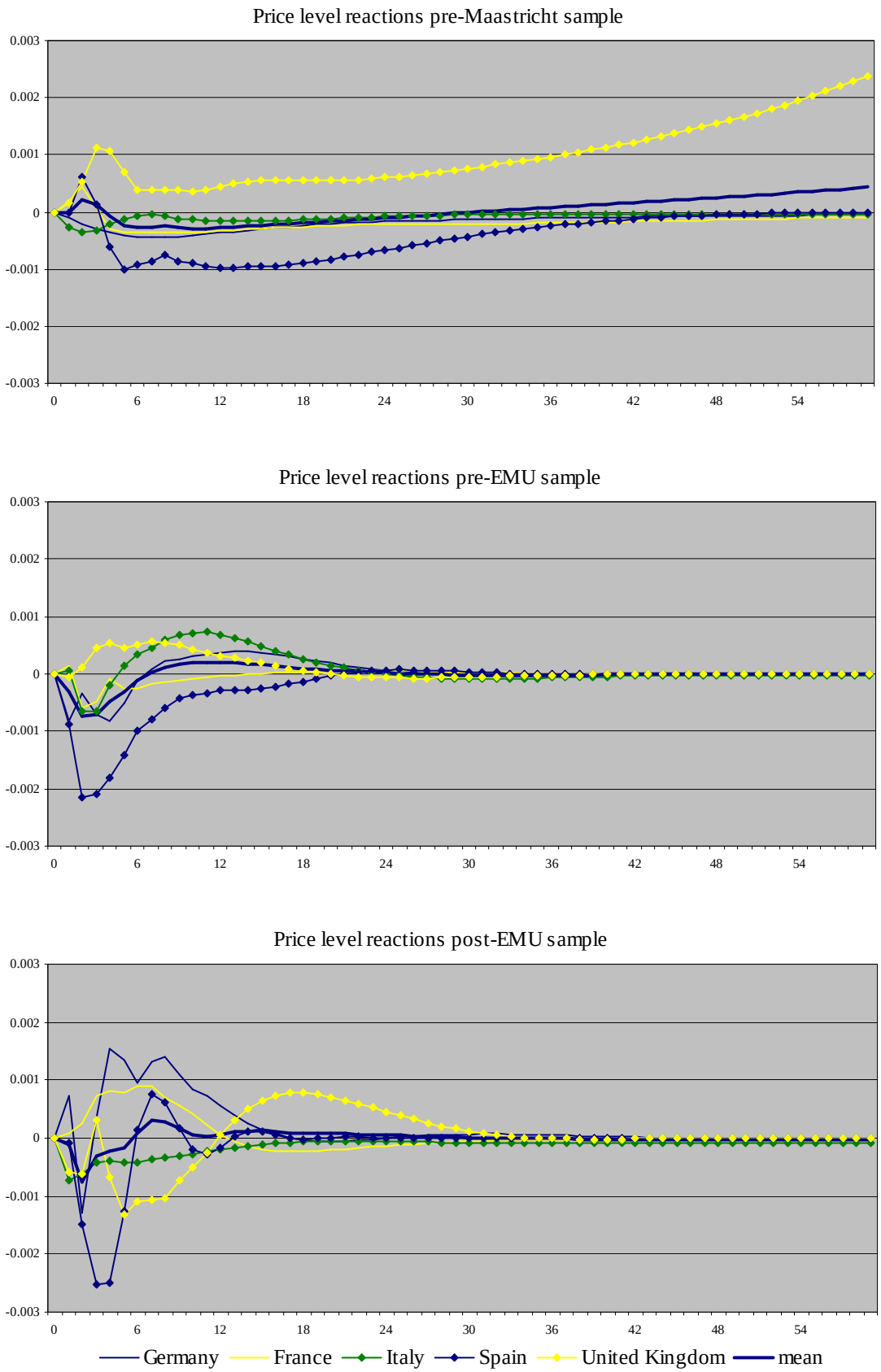
Price level

Figure 4.10 shows the reactions of price levels in different countries for the three samples. As mentioned before there is an explosive reaction in the UK for the pre-Maastricht sample, which will make the analysis with standard deviation more difficult. The other interesting thing is that the reaction of the Spanish price level is greater than reactions in other countries.

Looking at the series of standard deviation in *Figure 4.11*, one can see that both the group with the EU countries and the three country group are affected by the divergent movement of the UK price level in the first sample, so in these groupings only the differences in pre-EMU and the post-EMU samples can be compared. For the group of five EU countries the standard deviation between the impulse response functions for the last sample is both larger and converges more slowly to zero, than that of the pre-EMU sample. However for the euro area countries there is one small indicator pointing in the direction of convergence. Despite the fact that there is greater heterogeneity between the impulse responses in the post-EMU sample for the first year than in either of the other samples, the standard deviation of IRFs in this group converge faster to zero than the other two. For the group containing Germany, France and the UK the standard deviation increases from sample two to sample three.

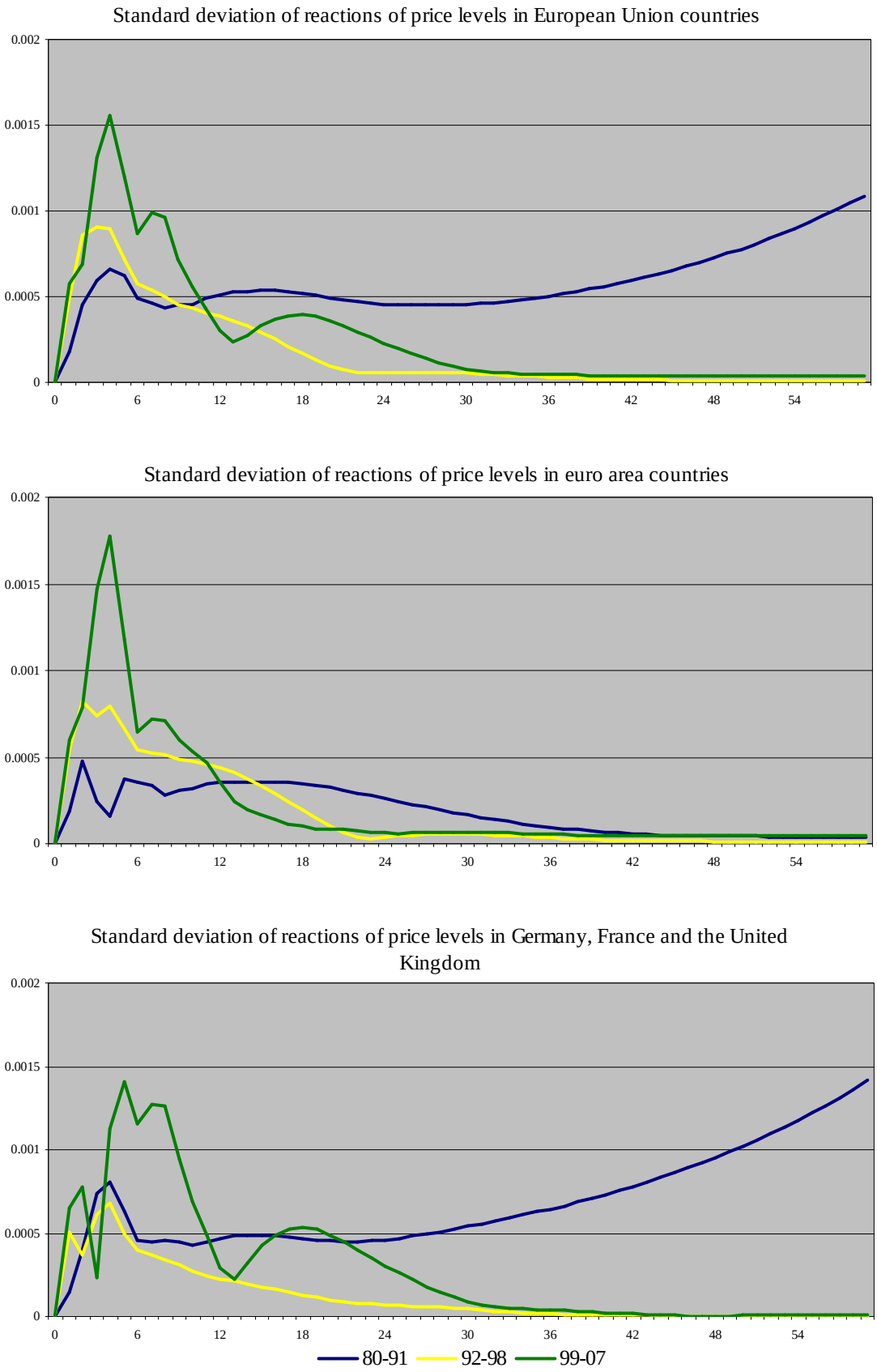
Because of the divergent UK reaction, it is even harder to answer the question of whether there is a 'euro effect' or not. For the second sample the picture is the same, as in the case of industrial production, the inclusion of the reaction of the UK price level does not change the standard deviation considerably, and the standard deviation between the reaction of Germany, France and the United Kingdom is smaller than those between the EU and between the EA countries. In the post-EMU sample the differences are even smaller between the different groupings than before; perhaps for the three country group it is somewhat smaller in the first year, but it also converges more slowly than the other two.

Figure 4.10. **Impulse responses of price levels with common shock and spill over effect**



Source: own calculation
Note: the five country mean is plotted.

Figure 4.11. Convergence in the reactions of the price level



Source: own calculation

4.4.4. Conclusion

In this Section I tried to test empirically the hypothesis whether the EMU or the preparation for the EMU endogenously changed the transmission of monetary policy in the participating countries. Using a VAR methodology, I tried to simulate artificially the environment of the EMU in previous samples, having common shocks, fixed exchange rates and spill over effects. After estimating models for each country, the standard deviation of the impulse response functions was used as a measure for heterogeneity in the reaction to the given shock. Relying on this measure I did not find any trace of convergence in the reaction of industrial production or price level, which means that the introduction of euro does not seem to have eliminated endogenously the differences in the monetary transmission mechanism. It may be that more time will have to elapse for this to become apparent.

My results here are in accordance with the result of *Ciccarelli and Rebucci* [2006], who found no change in the monetary transmission in the run-up to the EMU. On the other hand *Boivin et al.* [2008] find greater homogeneity of the transmission mechanism among countries of the Euro Area and also find that the monetary policy of the ECB has played a key role in this change.

Summary of the chapter

The goal of this chapter was to investigate the effect of common monetary policy on the transmission of monetary policy. As a first step the optimum currency area literature was examined, to serve as a framework for the investigation. At this point the differences in the monetary transmission mechanism were introduced as a possible obstacle to a well functioning currency area. The advantage of phrasing the problem within the optimum area literature is that the concept of endogeneity could be introduced in relation to the interaction between the common monetary policy and the differences in the transmission process.

The next step was to state whether there were differences in the effects of national monetary policies. The result of the literature review is that it depends on the method used. In the case of structural indicators and large macro models estimated by the member countries' national banks, the answer is yes, there were differences, which could influence the functioning of the common monetary policy.

If there were differences, what happened to them after the introduction of the euro? The common shock made the financial markets more integrated; there is plenty of evidence

for this in the literature. The other elements of the transmission mechanism were less affected; there is no evidence either in the literature, or in the structural indicators, that the effect of the monetary policy became more homogenous across countries. In the last section of this chapter a VAR model was estimated for five EU countries, taking special care of comparability between countries, to see whether the heterogeneity between their reactions declined in the different sub-samples. I found no sign of the impulse response functions becoming more homogenous, a result which is in line with the findings of the results of previous studies.

Appendix 4A

Source / Paper	Countries covered (EU) [a,]	Sample	Method(s)	Channels covered	Strength of the channel (output effect in case of aggregated effect) – conclusion
Favero and Giavazzi [1999]	F, D, I, E, S, UK	various	key variable / indicator	all	F < E = D < UK < I (missing data prevents the rating of S)
Guiso et al. [2000]	D, E, F, I, NL UK	various	key variable / indicator	all	UK < F = D < I; (no statement about the ranking of B, NL, E)
Suardi [2001]	B, D, E, F, I, NL, S, UK	various	key variables / indicator	all	smaller differences between euro area countries than between them and outsiders
Chatelain et al. [2001]	D, E, F, I	1985 – 1999 annual	micro panel estimation	interest rate channel – investment	E = F = I < D
Kashyap and Stein [1997]	B, D, DK, E, F, GR, IE, I, L, NL,.P, UK,	various	key variable / indicator	credit/bank lending channel	UK < B=NL < DK = D = IE = L = E < F = GR < I
Favero et al. [1999]	D, F, I, E	1991 – 1996 annual	case study	bank lending channel	D = I = F = E (stock of credit)
Chatelain et al. [2001]	D, E, F, I	1985 – 1999 annual	micro panel estimation	broad credit channel	D = E = F < I
Ehrmann et al. [2001]	D, E, F, I	1993 – 1999 yearly BankScope for D 1994q1 – 1998q4 for E 1991q1 – 1998q4 for F 1994q3 – 2000q3 for I 1988q1 – 1998q4	micro panel estimation	bank lending channel	I = D < F = I
Fountas and Papagapitos [2001]	D, F, I, UK	1981 – 1997 quarterly	ECM	broad credit channel	I > D > UK, F
Sims [1992]	D, F, UK	1961 – 1990 monthly (1961m4 – 1990m12)	VAR	aggregated	F < UK < D
Gerlach and Smets [1995]	D, F, I, UK	1979 – 1993 quarterly	SVAR (1 std shock)	aggregated	F < D = I < UK
Grilli and Roubini [1995]	D, F, I, UK	1974 – 1991 monthly	SVAR	aggregated	D < UK < F < I
Ehrmann [1998]	A, B, D, DK, E, F, FIN, I, IE, NL, P, S, UK	1984 – 1997 quarterly	SVAR	aggregated	UK < P = E < S = FIN < IE = I = A < B = NL = DK < D = F
Kieler and Saarenheimo [1998]	D, F, UK	1970 – 1997 quarterly (1970q1 – 1997q3)	VAR	aggregated	UK = D = F no significant difference
Ramaswamy and Slok [1998]	A, B, D, DK, E, F, FIN, I, NL, P, S, UK	1972 – 1994 quarterly	VAR (1 std. shock)	aggregated	DK = F = E < I = P = S < A = D = NL = UK < B = FIN

Kim [1999]	D, F, I, UK	for D 1965m3 – 1997m5 for F 1965m3 – 1996m6 for I 1965m3 – 1997m1 for UK 1961m3 – 1994m3	SVAR	aggregated	I < D = F = UK
Kouparitsas [1999]	A, B, D, E, F, FIN, I, IE, NL, P	1969 – 1997 annual	VAR	aggregated	A = B = F = FIN < D = I < E = NL = P = IE
Kim and Roubini [2000]	D, F, I, UK	1974 – 1992 monthly (1974m7 – 1992m12, (for F 1974m7 – 1992m2)	SVAR	aggregated	UK < F = I < D
Mojon and Peersman [2001]	A, B, D, E, F, FIN, GR, I, IE, NL,	1980 – 1998 quarterly (for D 1970q1 – 1998q4)	SVAR	aggregated	IE (pos) < GR = I < E < F = D < A < B = NL < FIN
BIS [2005]	A, B, D, E, F, I, NL	n/a	national banks macro models	aggregated	E < NL = A = B < D = F < I
van Els et al. [2001]	A, B, D, GR, E, F, FIN, IE, I, L, NL, P	n/a (simulated for 2001-2005)	national banks macro models	aggregated (decomposed into channels)	D < L = F = NL = B < FIN < I < A < IE < E < P < GR
Röger and in't Veld [2002]	D, F, I, UK	n/a	multi-country macro model	aggregated	I < D = F = UK
Hallett and Piscitelli [1999]	D, F, I, UK	n/a	multi-country macro model	aggregated	
Britton and Whitley [1997]	F, D, UK	1964 – 1994 annual	small scale macro	aggregated	D = F > UK
Dornbusch et al. [1998]	D, E, F, I, S, UK	1985 – 1997 monthly	small scale macro	aggregated	UK < D = E = F < I = S
Altavilla and Landolfo [2005]	A, B, D, E, F, FIN, GR, I, IE, NL	1979 – 1998 quarterly	small scale macro	aggregated	no significant difference, BUT D, I > others
Ciccarelli and Rebucci [2006]	D, E, F, I	1980 – 1998 monthly	small scale macro (bayesian)	aggregated	F < E < D = I
Clausen – Hayo [2006]	D, F, I	1979 – 1997 quarterly	small scale macro	aggregated	F < D = I

[a] A stands for Austria, B for Belgium, D for Germany, DK for Denmark, E for Spain, F for France, FIN for Finland, GR for Greece, I for Italy, IE for Ireland, L for Luxemburg, NL for the Netherlands, P for Portugal, S for Sweden and UK for the United Kingdom.

Appendix 4B

Samples, models and variables (for explanation of the abbreviations see the table below)

Country	Sample	Endogenous	Exogenous [a,]	p	k	Spill over
EMU	1991:1 – 2007:12	emu_ip, emu_p, emu_li, emu_si, emu_eusd	us_si, us_li, cp	3	-1	
Germany	1980:1 – 1989:12	d_ip, d_p, d_si, d_eusd	us_si, us_ip, co	3	0	
	1992:8 – 1998:12	d_ip, d_p, d_si, d_eusd	us_si, us_ip, co	3	0	
	1999:1 – 2007:12	d_ip, d_p, emu_si, emu_eusd	emu_li, emu_ip, cp	3	-1	emu_ip, emu_li
France	1981:6 – 1991:12	f_ip, f_p, f_si, f_eusd	d_si, d_ip, co	4	-1	d_ip, d_si
	1993:2 – 1998:12	f_ip, f_p, f_si, f_eusd	d_si, d_ip, co	3	-1	d_ip, d_si
	1999:1 – 2007:12	f_ip, f_p, emu_si, emu_eusd	emu_li, emu_ip, cp	4	-1	emu_ip, emu_li
Italy	1981:6 – 1991:12	i_ip, i_p, i_si, i_eusd	d_si, d_ip, co	4	-1	d_ip, d_si
	1992:8 – 1998:12	i_ip, i_p, i_si, i_eusd	d_si, d_ip, cp	4	-1	d_ip, d_si
	1999:1 – 2007:12	i_ip, i_p, emu_si, emu_eusd	emu_li, emu_ip, co	3	0	emu_ip, emu_li
Spain	1983:1 – 1991:12	e_ip, e_p, e_si, e_eusd	d_si, d_ip, co	5	-1	d_ip, d_si
	1993:3 – 1998:12	e_ip, e_p, e_si, e_eusd	d_si, d_ip, cp	3	-1	d_ip, d_si
	1999:1 – 2007:12	e_ip, e_p, emu_si, emu_eusd	emu_li, emu_ip, cp	3	0	emu_ip, emu_li
United Kingdom	1981:10 – 1990:5	uk_ip, uk_p, uk_si, uk_eusd	d_si, d_ip, co	4	-1	d_ip, d_si
	1992:9 – 1998:12	uk_ip, uk_p, uk_si, uk_eusd	d_si, d_ip, cp	4	-1	d_ip, d_si
	1999:1 – 2007:12	uk_ip, uk_p, uk_si, uk_eusd	emu_li, emu_ip, co	4	-1	emu_ip, emu_li

[a,] In every model there are monthly dummies and time trends

Times series and data sources

Country/Time Series	Definition
EMU	
emu_ip	EA (EA11-2000, EA12-2006, EA13-2007, EA15) monthly industrial production index (total industry, excluding construction), 2000=100, seasonally and working day adjusted from: Eurostat
emu_p	EA (EA11-2000, EA12-2006, EA13-2007, EA15) harmonized consumer price index (all items, HICP=Harmonized Index of Consumer Prices), 2005=100, seasonally unadjusted from: Eurostat
emu_li	EA (EA11-2000, EA12-2006, EA13-2007, EA15) long term government bond yields (monthly average, Maastricht definition, mf-ltgby-rt), seasonally unadjusted from: Eurostat
emu_si	EA (EA11-2000, EA12-2006, EA13-2007, EA15) 3-month market interest rate (monthly average, mf-3mi-rt), seasonally unadjusted from: Eurostat
emu_eusd	ECU(Euro)/USD exchange rates (monthly average) from: Eurostat
Germany	
d_ip	German industrial production index (mining, quarrying and manufacturing, USNI98), 2000=100, monthly, seasonally adjusted from: the Bundesbank
d_p	German (Western Germany (up to 1994), Germany (linked over January 1995)) consumer price index (definition: price index for the standard of living of all private households (1962-1999), consumer price index (from 2000), UUFB99), 2005=100, monthly, seasonally unadjusted from: the Bundesbank
d_si	German 3-month market interest rate (monthly average, SU0107) from: the Bundesbank
d_eusd	DM/USD exchange rate (monthly average), after 1999m1 the series are calculated using the fixed DM/euro conversation rate (1.95583 DM/euro) and the euro/USD exchange rate from: Eurostat
France	
f_ip	French industrial production index (13266...ZF...), 2005=100, monthly, seasonally adjusted from: IMF IFS
f_p	French consumer price index (108 cities, 13264...ZF...), 2005=100, monthly, seasonally unadjusted from: IMF IFS
f_si	French 3-moth treasury bill rate (monthly average, 13260C…ZF...) from: IMF IFS
f_eusd	FRF/USD exchange rate (monthly average), after 1999m1 the series are calculated using the fixed FRF/euro conversation rate (6.55957 FRF/euro) and the euro/USD exchange rate from: IMF IFS
Italy	
i_ip	Italian industrial production index (period average, 13666..CZF), 2005=100 , monthly, seasonally adjusted from: IMF IFS
i_p	Italian consumer price index (period average, all Italy, 13664...ZF), 2005=100, monthly, seasonally unadjusted from: IMF IFS
i_si	Italian treasury bill rate (13660C…ZF...) from: IMF IFS
i_eusd	ITL/USD exchange rate (monthly average, 136..RF.ZF), after 1999m1 the series are calculated using the fixed ITL/euro conversation rate (1936.27 ITL/euro) and the euro/USD exchange rate from: IMF IFS
Spain	

e_ip	Spanish industrial production index (period average, 18466…CZF), 2005=100, monthly, seasonally adjusted from: IMF IFS
e_p	Spanish consumer price index (period average, 18464...ZF), 2005=100, monthly, seasonally unadjusted from: IMF IFS
e_si	Spanish call money rate (period average, 18460B…ZF), monthly from: IMF IFS
e_eusd	ESP/USD exchange rate (monthly average, 184..RF.ZF), after 1999m1 the series are calculated using the fixed ESP/euro conversation rate (166.386 ESP/euro) and the euro/USD exchange rate from: IMF IFS
United Kingdom	
uk_ip	UK industrial production (including all production industries on constant 2003 prices, CKYW), 2003=100, monthly, seasonally adjusted from: The Office for National Statistics
uk_p	UK price level made from monthly changes in retail price index (all items excluding mortgage interest payments, CZFC), 1979m12=1, seasonally unadjusted from: The Office for National Statistics
uk_si	UK 3-month treasury bills discount rate (monthly average, IUMAAJNB) from: Bank of England
uk_eusd	GBP/USD exchange rate (monthly average, XUMAUSS) from: Bank of England
USA	
us_ip	USA industrial production index (industrial production and capacity utilization, INDPRO), 2002=100, monthly, seasonally adjusted from: Federal Reserve Bank of St. Louis
us_li	USA 10-year government bond yield, monthly (irt_lt_gby10_m), seasonally unadjusted from: Eurostat
us_si	USA 3-month market interest rate, monthly (irt_st_m; mat_m03m), seasonally unadjusted from: Eurostat
Commodity prices	
co	crude oil (petroleum) price index (simple average of three spot prices, POILAPSPW), 2005 = 100 from: IMF
cp	commodity (non-fuel) price index (includes food and beverages and industrial inputs price indices), 2005=100 from: IMF

Chapter 5. Summary and results of the dissertation

Introduction

The aim of the dissertation was to investigate how changes in the monetary policy's environment influence the monetary transmission mechanism.

This proved to be a very interesting research question for several reasons. The questions arising from the investigation of the transmission are the most basic questions in this discipline: the interaction between nominal and real variables, the frictions causing the monetary policy having real effects, the overwhelming role of expectations on the reaction of variables, causes of business cycle movements etc. On the other hand the monetary transmission process is a very complex system, as shown in Chapter 2, the transmission comprises several steps, more than dozen different channels, all in interaction with each other, with expectations and the environment. Many structural variables, institutional arrangements, historical events influence the mechanism on several points (e.g. the households property wealth, and housing finance system can influence the economy, and the inflation through several channels). Because of this complexity, the transmission mechanism is always hit by different shocks, it is always changing, developing. So finding out how a major, gradual change in the environment would change the parts or the whole mechanism, is not only an intellectual challenge, but also a methodological one.

For the exercise two major changes in the monetary policy’s environment were chosen, the first is the increased international financial integration, the second is the introduction of the common currency in the countries of the EMU. These choices made the empirical questions even more complicated as the two events, at times, coincide. In the following section I review the results of these investigations.

5.1. Effects of financial integration

Chapter 3 is dedicated to the changes caused by the increased financial integration. Financial integration denotes the process led by a new technological environment (the spread of the internet, decreased communication costs) and as a consequence of which, goods, labour and financial markets are becoming increasingly integrated globally.

5.1.1. Changes of overall monetary transmission due to international financial integration

The integration of financial markets enhances the element of unpredictability in the monetary transmission process. According to *Sukudhew et al.* [2008] and *Gudmundsson* [2008] the pass-through into short run interest rate should be stronger (the reaction of interest rates are more immediate and proportionally greater) in financially developed countries, with greater competitiveness in the financial system (see also *Mojon* [2000]) and deeper intermediation. On the other hand as *Gudmundsson* [2008] documents, in small open economies the long-term interest rate is more determined by global factors, and even in the USA the long-term interest rate does not react to changes in the short-term interest rate in the same way as it used to.[142] The response of aggregate demand to changes in the financial environment (changes in interest rates, stock prices and credit availability) is altered mainly by the changes in the financial portfolios of households. On the one hand financial integration made possible increased household indebtedness; on the other hand it also causes more volatile asset prices (*Wagner and Berger* [2003], *Rogoff* [2006]). These two added together result in an uncertain reaction on the part of households - a reaction which depends to an extent on how the volatile asset price is perceived by the households. Finally, there is an ongoing debate about the causes of changes in the relation of inflation to the domestic output gap. There is some evidence that the flatter Phillips curve might be caused by international financial integration (as shown by *Borio and Filardo* [2007], *Chmielewski and Kot* [2006], and *IMF* [2006]), an assertion disputed by others (*Yellen* [2006], *Kohn* [2006], *Ihrig et al.* [2007]).

1. thesis International financial integration made the transmission mechanism even more unpredictable then before, forcing the monetary policy to make slower and more cautious steps toward its goal.

5.1.2. Changes in the channels of monetary transmission due to international financial integration

Through the interest rate channel monetary policy can influence the opportunity cost/cost of capital and thus investments and consumption (substitution effect). The interest rate channel should be strengthened by liberalization and especially by interest rate deregulation. This encourages the banks to move from quantity to price

[142] This phenomenon is known as ‘conundrum’ as labeled by former Federal Reserve Chairman Alan Greenspan (see *Boivin and Giannoni* [2008])

determination, making clients react to prices. Disintermediation could also strengthen the reaction of aggregated demand, if the non-financial agents hold more interest-sensitive assets on their balance sheets (*Sukudhew et al.* [2008]).

According to *Mylonas et al.* [2000] and *Sukudhew et al.* [2008] the increase in financial assets caused by financial integration will strengthen the agents' reaction to a revaluation of assets, so increasing the weight of the wealth channels. However, this makes the reaction slower as well, because the revaluation of some wealth items (especially housing) takes a longer time and lengthens the response of households.

The consolidation of the financial system increased the size of the average bank, and financial innovations made it possible to lend without having assets on the books, so the importance of the common bank lending channel decreased. The development and integration of the capital markets makes alternative funding for companies available. In addition the technical developments made, to a certain extent, asymmetric information problems easier to solve, which according to the explanation provided by *Mishkin and Strahan* [1999] makes the collateral less important and the balance sheet channel weaker. Both of these components weakened the significance of the whole credit channel and also the financial acceleration should decline.

The exchange rate is one of the economy's most important relative prices and tools of adjustment which connects an economy with other countries. A deeper global integration of different economies and markets should make this tool more important, and thus also the importance of the exchange rate channel might be expected to increase. Despite this effect the working of the exchange rate channel is not clear, because integration also makes it possible for companies and households to hold liabilities denominated in foreign exchange, which makes the wealth and income effect of the monetary policy weaker or in extreme cases even reverses it.

The expectation channel is partly endogenous because beyond a credible commitment to price stability, the ability of monetary policy to influence the economy, output and inflation is essential for forming expectations, so it depends on the other channels as well. A consequence of the flatter Phillips curve is that the inflation rate reacts less intensely to the shocks of demand (or policy errors), but at the same time this also means that policy makers cannot influence the price dynamics easily through demand

channels. This makes credibility and the anchoring of expectations a more important channel (*Bundesbank* [2006], *Yellen* [2006], *Kohn* [2006]).

Looking at the channels of monetary transmission one can group the hypothetical effects based on whether they made the transmission of monetary policy stronger or weaker, or whether the variables react more quickly or need more time (*Table 5.1*).

***Table 5.1.* Expected effect of the changes of different channels on the monetary transmission process' speed and strength**

Changes of different channels make the MTM's	
stronger	weaker
- interest rate channel (*Sukudhew et al. [2008]*) - exchange rate channel (without foreign currency debt) - wealth channels (*Mylonas et al.* [2000])	- bank lending channel (*Bernanke* [2007b])

2. thesis Relying on the literature the conclusion can be drawn that international financial integration weakened the broad credit channels, and strengthened the interest rate and the wealth channels. The effect on exchange rate is dubious, as it depends not only on trade integration but also on cumulation of foreign currency debt.

5.1.4. Did the possibilities granted by the increased financial integration affected the monetary transmission in the Hungary?

In section 3.2 a special effect of the globalization was investigated as a case study of Hungary. In this case the special effect is the possibility for households to accumulate debt in foreign currency. As the rapid foreign currency debt accumulation made households' consumption more sensitive to exchange rate depreciation, the hypothesis was that the exchange rate channel of monetary policy should be weakened or even inverted.

To be able to compare the transmission of monetary policy in case of low and high amount of foreign currency denominated debt, a non-linear VAR model was used to make the resulting impulse response functions conditional on the accumulated debt. This methodology made it possible to compare the reaction of the economy in two scenarios. In the first case the IRF-s were launched from 2002q1, when household foreign currency debt was still negligible, the second case is from 2008q3 where the ratio of household debt denominated in foreign currency reached 64% of households' liabilities. A further advantage of these two dates is that neither the exchange rate nor

monetary policy regime changed significantly between these two points in time, keeping regime changes to the minimum.

The results show almost significant differences of the reaction of consumption in the presence of more foreign currency denominated debt in every scenario, but several counter-intuitive movements were found in the case of other variables, which makes the results less solid. On the other hand robustness checks showed that the result was not caused by specification problems, and remained robust under different specifications.

3. thesis The accumulation of foreign currency debt changed the exchange rate channel of the monetary policy in Hungary.

5.2. Effects of common currency

In Chapter 4 I investigated the interaction between the common monetary policy of a currency area and the different transmission mechanisms in the member countries. The basic hypothesis was that the common monetary policy changed the financial environment and, through this, slowly make the effect of monetary policy more homogeneous among the member countries. The investigation was done in three steps, phrased in the following three propositions.

5.2.1. The homogeneity of the monetary transmission as a criterion of optimal currency areas

In section 4.1 I reasoned that the common monetary policy can be seen as a source of asymmetric shocks, if the monetary transmission mechanism differs across the member countries. If this was the case then the differences in transmission should be treated within the OCA literature, using the same processes for adjustment. Relying on this result, the OCA literature was selected to serve as a framework for the investigation of transmission process inside the currency union. The advantage of phrasing the problem within the optimum area literature is that the concept of endogeneity could be introduced in relation to the interaction between the common monetary policy and the differences in the transmission process.

4. thesis The common monetary shocks can work as asymmetric shock, in case the monetary transmission differs across the member countries of the currency union.

5.2.2. Differences in the monetary transmission mechanism among the members of the EMU

As has been shown in subsection 4.2.1 there were structural differences before 1998 that could have caused the different channels of monetary policy transmission to pass on different impulses in different countries. *Guiso et al.* [2000] draw the conclusion that the experiments that are nearest to the ideal one (often the experiments with the models developed by central banks of the member countries) show the same result as the key variables method and point to noticeable differences in the transmission mechanism. According *Dornbusch et al.* [1998] small models are often subject to misspecification (see subsection 4.2.2 and 4.2.4), central banks' big macro models are not comparable (or too comparable), but it is helpful that these models incorporate local knowledge of the economy. These evidences lead to conclusion that there were differences between the countries that introduced the common currency, differences which affected the monetary transmission mechanism as well.

5. thesis Based on the reviewed literature using structural differences and big macro models the conclusion can be drawn that there were differences in the monetary transmission mechanism at the beginning of the third stage of the EMU.

5.2.3. Endogeneity of the monetary transmission mechanism

As a first step to answer the question of whether there is an 'euro effect' in monetary transmission I studied the structural changes caused by the introduction of the euro in section 4.3.

Results from the literature show that financial integration was further accelerated by the introduction of the euro. This increases the competition and makes reactions of interest rates and other asset prices more homogenous across countries. Other changes couldn't be linked to the homogenization of the monetary transmission across countries. The introduction of euro raised the trade among all the EU countries, but not disproportionately among the euro area member countries. At the same time the exchange rate pass-through decreased as prices of previously imported goods aren't exposed to changes of exchange rate any more. The structure of production hasn't (yet) reacted to the introduction of common currency. Neither did labour market, price flexibility and wealth portfolios.

In section 4.4 I tried to test empirically the hypothesis whether the EMU or the preparation for the EMU endogenously changed the transmission of monetary policy in the participating countries. Using a VAR methodology, I tried to simulate artificially the environment of the EMU in previous samples, having common shocks, fixed exchange rates and spill over effects. After estimating models for each country and each period, the standard deviation of the impulse response functions was used as a measure for heterogeneity in the reaction to the given shock. Relying on this measure I did not find any trace of convergence in the reaction of industrial production or price level, which means that the introduction of euro does not seem to have eliminated endogenously the differences in the monetary transmission mechanism.

6. thesis Relying on counterfactual vector autoregression models I found no evidence that the introduction of the common currency endogenously made the transmission of the monetary policy more homogenous across member countries.

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