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1) Motivation and Research Topic[1]

The introduction of the European Currency Unit and the Euro resulted in the establishment of a single central bank for the participating countries in 1998, the European System of Central Banks (ESCB) with the European Central Bank (ECB) on top of it. The policy mandate of this new monetary authority is based on the belief that monetary policy should primarily focus on maintaining price stability. As a result, the Treaty on the Functioning of the European Union states in article 127:

> *"The primary objective of the European System of Central Banks (...) shall be to maintain price stability. Without prejudice to the objective of price stability, the ESCB shall support the general economic policies in the Union (...)."*

This policy setup given to the ECB is the logical consequence of the theoretical concept of long run neutrality of money (LRN) which states that:

> "(...) *permanent changes in the level of the supply of money have no long-run effects on real interest rates or the growth rate of real output." (Espinosa-Vega 1998: 2)*

Without anticipating the discussion on whether a central bank is able to control the money supply that follows in the next two chapters, one can generalize this statement to the notion that LRN indicates that monetary policy is unable to systematically affect real variables such as output or employment in the long run. Even though the current New Keynesian mainstream in economic theory sticks to the concept of LRN, there are also numerous authors who reject it, especially in the Post Keynesian tradition. Not surprisingly, the debate over money neutrality has been a recurring one in economic science since the beginning of the discipline, due to its massive implications for conducting economic policy. Particularly if central banks are able to influence real variables like output and employment over longer periods, then the primary focus of the ECB on price stability is misguided and is likely to have slowed down growth in the euro zone over the last decade. Therefore, the aim of this master's thesis is to statistically assess the validity of the long run neutrality hypothesis and quantify the potential long run effects of monetary policy based on a broad sample of German data.

[1] I am grateful to Neil Foster-McGregor, Robert Kunst, Peter Mooslechner and Helene Schuberth for their support and helpful comments.

2) Theoretical Background: A New Keynesian Perspective

Before turning to the statistical model and data which will be applied to study the long run effects of monetary policy on the German economy, this and the next chapter will provide a theoretical background on monetary policy. In particular, I will present a currently widespread theoretical framework which is called New Keynesian economics and its implications for conducting monetary policy. Then I will proceed with a competing theory, namely Post Keynesianism. The rather different predictions from these two approaches will make it easier to interpret the empirical results in favor of one or the other.

2.1) The Development of the New Keynesian Consensus

In order to eliminate potential confusion in the beginning, it is important to mention that the line of economic reasoning which is labeled "New Keynesian" is less often also called the "New Neoclassical Synthesis", "NeoWicksellian" (Galí/Gertler 2007: 28) or "New (Keynesian) Consensus". Since the term "New Keynesian" is probably the most common one, I stick to it even though the other names might be better suited for characterizing this specific research approach. Until the 1960s, the widely unchallenged macroeconomic framework was the Neoclassical Synthesis and the associated IS-LM model developed by Hicks (1937) and popularized by Paul Samuelson. This model allowed for short run involuntary unemployment and indicated fluctuations in aggregate demand as important sources of short run output volatility. Unemployment as well as output fluctuations were the result of sticky prices (Romer 1993: 5). Since markets were assumed to be Walrasian and thus were assumed to work under perfect competition, the obvious question emerged how prices could be sticky in such a competitive environment. Additionally, the rise of monetarism and the formulation of Lucas's critique challenged the then standard IS-LM-like models. The central argument of Lucas which later led to the incorporation of rational expectations into macroeconomic models, was that policy analysis cannot be based on structural models without proper microeconomic foundations since such models do not account for the adaptive capabilities of economic agents. These debates let the Neoclassical Synthesis collapse and its former supporters split up into two groups. One school – New Keynesians – tried to provide a theoretical underpinning of sticky prices and also incorporated rational expectations into their models. The other school – real business cycle (RBC) analysis – denied any market imperfections and thought that macroeconomic fluctuations can be

studied solely by focusing on real instead of nominal phenomena (Romer 1993: 6). Thus, RBC theorists developed models with rigorous micro-foundations driven by real factors such as productivity, taxes and oil prices only. Over the years New Keynesians made use of the methodological developments of RBC theory and incorporated more realistic ideas into this framework: monopolistic competition and staggered price adjustment as well as Taylor rules. Thus, the New Keynesian paradigm combined intertemporal microeconomic optimization and rational expectation methods from RBC analysis with ideas about sticky prices and market power of firms (Goodfriend/King 1997). These models allowed them to provide the previously missing explanation of price stickiness on a microeconomic level and became the dominant macroeconomic framework among most macroeconomists nowadays (Blinder 1997).

2.2) The Basic Structure of a Simple New Keynesian Model

Even though the New Keynesian paradigm builds on the methods of RBC analysis, there are some crucial differences. According to the model of Galí and Gertler (2007), these differences are: The introduction of money, monopolistic competition and nominal rigidities. All three are important for special reasons: First, money is used as a unit of account and thus to introduce nominal prices. However it is not used as a medium of exchange or asset. Second, in order to introduce price stickiness, firms need to be price-setters. Therefore, New Keynesian models typically exhibit a final and an intermediate goods sector. The former is perfectly competitive whereas the latter consists of monopolists, which produce differentiated goods used to produce the final good. This structure allows for active price setting, at least in the intermediate goods sector. Third, nominal rigidities are used to allow monetary and fiscal policy to affect real output in the short run.

The basic structure of New Keynesian models consists of three equations: the IS or aggregate demand relation, the New Keynesian Phillips curve or supply relation and a Taylor rule as in Taylor (1993). As suggested by its name, the IS relation is equivalent to the concept from the IS-LM model. Thus, it basically relates aggregate demand inversely to the short term interest rate. The most important difference to the traditional IS curve is that in the New Keynesian version expectations about future demand or future interest rates enter the equation and thus it is "forward looking". Using a simplified version of the model in Galí and Gertler (2007), combining the optimal spending conditions and budget constraints for households and firms yields[2]:

[2] A detailed derivation of the following log-linearized equations can be found in a very similar form in Clarida, Galí

$$(2.1) \qquad y_t = -\gamma_c rr_t + \gamma_i q_t$$

where y_t represents the gap between current real output and its natural level, rr_t the gap between a long term real interest rate and its natural level and q_t the corresponding gap in Tobin's q. Natural levels are defined as those values corresponding to the equilibrium solution of the model where prices are perfectly flexible and all other distortions are absent as well, as in the case of RBC models (Gali/Gertler 2007: 30). It is important to note that equation (2.1) does not explicitly contain any expectational terms. The reason is that they are implicitly part of the equation. The long run interest rate gap depends positively and the gap in Tobin's q depends negatively on current and expected future values of the short run interest rate. Overall, this leads to a negative relationship between the short run interest rate gap and aggregate demand. Finally, it is important to note that in this model, the derivation of the IS relation from spending decisions of households and firms requires the assumption of perfect insurance and capital markets. In such a framework, the permanent income hypothesis holds (Gali/Gertler 2007: 32).

The aggregate supply relation or the New Keynesian Phillips curve is derived from the price setting decisions of firms. It is assumed that in each period only a fraction of firms in the monopolistic intermediate goods sector are allowed to adjust prices. This fraction is independent of the state of the economy and thus this setup is called time dependent pricing (Goodfriend/King 1997: 253). As a result, firms set prices according to their expectations about the future. Particularly firms set markups over marginal costs and thus set prices according to their current and expected future marginal costs. On the other hand, firms which are not allowed to adjust prices in a given period simply adjust output in order to meet demand. Combining the optimal price setting equations, the price index and the labor market equilibrium, one obtains the New Keynesian Phillips curve (Gali/Gertler 2007: 32):

$$(2.2) \qquad \pi_t = \beta E_t \pi_{t+1} + \kappa y_t + u_t$$

where π_t is the rate of inflation from the previous period to period t and u_t represents an exogenous cost push shock, which might be an oil price increase for example. u_t simply represents factors influencing inflation other than excess demand. This New Keynesian Phillips curve is strictly forward looking. If one repeatedly plugs in future values of π_t into (2.2) one sees that current inflation depends on discounted values of current and future values of y and u. This

and Gertler (1999) or Walsh (2010).

implies that the credibility of the central bank in meeting its policy goals is essential, as will be pointed out in the next section. So far, it is important to note that inflation is determined by the output gap and some exogenous factors, meaning that if output is above its natural level (or expected to be), inflation will rise.

Finally, a Taylor rule is defined in order to close the model. The concept of a Taylor rule is motivated by the idea that the central bank sets its short term interest rate according to the state of the economy:

$$(2.3) \qquad r^t_t = rr^n_t + \phi_\pi \pi_t + \phi_y y_t$$

where r^t_t is the central bank's interest rate target, rr^n_t is the natural interest rate and $\phi_\pi > 1$ as well as $\phi_y \geq 0$. The natural interest rate is defined as the marginal productivity of the capital stock. Equation (2.3) states that with zero inflation and zero output gap, the central bank tries to identify and set its short term rate according to the natural rate. In contrast, if the economy is in an expansion with a positive output gap and inflation, the central bank raises the interest rate level. The limitation on the inflation coefficient ensures that interest rates are increased more than 1:1 with inflation rates. In the case of the output gap coefficient, the condition $\phi_y \geq 0$ ensures that interest rates are raised proportionately to changes in the output gap. Taylor rules are in sharp contrast to previously used approaches of modeling monetary policy, like the LM curve. In the traditional IS-LM framework, for example, the central bank is modeled as adjusting the money supply in order to influence interest rates. A Taylor rule assumes that interest rates are set and then central banks adjust the money supply to the resulting money demand. The reason for this latter approach is that money demand is often unstable, and focusing on a money supply rule would result in undesired interest rate volatility (Gali/Gertler 2007: 35).

2.3) The Main Properties and Policy Implications of New Keynesian Models

The framework presented in the last section leads to far reaching conclusions about how modern economies work and which policy measures should be applied in order to achieve socially beneficial outcomes. The most important feature of New Keynesian models is that rigid price adjustments are the fundamental reason why short run fluctuations in output and employment occur. The underlying argument is that price stickiness prevents markets from being cleared (Gordon 1990: 1118, 1135). This means that shifts in aggregate demand due to shifts in public or

private spending as well as in net exports, affect the real output level because the price mechanism does not work properly. The same holds for changes in the central bank interest rate and thus monetary and fiscal policy are effective in the short run. Since policy is effective, it faces a trade-off between inflation and output. Put differently, governments and central banks are able to push real output above its natural level, at the cost of higher inflation. This relation is evident in equation (2.2), where a positive output gap increases inflation.

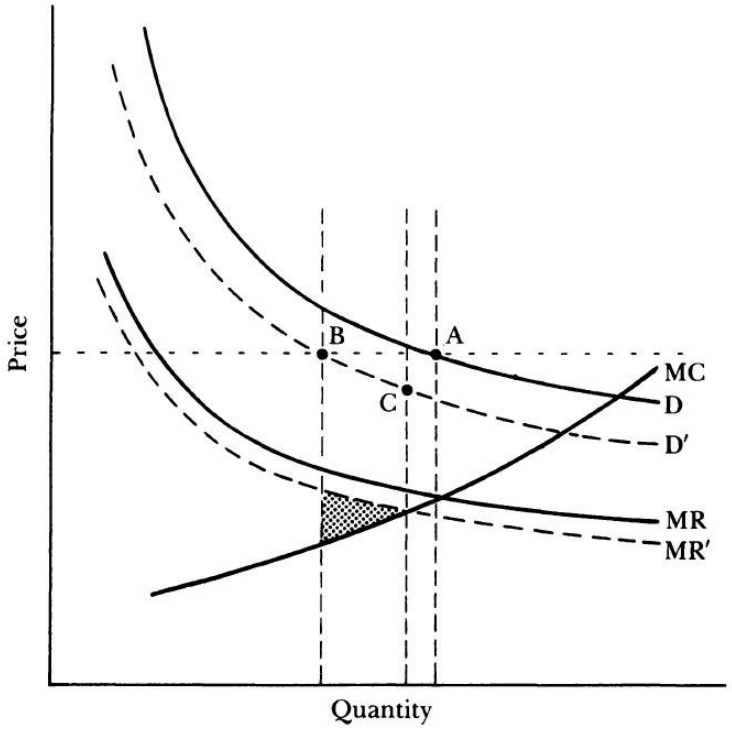

Figure 2.1: The New Keynesian model of the firm.
Source: Romer (1993)

Romer (1993) provides a brief overview of the underlying mechanics of price stickiness. He states that given a framework of monopolistic competition, the central question is what prevents firms from adjusting prices in response to changes in aggregate demand such that real variables stay constant. Romer's argument is that direct costs of price changes (nominal rigidities) like menu costs or consumers being used to stable prices, are not convincing enough to explain why firms are reluctant to adjust prices. The fundamental reason for stickiness is that there are only small gains to be made from immediately adjusting prices (real rigidities). In explaining real

rigidities, Romer uses the model of a representative firm, which maximizes profits in a monopolistic competition, diminishing returns environment and thus wants to produce at its marginal cost (MC) being equal to its marginal revenue (MR)(Romer 1993: 8), which corresponds to point A in Figure 2.1. Increasing production from this point would create a loss (since MC > MR) and decreasing production would lead to forgone profit (since MC < MR). Romer assumes a reduction of aggregate demand (due to policy) which changes the firm's demand from D to D' and, thus, also its marginal revenue situation from MR to MR'. Additionally, the reduction in aggregate demand reduces aggregate labor demand and if wages decline as a reaction to lower demand, the firm's cost situation changes. Romer, however, argues that it is sticky wages, mainly due to efficiency wages, which prevent wages from falling in the labor market and thus the cost situation of the firm stays relatively unchanged. In the case above, the firms optimal production plan then would be point C, where MR'=MC. So depending on the relation of the change in the firm's costs and revenues, there is a strong or weak incentive in the form of forgone profit to change prices. In Figure 1, not adjusting prices corresponds to production at point B which would lead to forgone profit as indicated by the shaded triangle. Since the MC curve does not shift and due to the direct costs of changing prices (nominal frictions) the representative firm chooses to adjust quantities rather than prices and thus produces at point B. As a result, real effects occur. Other authors like Gordon (1990) argue that real rigidities in the labor market like efficiency wages need not be the main source of price stickiness. In his view, raw materials and intermediate goods are much more important cost determinants relative to labor costs, at least for individual firms. If this is the case, the price of these inputs can evolve independently of wages and thus even if wages were flexible incentives to adjust prices after a shift in aggregate demand could be low. Thus, Gordon identifies the complex structure of supplier relations in modern markets and the resulting independence of aggregate demand and individual costs as another potential source for real rigidities.

The New Keynesian view on the long run behavior of an economy is strongly different from the mechanisms discussed in the previous paragraph. New Keynesians believe that in the long run prices are flexible. As a result, the equilibrium of an economy is determined solely by real or supply factors such as changes of productivity, raw material prices, taxes or regulations because shifts in demand are offset by price adjustments. Technically speaking, the long run equilibrium or the natural values of a New Keynesian model are represented by its RBC core and thus are

equivalent to the equilibrium of the NK model without price or wage stickiness but still with perfect competition. One can also say the long run equilibrium is supply-determined. It is important to note that these natural values provide the primary reference points around which the economy fluctuates in the short run. Since in the long run prices adjust to changes in the aggregate demand, monetary or fiscal policy which is conducted in order to manage aggregate demand are not effective anymore and only result in price level changes. Put differently, policy faces little trade-off between inflation and output (Goodfriend/King 1997: 256). Equation (2.2) shows that if output equals its natural value, which is the case by definition in the long run, then inflation only depends on the agents' expectations. As will be pointed out in the next paragraph, there is not only no trade-off between inflation and output in the long run but also output is stabilized most successfully around its natural value by low inflation monetary policy.

Given the behavior of the economy due to short and long term influences, an important question is how monetary policy should be conducted in such a framework. The answer is that monetary authorities should primarily focus on achieving permanent low, near zero rates of inflation by stabilizing aggregate demand (Goodfriend 2007: 61). The reasoning is that if aggregate demand is stable, firms only face few incentives to adjust prices, as was described above. Additionally, an overall low and steady rate of inflation makes it easier to plan and manage unavoidable price adjustments even if prices are sticky and adjustments are costly[3]. So given these arguments, a central bank which manages to provide low rates of inflation also manages to keep the economy close to its natural equilibrium (Goodfriend/King 1997: 266). Deviations from natural equilibrium are caused by short-run demand shocks putting pressure on firms to adjust. Thus, low inflation resulting from stable aggregate demand is equivalent to little pressure to adjust prices or quantities. Therefore, a central bank which aims at offsetting demand shocks and thus raises interest rates in response to expansionary fiscal policy, keeps the output gap small. However, the economy is not only hit by demand shocks but also by real or supply shocks. Those have the potential to affect the natural equilibrium. Suppose, for example, productivity growth increases and thus the economy's natural equilibrium real interest rate increases as well. In such a case, the central bank should react by increasing its nominal rate in order to keep the gap in the real rate (and thus the gap in output) close to zero (Galí/Gertler 2007: 40). Put differently, the

[3] For further arguments why a central bank should prefer a low and steady rate of inflation over a higher but also steady rate see Goodfriend (2007:62).

central bank should counteract demand shocks and accommodate real shocks in order to keep the economy near to its long run equilibrium. This requires that the central bank keeps track of the natural equilibrium of the economy, which is affected by real shocks such as productivity or taxation. Even though this may sound reasonably easy in theory, the practice of correctly detecting shocks is much more complicated. Suppose, for example, the economy is hit by an oil price shock (the u_t term in equation (2.2)). The relevant question, then, is whether the shock is only temporary or of permanent nature. In the latter case, it is equivalent to a negative productivity shock whereas in the former case, it is a temporary distortion of relative prices to which the central bank should not react (Goodfriend/King 1997: 272). So even if the starting point in this scenario is identical, the policy conclusions are completely different, depending on the assessment of the situation. In order to avoid problems with such oil-price-like cost push shocks, the monetary authority should focus on core rather than headline inflation. This means it should exclude volatile and exogenously determined prices from its inflation indicators. Goodfriend (2007) proposes to strictly focus on this core inflation and act preemptively in order to implicitly track the natural rate. He argues that raising interest rates before core inflation rises either due to demand or supply pressure would keep the economy close to its natural equilibrium without the need to permanently assess its natural equilibrium. Additionally, it is important to note that inflation indicators which were reliable in the past might not be useful anymore, because if central banks pursue a credible low inflation policy, agents will act differently than they did in the past. So it might be necessary to develop new indicators in order to detect signs of increasing inflation (Goodfriend/King 1997: 278). Finally, it is important to emphasize the major role credibility plays for central bank policy. The mechanisms described above only work properly if firms can rely on future low inflation rates. If this is not the case and firms are expecting high inflation in the future, they face incentives to increase prices even in the present (technically speaking those firms able to adjust would increase their prices in the present). The result would be persistent higher inflation or higher costs in terms of lost output in fighting inflation as Galí and Gertler (2007) point out. Thus, it is a key feature for monetary policy in a New Keynesian framework to focus and maintain its credibility of providing low inflation rates in the present and in the future.

3) Theoretical Background: A Post Keynesian Perspective

In this chapter, a theoretical alternative to the New Keynesian mainstream is presented, namely the Post Keynesian approach. Although there are debates among Post Keynesian economists who should be labeled “Post Keynesian” (Galbraith 1978, Lavoie 2005, Davidson 2004), I will not focus on these debates. Generally speaking, one can say that Post Keynesian economists reject Hicks' IS-LM interpretation of Keynes' General Theory. They argue that this interpretation is lacking the most important insights of Keynes. In the following chapter, I will present some of those important insights of Keynes and also later Post Keynesian authors such as Michael Kalecki.

3.1) The Theoretical Cornerstones of Post Keynesian Economics

Probably the most important insight of Keynes and his General Theory was that Say's Law does not apply to modern capitalist economies (Davidson 2002, Keen 2004). Keynes claimed that the belief in an aggregate equilibrium needs not to hold. He rejected the belief in permanent zero excess supply or demand over all markets and thus rejected Say's Law. Say argued that production is simply carried out in order to consume. Thus, producers and workers supply commodities only to demand and consume different ones later. Therefore, supply and demand need to be balanced over the economy and, as a result, overall excess demand or supply is zero at any point in time. Importantly, this does not imply that all markets need to be cleared at any time. Say's Law only states that excess demand/supply in one market is accompanied by excess supply/demand in another market. Keen (2004) argues that in modern macroeconomic theory, Say's Law is replaced by Walras' Law which states that the sum of notional excess demand over all markets is zero but that both principles lead to the same conclusion: price adjustments will eliminate excess demand/supply in markets out of equilibrium. For example, if there is excess supply in the labor market due to excess demand in the money market, then, under Walras' Law, a decrease in the price of labor and an increase in the price of money and thus deflation would restore the overall equilibrium of the economy. Keynes argued that this is unlikely to happen. If one divides aggregate output into investment and consumer goods, then due to Walras' Law a decrease in consumption demand would require investment spending to offset the excess supply. However, it would be more likely that as a result of declining consumption demand also investment demand falls and, thus, leading to an even higher excess supply in the goods market. The reason would be that investment spending depends on expectations about future profits for

which current sales are a proxy (Keen 2004: 192). Keynes concluded that investment spending is highly volatile and thus the main source of output and employment variation because it depends on future profit expectations which are formed in a fundamental uncertain environment. Additionally, since Say's Law is unlikely to hold, it is possible that the economy persistently does not return to an equilibrium of full resource utilization and thus could experience periods of unemployment which would not be corrected by market forces.

Another important theoretical cornerstone of Post Keynesian economics is the concept of endogenous money. It states that the money stock is not exogenously determined by the central bank as it is in the standard IS-LM model through the money multiplier (Blanchard 2006: 83). Post Keynesian authors reject that logic and argue that the central bank is only able to set the price for money, namely the interest rate, but the quantity is determined in the private banking system. There is a discussion among Post Keynesian economists whether the monetary authority is completely unable to directly influence the money stock and just supplies reserves as banks demand them (horizontalist approach) or the central bank has some influence but that the private banking sector still plays an important role (structuralist approach)(Fontana 2003; Lavoie 1996; Moore 1988; Wray 2007). However, in both cases the two most fundamental conclusions stay the same. First, central banks should use the interest rate as their primary policy instrument and should not try to control the money stock. Second, there does not exist a unique natural interest rate which necessarily equates investment and savings and thus enforces a goods market equilibrium. As pointed out in the previous chapter, New Keynesians share the first insight but reject the second one. The reason why Post Keynesians do not believe in the existence of a (Wicksellian) natural interest rate is the reversed causation between investment and savings. The argument is the following: investment demand increases demand for loans and thus money. As a result, the money stock is endogenously determined because private banks accommodate these demands as long as they believe in the soundness of their customers. However, since the central bank supplies the reserves which banks need to grant these loans, banks do not need any additional deposits (and thus savings) before making these loans. Thus, it is loans causing deposits and not the other way round because firms use these loans to pay workers and buy intermediate goods inputs and thus these loans become deposits in the hands of other market participants. Since the demand for loans increases with investment spending, it is investment

which creates deposits and thus saving (Lavoie 2006: 57/58; Moore 1998: 349). As a result of endogenously evolving savings, the concept of a single natural interest rate which ensures equilibrium between investment spending and savings is redundant.

3.2) A Simple Post Keynesian Short Run Model

The two models presented in this and in the next sections, which are drawn from Lavoie (2006), are rooted in the tradition of Michael Kalecki. Even though the latter shared many insights with Keynes, his approach was rather different. Keynes, for example, accepted some of the core assumptions of neoclassical theory such as a given money stock and production at diminishing returns. Kalecki, on the other hand, did not use these assumptions because his motivation was not, as in the case of Keynes, to convince his classical colleges but to develop a standalone theory. This theory is based on the assumption of production at constant unit cost and thus with constant returns to scale, at least until firms reach their full capacity limit. Additionally, firms interact in an oligopolistic environment where they act as price setters and normally produce below full capacity levels. This last characteristic is essential to the following analysis and confirmed empirically as well as theoretically as a strategy of preventing competitors from market entry (Lavoie 2006: 41/43). In this framework, the short run is characterized by assuming the capital stock to be fixed, meaning that investment does not change capacity.

The first step in developing the model is to define national output. The definition abstracts from government and trade and thus output consists of consumption and investment spending only. If the goods market is in equilibrium, then output can be considered as the wage sum; that is the average wage rate times the people employed plus profits. If one assumes further that workers do not save, then profits equal autonomous spending which consists of investment spending and consumption out of profits. These definitions result in the real aggregate demand curve:

$$(3.1) \quad RAD = a_{cc} + a_{cw} + a_i = a + N * w/p$$

where p is the price level and thus w/p is the real wage, a_{cc} is real consumption out of profits, a_{cw} is real consumption out of wages, a_i is real investment spending, a is autonomous spending (and thus the sum of a_{cc} and a_i) and N is the level of employment. So equation (3.1) states that increases in investment spending or real wages boost aggregate demand. Since this model abstracts from changes to the stock of capital and assumes constant returns to scale production

due to idle capacity, real aggregate supply is just a linear function of employment, where the slope represents the level of technology or output per worker. Combining such an aggregate supply relation (3.2) with equation (3.1) yields the effective labor demand curve or the effective labor demand constraint (3.3), which reflects labor demand and the corresponding real wage under the condition of a goods market equilibrium:

$$(3.2) \qquad RAS = TN$$

$$(3.3) \qquad w/p = T - a/N$$

where T is output per worker. If labor supply is assumed to be constant and equal to the full employment level this yields a vertical labor supply curve and one can close the model. Figure 3.1 demonstrates that for a given real wage level, for example w/p_1 the corresponding employment level would be N_1 which lies below the full employment level N_{fe}. Only an increase in autonomous spending from a_1 to a_2 or an increase in the real wage rate to w/p_{fe} would result in a full employment equilibrium for a given technology level T.

So, as in the New-Keynesian model, an increase in autonomous spending, which could be triggered by expansionary monetary or fiscal policy, would increase output and thus employment. Since firms produce with excess capacity, it is more desirable for them to respond to additional demand by increasing output rather than increasing prices and risking a loss of market shares to competitors. So, in an expansionary scenario price adjustments would not occur because of sticky prices but because of idle capacity. However, if the economy suffers from unemployment, like in the case of w/p_1 then there does not exist an automatic price adjustment process which would force the economy back to the full employment equilibrium. Falling real wages would depress the economy even further due to the higher propensity to consume out of wage income compared to profit income. On the other hand, rising real wages due to falling prices are unlikely to put the economy back to equilibrium because deflation depresses consumption demand, since postponing consumption yields purchasing power gains and additionally deflation increases the debt burden of creditors which destabilizes the financial system (Lavoie 2006: 95; Palley 2002: 173).

So even though policy is effective in the short run both in New Keynesian and in Post Keynesian models, the underlying mechanisms are quite different. In Post Keynesian models, it is not the stickiness of prices due to nominal rigidities which prevents the economy from offsetting policy

measures and restoring equilibrium in the short run. In the Kaleckian type model presented above, it is excess capacity and the differences in the propensity to save across income classes which result in policy effectiveness and the positive relation of real wages and output. In an extension of this baseline model, particularly by assuming that the labor supply curve is backward bending, Lavoie demonstrates that even if prices were sticky, this could have beneficial effects, ensuring higher output and welfare levels than in a flexible price environment (Lavoie 2006: 97). Beside these models, there are also other ways to demonstrate policy effectiveness and the need of stabilization policy in the short run. Even in a framework with full capacity utilization and no differences in propensities to save, one can use a typical decreasing returns production function model to demonstrate that flexible prices are not sufficient to restore a full employment equilibrium. The crucial element in this approach is the decreasing wage rate due to diminishing returns. This results in a lack of demand which needs to be compensated by autonomous spending (Lavoie 2003).

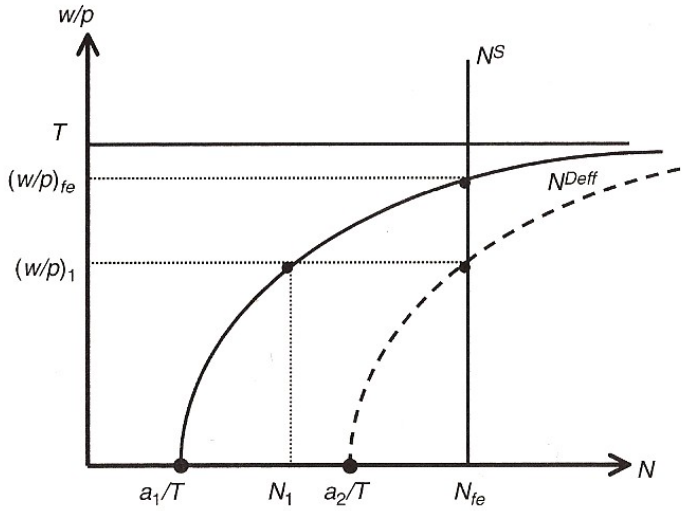

Figure 3.1: Short Run Dynamics. Source: Lavoie 2006: 93

3.3) A Simple Post Keynesian Long Run Model

In contrast to the previous model, now the assumption of a fixed capital stock is relaxed as well as the assumption of autonomous spending being determined in previous periods. Thus, one can define the profit rate as follows:

$$(3.4) \qquad r = P/K = (P/Y)(Y/Y_{fc})(Y_{fc}/K) = \pi u/v$$

where r is the profit rate, P are profits, Y is actual income, Y_{fc} is full capacity income, K is the capital stock, π is the profit share (π=P/Y), u is capacity utilization ($u=Y/Y_{fc}$) and v is a technology coefficient ($v=K/Y_{fc}$). In the way Lavoie (2006) presents the model, he assumes v and π to be exogenous variables. Since π is direct proportional to the mark up of firms, real wages are indirect proportional to π in this simple setting. Therefore, the profit rate can increase due to three different channels. First, firms can try to increase the profit share by increasing their markups. Therefore, the level of competition is an important factor in the goods market. Second, producing at higher capacity increases the profit share, since sales increase but the capital stock remains constant. Third, firms can develop or adopt new technologies from competitors. The next step is to define an investment function:

$$(3.5) \qquad g^i = \alpha + \beta(u - u_n)$$

where g^i is the planned capital stock growth as intended by capitalists, u is actual capacity utilization, u_n is normal capacity utilization and α and β are coefficients, where α can be interpreted as the expected trend growth rate of sales. Equation (3.5) implies that firms increase their investment spending whenever they produce above normal capacity level. Normal capacity utilization can be interpreted as a long term trend, where empirical studies indicate that it is around 80%. As argued before, it can be reasonable for firms to maintain idle capacity in order to complicate market entry or to maintain flexibility. The last component of the model is a savings function:

$$(3.6) \qquad g^s = s_c r$$

where g^s represent available funds for investment in the form of savings out of profits, since s_c is the propensity to save out of profits. Solving these equations yields the three endogenous variables g* which is the actual growth rate of capital or the rate of accumulation, u* which is the actual rate of capacity utilization and r* which is the actual profit rate.

In this framework, a decrease in aggregate demand, whether resulting from a higher propensity to save, falling real wages or a decrease in autonomous spending, will depress output and thus lower capacity utilization. The decrease in utilization, however, will induce firms to cut investment spending and thus capital growth will decline. Additionally, a fall in utilization rates will put downward pressure on the profit rate. Therefore, a decrease in aggregate demand will lead to a lower growth rate, lower capacity utilization and a lower profit rate in the long run. A

decrease of autonomous spending can be triggered by higher central bank interest rates. Such a scenario would raise the cost of financing production and thus firms needed to increase savings out of profits and were likely to cut investment spending. Additionally, consumer spending (especially on durable consumer goods) might fall as well. Both factors will depress aggregate demand and as a result capacity utilization will fall and the mechanism described above sets in. So in this model, since firms adjust their capacity utilization rate instead of prices or mark ups, monetary and fiscal policy is able to influence real output even in the long run. Nevertheless, so far the model only focused on demand side phenomena, which certainly is too simplistic. Lavoie (2006) discusses three potential extensions dealing with supply side issues.

First, the natural growth rate, determined by technological progress and population growth might differ from the actual growth rate. In such a situation, the unemployment rate would steadily increase (decrease) if the natural rate was higher (lower) than the actual rate. However, Lavoie points out that the natural growth rate probably adjusts to the actual growth rate and thus is itself determined endogenously. Possible reasons for such behavior could be that strong economic growth leads to fast growth of the labor supply due to increasing working hours or migration. Additionally, in a booming economy labor shifts toward more productive sectors, economies of scale arise, learning by doing effects appear and innovations are adopted more quickly because of strong demand. All those effects lead to a higher natural rate. These concepts are known as hysteresis or path dependency and the positive relation between economic growth and technological progress is known as Verdoorn's Law and has been validated for various countries. The result of such an endogenous natural growth rate would be that policy became even more effective.

Second, so far the model was wage-led, which means higher wages lead to higher accumulation rates. If one adjusts the investment function by adding profits, then it is also possible that higher wages and thus lower profits lead to lower accumulation rates, depending on the parameter values. Such economies are called profit-led and require quite different policy measures, especially concerning the labor market, than wage led economies. In such an environment strong unions and high real wages would indeed slow economic growth.

Third, inflation might be the result of upward deviations from the normal rate of capacity utilization. Central banks would react by increasing interest rates in order to fight inflation and

bring back capacity utilization to its normal level. So permanently high interest rates due to expansionary fiscal policy could hurt firms profit and sales expectations and increase finance costs and thus lead to lower growth rates. Lavoie however argues that since firms have idle capacity, such a scenario is unrealistic until utilization is above maximum capacity. Therefore, a Post Keynesian Phillips curve is likely to be positively sloped with a flat part in the middle, meaning that for some deviation around the normal capacity utilization rate, no inflationary pressure evolves. Inflation is more likely to be the result of class struggles over income shares and thus could arise in situations of high growth were workers and unions are demanding high nominal wages. Inflation can occur if the productivity gains of rapid growth are smaller than the wage increases. Thus, inflation is more likely to be the result of insufficient (wage bargaining) institutions than excess demand.

3.4) Implications for Monetary Policy

The two models presented above yield insights for monetary policy which are quite different. The New Keynesian approach which emphasizes natural rate targeting sees inflation mainly as an excess demand phenomenon which can be cured by setting the central bank rate in line with the natural rate. The Post Keynesian approach rejects this conclusion for two reasons. First, there does not exist a unique natural rate which ensures macroeconomic equilibrium and thus low inflation. Instead, since investment decisions not only depend on the interest rate but also on factors like capacity utilization and expectations about the future, market equilibrium does not depend primarily on the interest rate. Thus, it makes no sense for the central bank to spend time and resources on tracking a "natural" interest rate. Second, there exist also other causes for inflation than excess demand like cost push shocks due to raw material price movements or conflicts over income distribution in wage bargaining processes (Lavoie 2006). In both cases, monetary policy is an inappropriate or damaging instrument to fight inflation, since price stability can be restored only by triggering a recession. Instead, proper wage bargaining institutions and reduced dependence on volatile raw materials are better responses.

However, in situations where inflation is the result of excess demand then there is no need to exclude fiscal policy from handling the problem. This is especially because the effects of monetary policy might be harder to predict than fiscal policy due to very different transmission channels such as the influence on investment and on exchange rates (Arestis/Sawyer 2006). Beyond that, if

there are long run real effects of monetary policy as suggested by Post Keynesian models and especially if monetary policy affects supply conditions by directly influencing investment more than fiscal policy does, an inflation targeting approach is likely to hurt the long run growth perspective (Fontana/Palacio-Vera 2003). Thus, monetary policy should at least coordinate with fiscal policy in order to limit the negative consequences of raising interest rates and focus on a core inflation index which focuses on domestic inflation, excluding highly volatile raw materials and non-domestic goods. Overall, Lavoie (2006) argues that there exists empirical evidence supporting the view of a non-linear Phillips curve with a flat part around normal capacity utilization and, without an inflation-unemployment trade-off, around normal capacity utilization. If this is the case, then optimal monetary policy would aim to push the unemployment rate to the upper limit of the flat part of the Phillips curve instead of the lower one. However, detecting and distinguishing these points from each other surely is difficult and involves some "testing" (Lavoie 2006: 129).

Additionally, Post Keynesians emphasize that stabilizing aggregate demand and inflation through setting interest rates is not the only goal a central bank should pursue. Arestis and Sawyer (2006) argue that prudential credit controls should be used as a temporary measure in order to fight and prevent credit bubbles in certain sectors of the economy. One can think about implementing a maximum loan to income ratio or maximum payback intervals as examples for such measures. Even though credit controls face considerable implementation problems, because banks can work on circumventing them by introducing new financial instruments, they have also clear advantages. Since credit bubbles often affect a certain sector of the economy and credit controls can be tailored to specific sectors, such measures are more appropriate than interest rate setting which influences the whole economy immediately. So even though the discussion of financial regulation is beyond this work, the recent financial crisis has clearly demonstrated that a central bank needs to pay attention to financial markets even when they are not directly related to the central bank's policies.

Policy recommendations from Post Keynesian authors remain limited compared to the extensive amount of work done on this issue by New Keynesians. The latter present a clear and simple monetary policy rule for central banks. Post Keynesian authors need to work more on this issue in order to come up with more detailed policy recommendations as an alternative.

4) Empirical Approach

The statistical framework I use to study the effects of monetary policy is the factor augmented vector auto-regressive (FAVAR) approach as introduced by Bernanke, Boivin and Eliasz (2005). Their newly established model combines classical vector autoregression (VAR) methods with techniques from factor analysis. The former approach was introduced by Sims (1980) as a means to reduce necessary theoretical restrictions in macroeconometric analysis. Since then, a large body of literature using VAR models to study especially the effects of monetary policy emerged[4]. These models can be applied to small data sets only since including more and more variables leads to imprecise estimators due to a loss of degrees of freedom. Additionally, it became apparent that certain problems and implausible results occur across a wide range of specifications and data sets. The most important one is the 'price puzzle', which means that in many VAR models a positive (negative) interest rate shock depresses (stimulates) output but at the same time triggers inflation (deflation). Some authors, such as Sims, argue that the problems of implausible results like the price puzzle are rooted in the limited amount of information these models are able to process. Since lots of relevant macroeconomic variables cannot be added, due to the mentioned degrees of freedom problems, the results are biased. As an answer to this critique, Bernanke et al. (2005) present a framework which processes large data sets and yields precise estimates as well. Their model uses results from the dynamic factor models literature, where methods to exploit many time series at once existed already. The basic idea of factor analysis is that a small number of general factors are the driving force behind economic dynamics. Those factors might be interpreted as unobservable concepts such as the “output gap” or “credit conditions”. If this is the case, those factors can be extracted from a large data set and used in forecasting or classical VAR analysis. As a result, a large amount of information contained in those factors can be used without including hundreds of variables in one's model.

4.1) The Statistical Model of Bernanke, Boivin and Eliasz

Bernanke et al. (BBE in the following) define Y_t as an Mx1 vector of observable variables which are essential for the dynamics of the economy. Y_t can be thought of as including time series of industrial production or price indices, interest and unemployment rates or monetary aggregates. These are the typical variables included in standard VAR analysis. As argued in the previous

[4] An overview can be found in Christiano, Eichenbaum & Evans 1999.

section, additional information is needed to correctly model the dynamics of a modern economy. This additional information is summarized by a Kx1 vector of unobservable factors F_t which can be interpreted as "real activity", "output gap", "credit conditions" or other not directly observable but highly important concepts in macroeconomics. Based on these definitions, BBE assume that the relationship between Y_t and F_t can be described through a transition equation:

$$(4.1) \quad \begin{bmatrix} Y_t \\ F_t \end{bmatrix} = \Phi(L) \begin{bmatrix} Y_{t-1} \\ F_{t-1} \end{bmatrix} + v_t$$

where the lag polynomial $\Phi(L)$ is of order d. Equation (4.1) is a VAR in the vector $(Y'_t \; F'_t)$. Since this is not a standard VAR but also contains the factors F_t, BBE call it a factor augmented vector autoregression (FAVAR). One can see that if the factors contain relevant information, estimating a VAR only using the vector Y_t would result in an omitted variable bias and thus would yield inconsistent estimates. Since the factors are not observable, equation (4.1) cannot be estimated directly. Nevertheless, BBE define X_t as an Nx1 dimensional vector of observable background variables which is related to the unobservable factors in the following way:

$$(4.2) \quad X_t = \Lambda^f F_t + \Lambda^y Y_t + e_t$$

where Λ^f is an NxK matrix of factor loadings, Λ^Y is an NxM matrix of coefficients and e_t is an Nx1 vector of error terms (BEE 2005: 391/392). Equation (4.2) captures the idea that a broad set of economic time series, X_t, is driven by observable variables such as interest rates or industrial production, as well as by unobservable general factors. So conditional on Y_t the data set X_t can be used to extract those common factors (BBE 2005: 393). After obtaining an estimate for F_t it can be used to estimate equation (4.1).

4.2) Extracting the Factors

BBE provide two different estimation approaches for the system (4.1) and (4.2); however, I will only discuss the simpler and also the one preferred by BBE, which involves two steps. First, the factors F_t are estimated by principal components based on the methods presented in Stock and Watson (1998) as well as in Stock and Watson (2011). The difference between those models and equation (4.2) is that (4.2) contains not only unobserved factors but also the vector Y_t which will become important shortly. For now, Y_t will be ignored and based on the solution of a least square problem in matrix notation, unobserved factors $\tilde{F}_t$ are extracted from the normalized data set and expressed as a function of the factor loading matrix Λ:

$$(4.3) \qquad \tilde{X}_{it} = \frac{X_{it} - \mu_X}{\sigma_X} \in \tilde{X}$$

$$(4.4) \qquad S = \min e'e = (\tilde{X} - \Lambda F)'(\tilde{X} - \Lambda F)$$

$$(4.5) \qquad e'e = \tilde{X}'\tilde{X} - 2\tilde{X}'\Lambda F + F'\Lambda'\Lambda F$$

$$(4.6) \qquad \frac{\delta S}{\delta F} = -2\Lambda'\tilde{X} + 2\Lambda'\Lambda F = 0$$

$$(4.7) \qquad \tilde{F}(\Lambda) = (\Lambda'\Lambda)^{-1}\Lambda'\tilde{X}$$

Equation (4.7) is a classical least square result. The important difference to a standard OLS framework is that the estimator $\tilde{F}_t$ does not only depend on the observed data $\tilde{X}_t$ but also on the unobserved factor loadings equivalent to those in equation (4.2). Plugging the estimator back into equation (4.4) and rearranging terms yields:

$$(4.8) \qquad \max \Lambda'\hat{\Sigma}_{\tilde{X}}\Lambda \quad \text{s.t.} \quad N^{-1}\Lambda'\Lambda = I$$

where $\hat{\Sigma}_{\tilde{X}}$ is the estimator of the sample variance matrix, which is simply XX' due to the normalization of the data. As a result equation (4.8) can be solved by choosing Λ equal to the eigenvectors of XX' corresponding to the K largest eigenvalues. Then, it follows from $N^{-1}\Lambda'\Lambda = I$ that $\tilde{F}_t = N^{-1}\hat{\Lambda}'X$ and thus one has extracted K factors from the normalized data set (Stock/Watson 2011: 40/41). So far, this first step relied on the normalization of the data as well as on the assumption that the error term in equation (4.2) is independent and identically distributed with $N(0,\sigma^2_e)$, which is a rather strong assumption (Stock/Watson 1998: 10). The normalization is necessary because there are infinitely many solutions to the least square problem of equation (4.4), since there are two unknown elements. Another way of thinking about this problem is that infinitely many solutions exist because the factors as well as the loading matrices can be arbitrarily rescaled by a constant while they still solve (4.2). By normalizing the data, one introduces an additional restriction which enables to solve the system and since the important information contained in the factors is the space they span, scaling them to zero mean and unit standard deviation does not alter this space (BBE 2005: 400). Stock and Watson also relax the restrictive assumption made about the error term when deriving the asymptotic results for their estimates (Stock/Watson 1998: 9/10/14). In particular, the factor estimator just derived

stays consistent even in the presence of serial and cross correlation in e_{it} in equation (4.2).

Before coming back to the fact that we ignored the influence of Y_t on X_t when extracting the factors, it is important to make the intuition of factor estimation by principal components explicit. What factor models do is to pool the information in the predictor variables (thus, the Xs) and average away the idiosyncratic variation (Stock/Watson 2002: 147), which can be interpreted as a sector or variable specific shock or measurement error. More technically speaking, the estimated factors are linear combinations of the predictor variables such that their variance is maximized or such that they are optimal in explaining those predictor variables. The former interpretation is represented through equation (4.8) whereas the latter one trough equation (4.4), which are equivalent after plugging in (4.7).

Now we will deal with the presence of the observed variables in equation (4.2), which was ignored so far. Principal component estimation asymptotically identifies unobservable factors which are driving the predictor variables X_t as long as the estimated factors and the number of predictor variables are large enough (Stock/Watson 1998: 16). However, ignoring the fact that the variables contained in Y_t are observable means that the estimated factors also contain parts of the information represented by Y_t which includes the central bank interest rate R_t. In particular, depending on the detailed specification of the model, the vector Y_t contains either only a short term central bank interest rate or such a rate and additional key variables. Since the model's goal is to study the influence of R_t on the economy, it is necessary to obtain an accurate estimate of F_t which does not depend on R_t and which will be denoted by $\hat{F}_t$ [5]. The construction of such an estimate involves the removal of the direct dependence of $\tilde{F}_t$ on R_t (BBE 2005: 405). In order to determine the influence of R_t, a simple regression of $\tilde{F}_t$ on Y_t, however, is not appropriate because relevant information on which the factors are based on would be omitted and a correlation between Y_t and the error term would be the likely result. BBE tackle this problem by defining two subsets of X_t: slow moving variables like output or wages and fast moving variables like asset prices or exchange rates. The latter ones are assumed to react within one period and thus within one month to central bank interest rate changes. Slow moving variables are assumed not to react within one period to changes of the central bank interest rate. The exact specification of slow and fast moving variables is documented in the appendix. Extracting factors form the sample of slow

[5] The reason will become clear when the question of how to identify the system is discussed in the next section.

moving variables only, denoted by $\bar{F}_t$ allows BBE to determine the influence of R_t and to compute estimates of the "pure" factors F_t:

$$\tilde{F}_t = \alpha R_t + \beta \bar{F}_t + u_t \qquad (4.9)$$

$$\hat{F}_t = \tilde{F}_t - \hat{\alpha} R_t \qquad (4.10)$$

Equation (4.9) is a regression to assess the particular influence of the central bank rate on the "naive" factors from the entire sample. Equation (4.10) computes the final estimate of the factors by subtracting R_t times the estimated coefficient. So by including the factors from the slow moving sample, the missing information in determining the influence of R_t is reduced. Nevertheless, even by including the slow moving factors in equation (4.9), it is still a question of belief whether the error term u_t captures missing information systematically and thus hurts the estimation coefficients. This issue will be studied in the next chapter when robustness checks are performed with respect to using $\tilde{F}_t$ or either $\hat{F}_t$.

4.3) Estimating the Dynamics

Finally, the corrected factors can be used in estimating the VAR of equation (4.1) by multivariate OLS. BBE point out that the basic idea of VAR analysis is to correctly specify and estimate a monetary policy reaction function and then treat the errors as exogenous monetary policy changes (BBE 2005: 387/402). The specific advantage of using a VAR framework is that only the reaction function and thus the monetary policy shocks must be identified. This means that in the FAVAR framework, it is not necessary to provide clear interpretations of the K estimated factors. What is needed in order to perform structural analysis in the form of impulse response analysis are assumptions about the correlation structure of the error term in equation (4.1). More specifically, tracing the effect of an exogenous monetary policy shock through the system requires to define how such a shock also affects the other variables in the system (Lütkepohl 2007: 57). In general there are three possibilities. First, one can just assume that shocks are independent and thus, in the first period, a monetary policy shock for example only affects the interest rate. Second, a so-called Choleski decomposition or a recursive model can be used (Lütkepohl 2007: 59/658). This approach assumes a specific correlation structure depending on the ordering of the variables in the VAR system, particularly in the form that variables ordered first in the data vector

influence all other variables ordered after them. As a result, a shock to the variable ordered last does not affect any other variable in the first period. Thus, by changing the ordering, the researcher can impose the preferred correlation structure along the limitation that a variable affects all the others ordered behind it. Third, one can use a structural VAR model (SVAR), which means one imposes a specific structure on the correlation of shocks based on a theoretical model of the economy (Lütkepohl 2007: 357). Thus, a FAVAR or VAR framework does not force the researcher to come up with a detailed model of the economy to study the effects of monetary policy. Now it is clear why BBE spent so much time on extracting the factors and removing their dependence on the interest rate. The reason is that if some of the "naive" factors $\tilde{F}_t$ also contain information about the interest rate, none of these identification schemes would be appropriate because in such a situation an exogenous shock to the interest rate would also immediately affect those general factors.

BBE use a recursive identification scheme where the central bank interest rate is ordered last, which means that factors do not react within the period to changes in monetary policy (BBE 2005: 404). The fact that BBE rely on the recursive model implies that their identification approach becomes less plausible when additional variables than the central bank rate are included into the vector Y_t since this would require justification of the ordering of the elements of Y_t and the factors. Particularly, the more variables are included, the more assumptions are implicitly made about the structure of the economy which is studied. This is especially problematic since the factors have no clear interpretation and thus it is also hard to justify a specific ordering. The confidence intervals BBE use are obtained by a bootstrapping method based on Kilian (1998).

Thus far, the estimation approach of BBE can be summarized as following: In order to be able to investigate 'pure' interest rate shocks using the system (4.1) and (4.2), the factor estimates $\hat{F}_t$ need to be independent of any dynamics captured by Y_t. This goal is achieved by first defining two subsets on X_t: slow and fast moving variables. It is assumed that the latter react within one period to an interest rate change while the former don't. Then $\hat{F}_t$ is constructed in the following way:

- $\tilde{F}_t$ are extracted from the entire standardized data set by principal components and thus the eigenvalue problem on the sample covariance matrix $\Sigma_X = XX'$ is solved.

- $\bar{F}_t$ is extracted equivalent to $\tilde{F}_t$ but from the slow moving data subsample only.
- Then the regression $\tilde{F}_t = \alpha Y_t + \beta \bar{F}_t + u_t$ is run and $\hat{F}_t$ is computed as $\hat{F}_t = \tilde{F}_t - \hat{\alpha} Y_t$ in order to remove the influence of Y_t on $\hat{F}_t$.
- In a final step, the VAR of equation (4.1) is estimated by multivariate OLS where F_t is replaced by $\hat{F}_t$.

4.4) Data and Descriptive Statistics

The data set X_t consists of 74 monthly time series ranging from 1991:12 to 2007:12 and is built to model the dynamics of the German economy. However, since some series are not available on a monthly basis (such as GDP), important information might be missing. In the following, the data are introduced in more detail.

4.4.1) Production, productivity and wages: Industrial production, specifically the production index published by the German statistical agency (Statistische Bundesamt), is used as a proxy for GDP. This index (PROD_PROD) measures industrial production on a real basis for the entire manufacturing sector[6]. There are also production indices for five sub-sectors (main industrial groupings, MIGS) which are defined by the European Commission (regulation 656/2007[7]). These are indices for the capital goods sector (PROD_CAP), durables (PROD_DUR), energy (PROD_ENERG), intermediate-goods (PROD_INTER) and the non-durables sector (PROD_NONDUR). Additionally, an index for the construction sector (PROD_CONSTR), an index of the real gross hourly wage of workers in the processing[8] and construction sector (REALGRWAGE) and an index of output per working hour in the processing and construction sector (PRODUCTIVITYH) are used. All series are seasonally adjusted, based on the year 2005, denominated in constant 2005-prices and are presented in Figure 4.1.

4.4.2) Sales and orders: The sales indices (SAL_*) are based on the main industrial groupings. The indices for new orders (ORD_*) are based on MIGS as well, except that an index for the energy sector is not available. Instead, there exists an index of orders in the construction sector which does not exist for sales. All series are based on seasonally adjusted constant 2005-prices with

[6] manufacturing sector = produzierendes Gewerbe as defined in Statistisches Bundesamt (2012)
[7] see http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:155:0003:0006:EN:PDF
[8] processing sector = verarbeitendes Gewerbe as defined in Statistisches Bundesamt (2012)

2005 as the base year, and are presented in Figure 4.2. The development of these series is very similar to those of the production indices. The extreme increase in new orders for durable consumption goods in October 2007 seems to be a special outlier. Both sales and new orders for non-durable consumption goods strongly increased beginning in 2004.

4.4.3) Stock prices and exchange rates: These series are presented in Figure 4.3. All indices are expressed as price indices and for reasons of increased comparability are based on the year 2005 except the German index, which is based on 1987. Exchange rates are expressed as the value of 1 unit of foreign currency in Euro (indirect quotation). Prior to 1999 exchange rates in DM are converted into Euro using the €/DM exchange rate at which Germany joined the EMU. As expected the stock prices clearly reflect the dot-com and the subprime bubble bull markets.

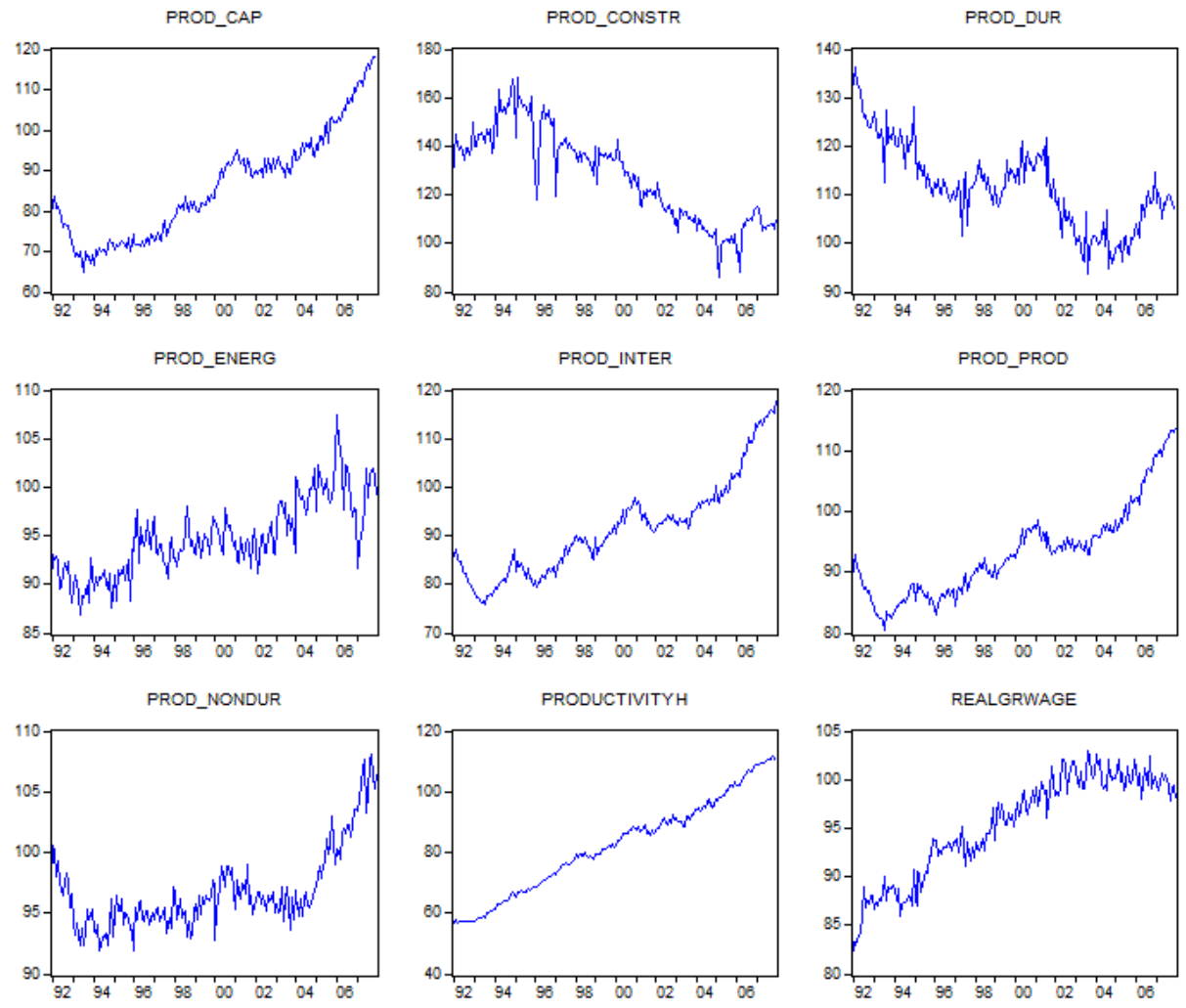

Figure 4.1: Production

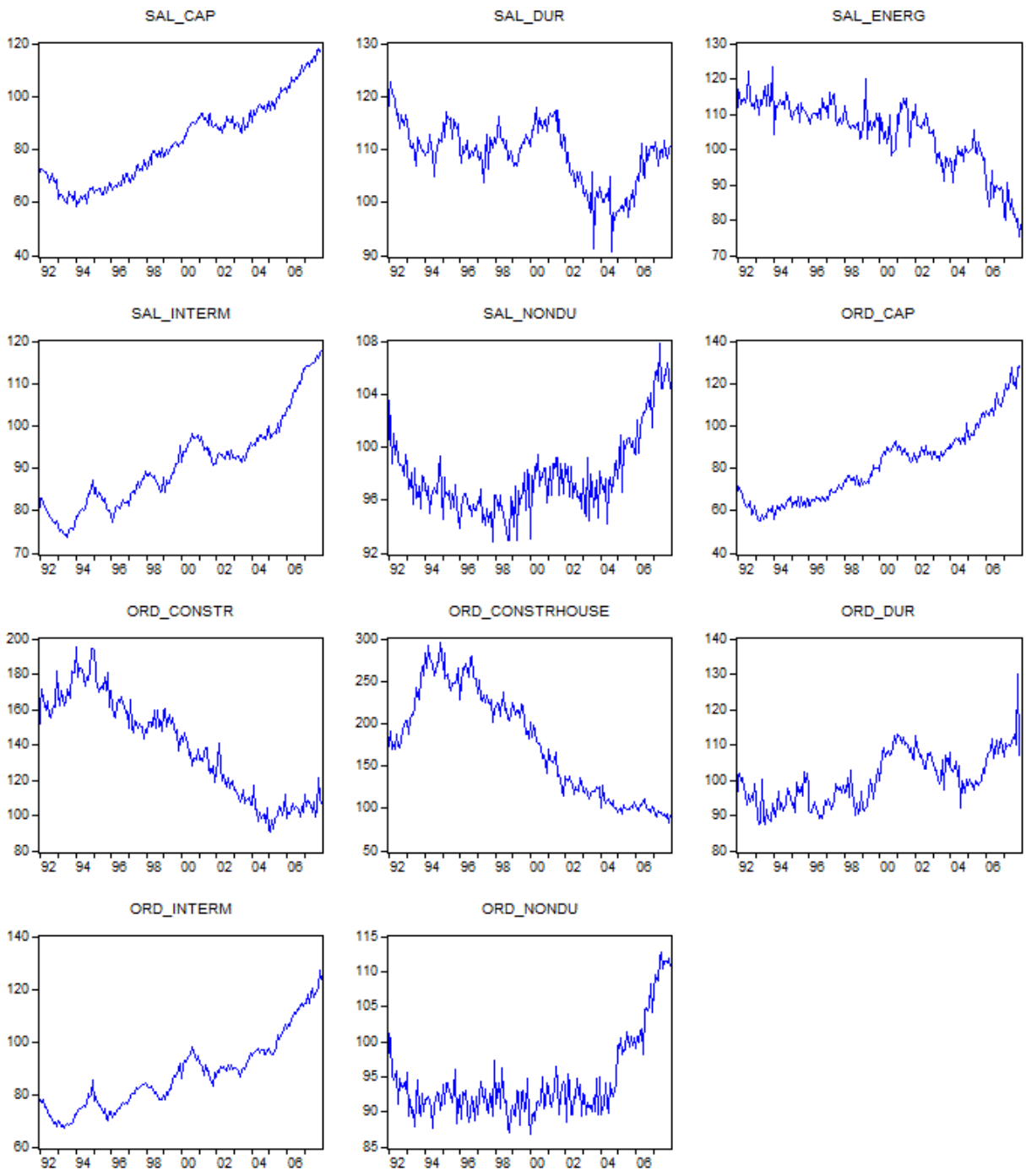

Figure 4.2: Sales and new orders

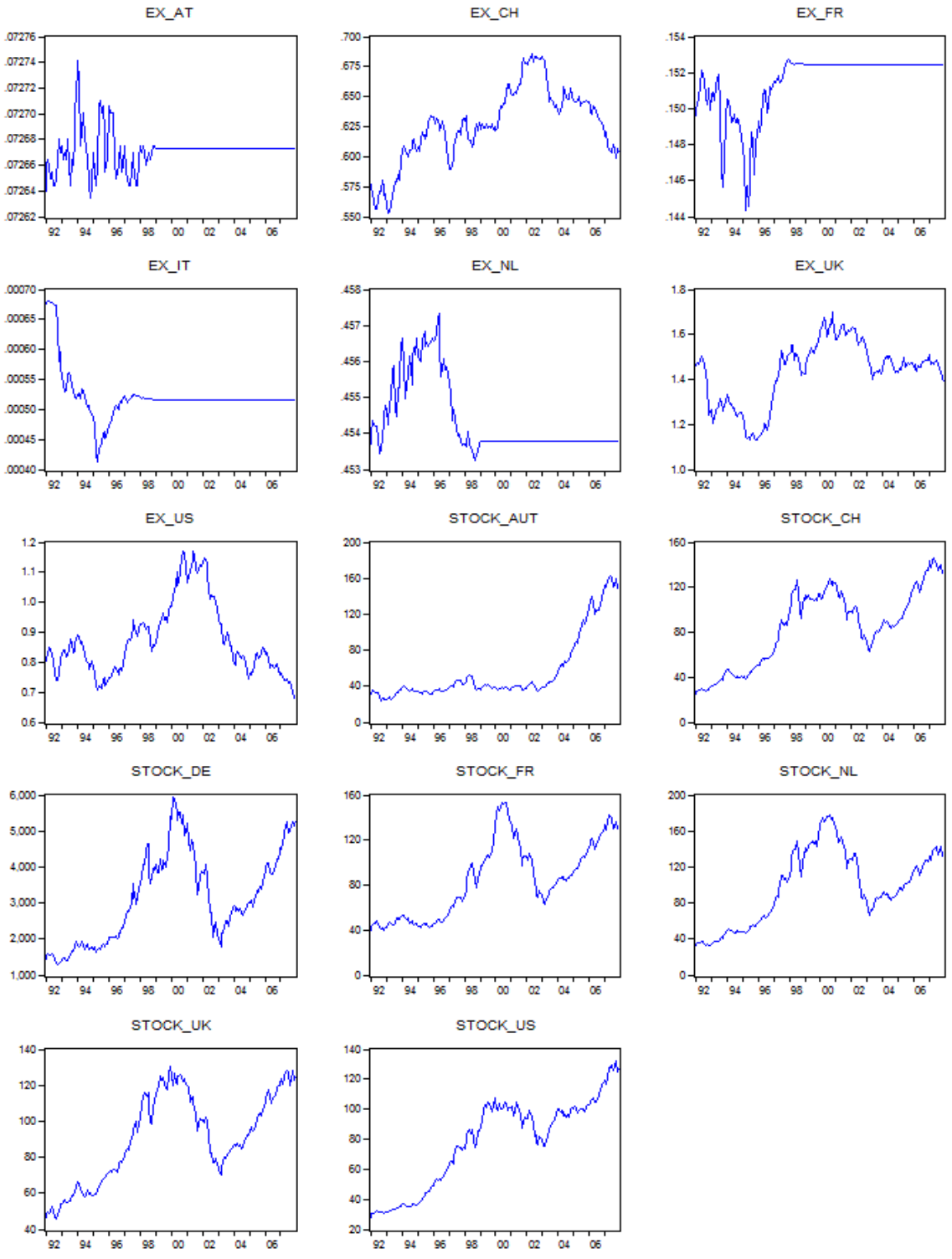

Figure 4.3: Exchange rates and stock price indices

4.4.4) Banking sector aggregates: The banking sector is modeled using 12 series published by the German central bank. Seven series belong to the asset side of the aggregate balance sheet of banks in Germany[9]. These are lending to domestic and foreign banks (LENDBANK), lending to domestic and foreign non-banks (LENDNONBA), participating interests (PARTINTEREST) and cash in hand and credit balances with central banks (CASHBANK). LENDBANK contains balances and loans as well as securities issued by banks (SECBANK). From LENDNOBA, two more detailed sub-series are used. SECNOBA contains the securities issued by non-banks and MLLOANDEH contains medium and long-term loans to domestic enterprises and households. BANKTOTAL represents the balance sheet total of banks in Germany. Four series model the liabilities side: Deposits and borrowing from domestic and foreign banks including the central bank (DEPBANK), deposits and borrowing from domestic and foreign non-banks (DEPNOBA), bearer debt securities outstanding issued by banks (BONDBANK) and finally capital including published reserves, participation rights capital and funds for general banking risks (CAPBANK). These series represent more than 90% of the aggregate assets as well as aggregate liabilities of the German banking sector throughout most of the sample period as presented in Figure 4.4 which plots LENDBANK, LENDNOBA, PARTINTEREST and CASHBANK (assets) and DEPBANK, DEPNOBA, BONDBANK and CAPBANK (liabilities) as a share of balance sheet total (BANKTOTAL). All series are deflated using the producer price index of 2005. The structure of these series is presented in Table 4.1 and the evolution over time relative to the aggregate balance sheet total in billion Euros in Figure 4.5. The graphs show three important developments in the German banking sector.

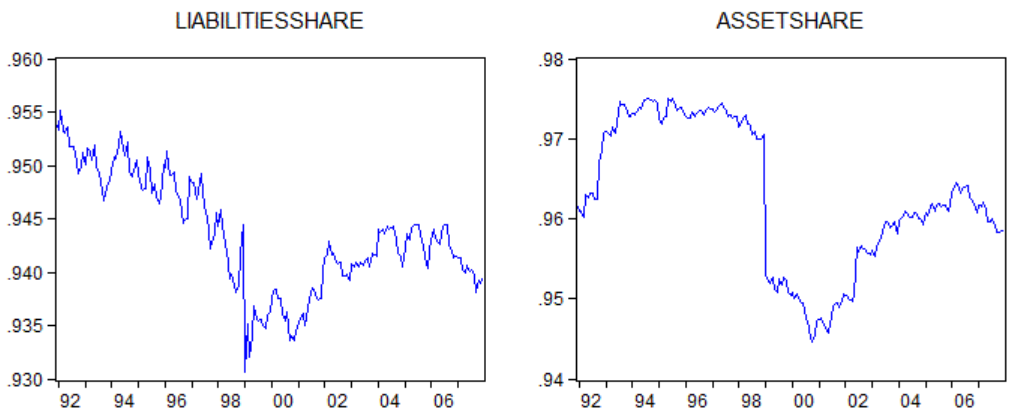

Figure 4.4: Used assets/liabilities as share of balance sheet total

[9] For a definition of banks in Germany see Bundesbank 2012 p. 28

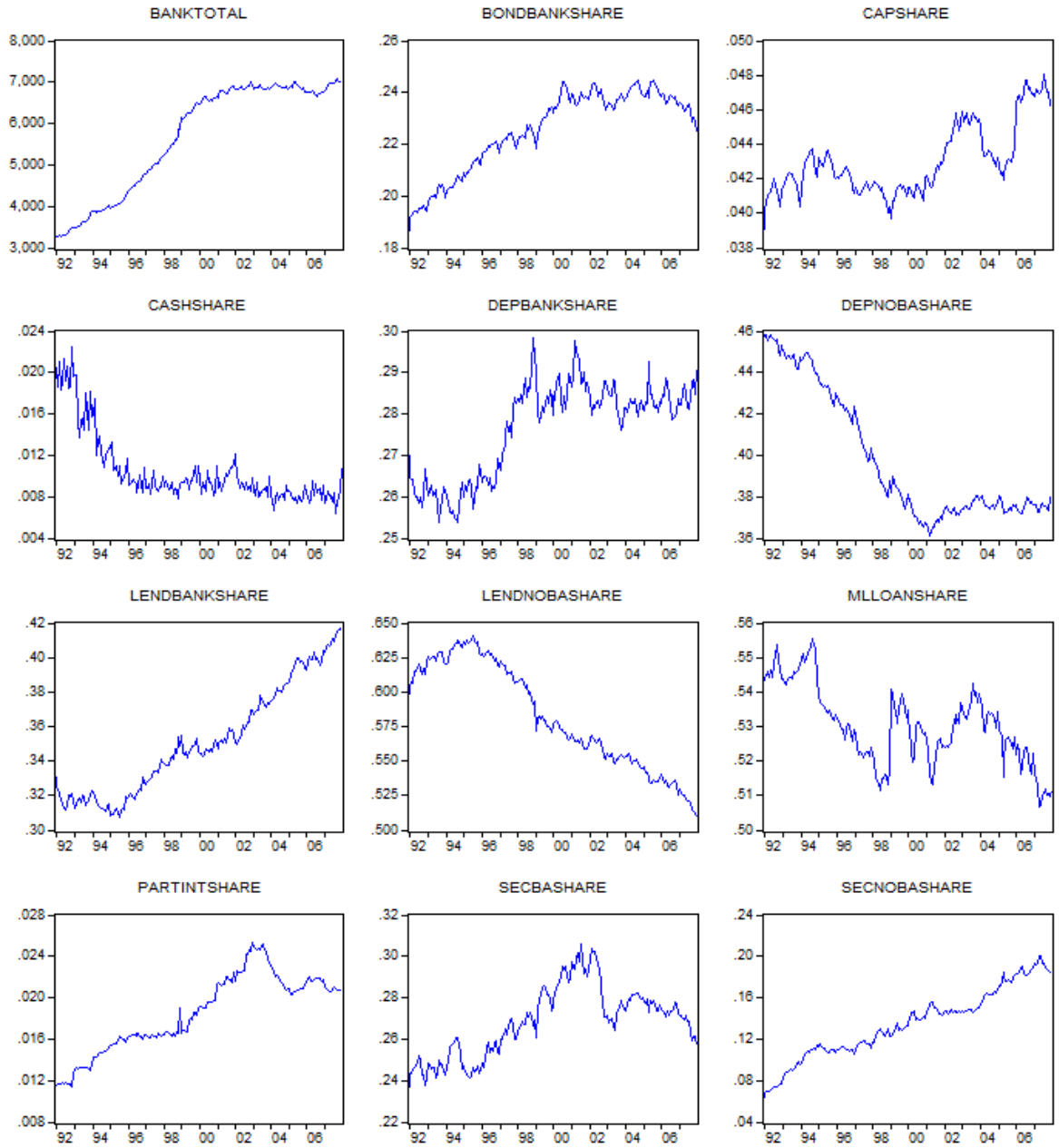

Figure 4.5: German banking sector

First, banking activities, measured by the balance sheet total, increased strongly in the first ten years of the sample. Second, this expansion in activity was financed by increasing relatively security issues (BONDBANKSHARE) and at the same time relatively reducing deposits and borrowing from non-banks (DEPNOBASHARE), while the capital held remained fairly constant

(CAPSHARE). Third, banks used their additional funds to increase lending to the banking sector itself (LENDBANKSHARE) by buying the newly issued securities (SECBASHARE). Lending to non-banks decreased (LENDNOBASHARE) relative to the balance total while at the same time securities became more important in non-bank lending (SECNOBASHARE) and traditional loans decreased (MLLOANSHARE). This indicates that financial assets and the related markets became more important while traditional loans became less important in German banking. All series have been deflated with the general producer price index based on 2005 prices (PRICE_PPI) which is introduced in the next section.

Assets	Liabilities
LENDBANK of which	DEPBANK
SECBANK	DEPNOBA
LENDNOBA of which	BONDBANK
SECNOBA	CAPBANK
MLLOANDEH	**BANKTOTAL**
PARTINTEREST	
CASHBANK	
BANKTOTAL	

Table 4.1: Structure of banking sector series

4.4.5) Price indices and trade: All indices in this category have 2005 as the base year. There is a general consumer price index (PRICE_CPI), a consumer price index for food (PRICE_CONSFOOD) and one for energy (PRICE_ENERG) as well as a general producer price index (PRICE_PPI) which was used to deflate various other series. Additionally a producer price index for petroleum products (PRICE_OIL) is used. German trade is represented by total net exports in 2005 prices and denominated in billion Euros (TRADE_NX), a unit labor cost index for the manufacturing sector deflated with the 2005 CPI (TRADE_COMP), a general import price index (TRADE_IMPPRICE) and one for raw materials (TRADE_IMPPRAW) as well as an import price index for petroleum products (TRADE_IMPPOIL). The series are presented in Figure 4.6. Most importantly, the prices of raw materials increased much faster than the average CPI or PPI over the sample period while at the same time Germany steadily increased its trade surplus.

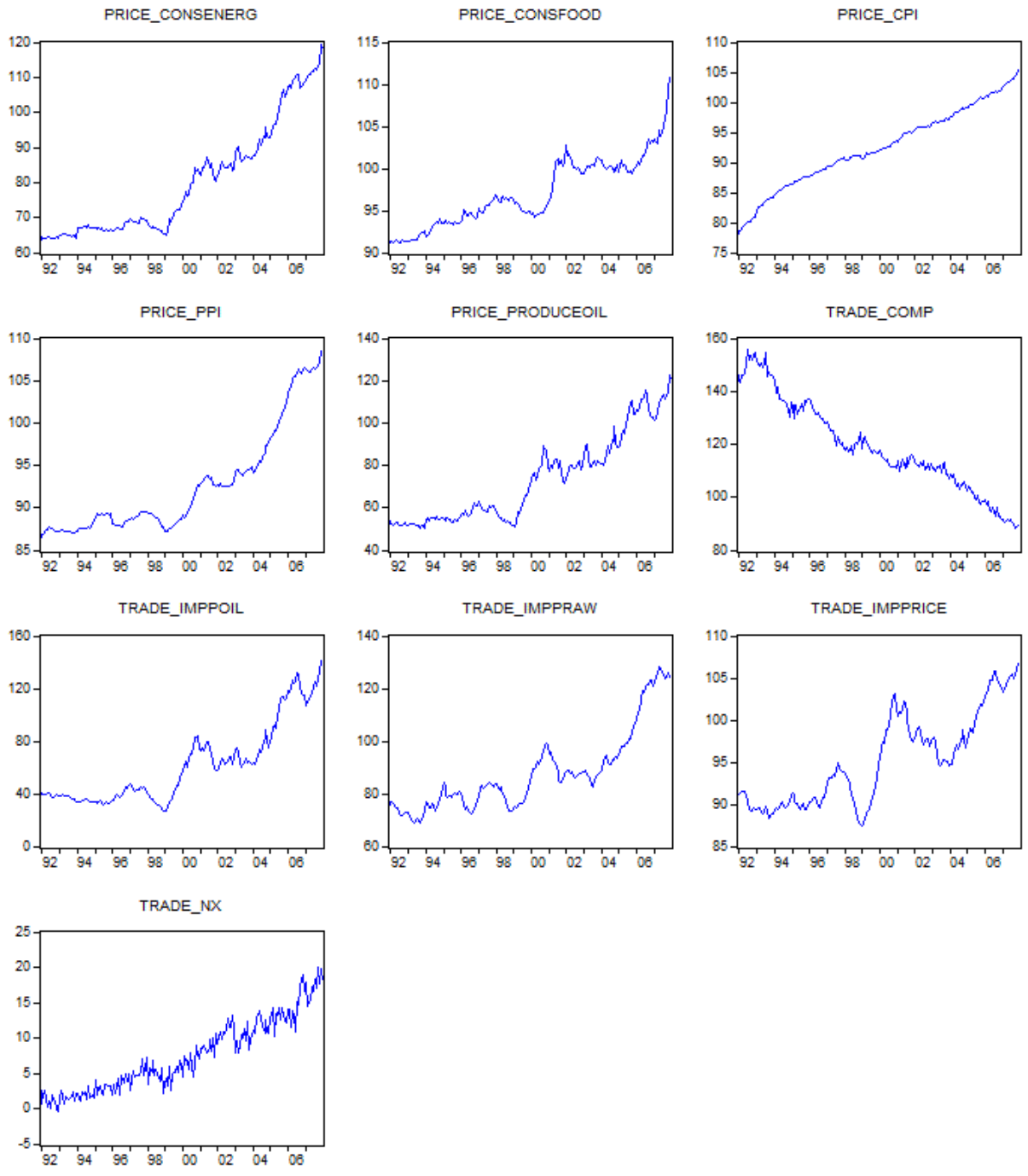

Figure 4.6: Prices and German trade

4.4.6) Labor market: The German labor market is characterized by four time series. First, the number of people in paid work (PEOPLEPAID). Second, the number of unemployed people according to the national definition (§ 16 SGB III) (UNEMPLOYED). Third, the unemployment rate

defined as unemployed people in relation to the number of people employed (UNEMPLRATE) and fourth, the number of people working short-time (SHORTTIMEWORK). All series are seasonally adjusted and, except for the unemployment rate, the unit of measurement is one-thousand people (see Figure 4.7). Not surprisingly, the number of working people steadily increased throughout the sample except shortly after the early 2000s when the unemployment rate increased and the number of people in paid work decreased.

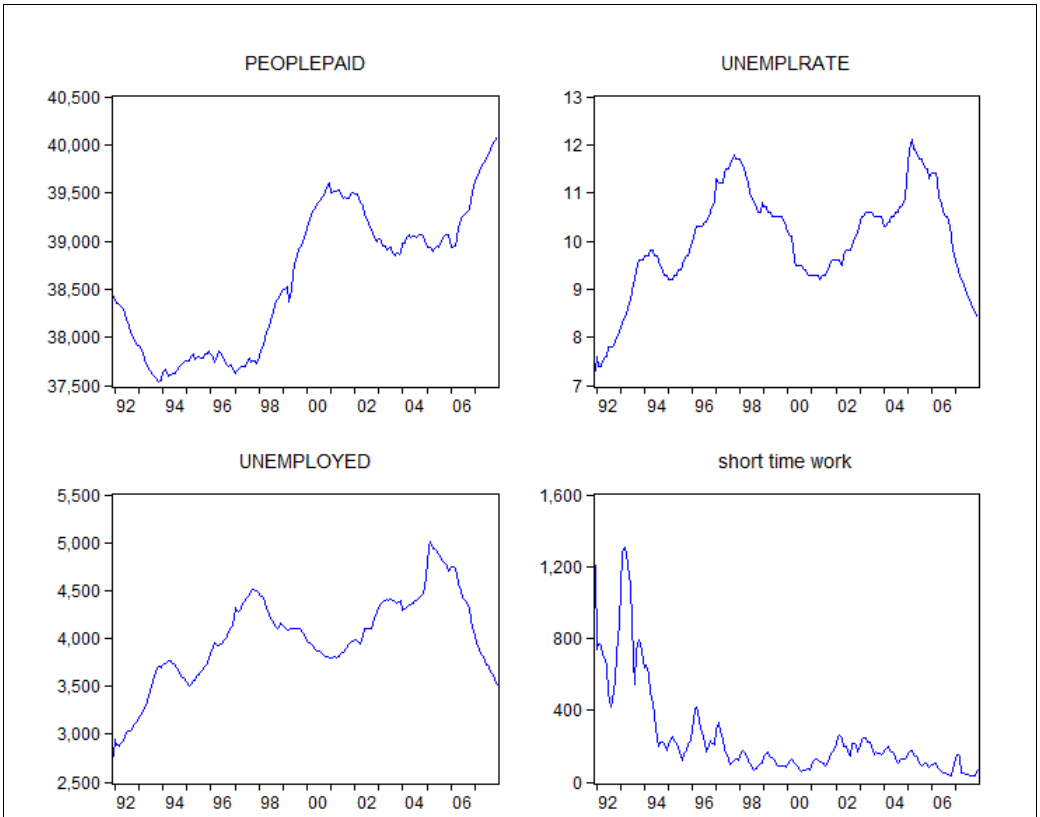

Figure 4.7: German labor market

4.4.7) Capital and money markets: The German money market is represented by four interest rate series reported by major Frankfurt banks and published by the Bundesbank. These series (FRANKFURT*) are short run interest rates from 1 up to 12 months. Capital markets are represented by series on the yield of outstanding debt securities of different issuers: governments (YIELDPUBLIC), firms (YIELDCORPORATE) and banks (YIELDBANK). These series are presented in percentage points in Figure 4.8. Additionally, net sales (gross sales less redemptions) of bank (BANKSECSALE) and public debt securities (PUBSECSALE) are reported as

well as net sales of corporate bonds (CORPBONDSALE). Finally, the net increase/net decrease of shares in circulation issued by residents (CHANGESHARE) and the sales of mutual funds shares in Germany (SALESMUTUAL) are reported. These last five series are denominated in million Euros

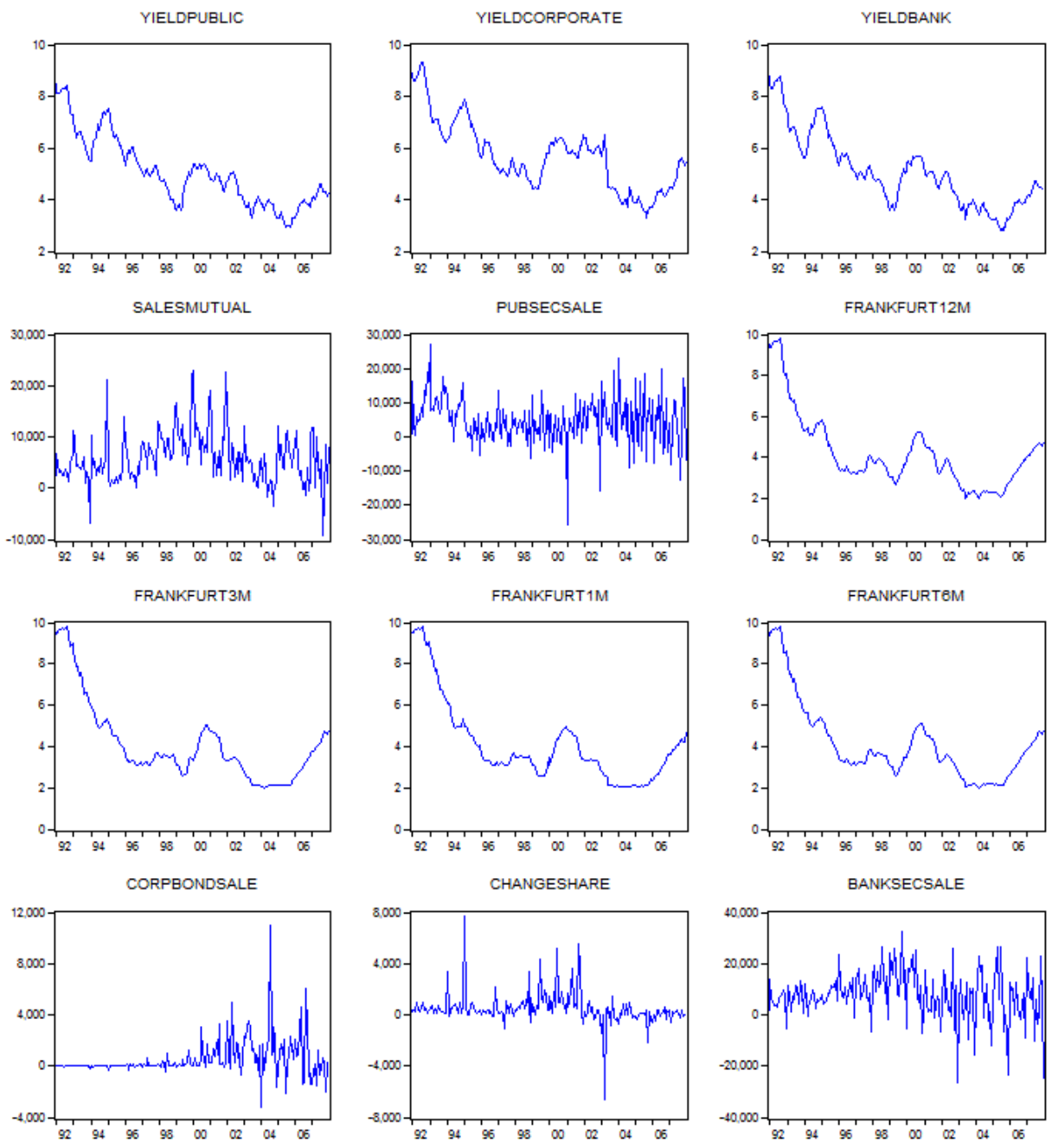

Figure 4.8: Capital and money markets

and are deflated with the general 2005 based producer price index (PRICE_PPI). The Frankfurt money market interest rates as well as the yield of the various outstanding debt obligations behaved in a similar way: They decreased from the beginning of the sample period and took off before the dot-com and the recent financial crisis.

4.4.8) Expectations: Expectations of firms about future economic developments are captured by the according seasonally adjusted indices based on the year 2005 published by the Ifo institute in Munich. These are the current business situation index (IFO_CURRENT), the business outlook index (IFO_EXP) and the business climate index (IFO_CLIMATE) which is the mean of the former two. They are presented in Figure 4.9.

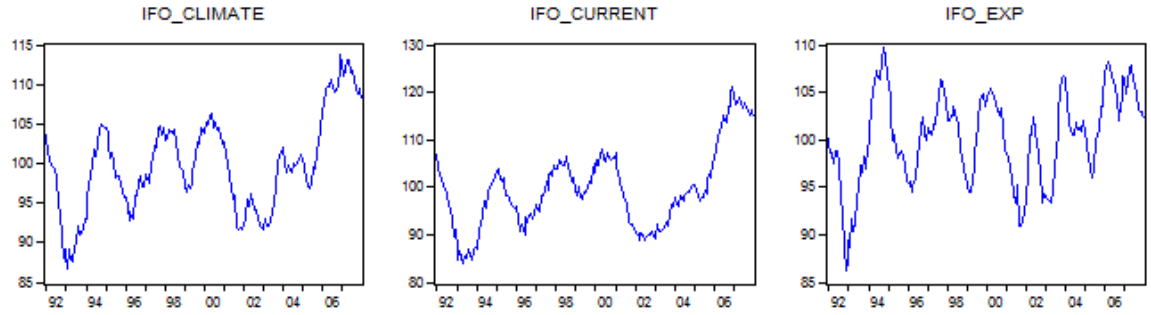

Figure 4.9: Ifo indices

5) Estimation Results

Prior to estimation the series were transformed such that they fulfill the requirement of stationarity as indicated by standard augmented Dickey-Fuller tests. The transformation of each individual series is reported in Appendix 1. In order to estimate the model, the Matlab code of BBE, which is available on Jean Boivin's homepage[10], was used and adopted when necessary. This also allowed me to reproduce the results of BBE when needed.

5.1) Results from Baseline Model

The first specification uses a dataset consisting of 74 variables for factor extraction (X_t) and the one month interbank interest rate as a proxy for the Bundesbank respectively ECB interest rate (Y_t). In order to determine the lag order as well as the number of factors used in equation (4.1), I extracted up to ten factors from X_t and determined the lag order for each of these models based on the Schwarz information criterion. Then, the model including eight factors and one lag was chosen since the results were robust from one up to ten factors. For impulse response analysis, the system is shocked by a 100 basis points decrease in the one month Frankfurt interbank rate. The impulse response functions (IRFs) according to this shock are presented in standard deviation units of the transformed data and are displayed in figure (5.1), including 80% bootstrapped confidence intervals based on Kilian (1998). Figure (5.2) displays the IRFs without the confidence intervals.

The 100 basis points interest rate shock gradually fades out and after 48 periods the interest rate lies 0.17 standard deviations (corresponds to 33 basis points) below the mean or below the starting point. As a result, the monthly growth rate of the industrial production index stays 0.037 percentage points above its initial value. This seems small but one has to keep in mind that an average monthly growth rate of 0.17% corresponds to an annual growth rate of 2%. Unemployment growth is 0.045 percentage points below its starting value. These responses indicate that interest rate changes do have long lasting real effects. Nevertheless, it is important to note that the numerical interpretation of these results might be troubling. Since most of the data (for details see Appendix 1) is used in standardized logarithmic differences, the IRFs displayed in Figures (5.1) and (5.2) are denoted as deviations from mean growth rates in

[10] See: http://neumann.hec.ca/pages/jean.boivin/ [18.02.2013]

standard deviation units. This poses several problems. First, the standardization of the data prior to estimation uses the arithmetic mean, which cannot be interpreted as an average growth rate because such an interpretation would require the geometric mean. It also remains unclear if the results are sensitive to these kind of transformations. Given these problems, it is not surprising that BBE do not interpret their results in any numerical way but only refer to their IRFs as being denominated in standard deviation units (BBE 2005: 405) and discuss them qualitatively. I will follow their approach and discuss the results mainly qualitatively.

The Euro-Dollar as well as the Euro-Pound exchange rates increase whereas the interest rate shock has a much stronger effect on the Pound compared to the Dollar exchange rate. The fact that both rates are increasing contradicts standard theory, in particular the uncovered interest parity hypothesis which states that interest rate differentials should be eliminated by exchange rate movements. Nevertheless, since the exchange rate channel of monetary policy is not of primary interest here and because there are good arguments why the uncovered interest parity condition likely fails in reality, these results are not considered problematic. The Bundesbank (Bundesbank 2005: 27-42) argues that the empirical evidence in favor of the uncovered interest rate parity hypothesis is at best weak and bubbles and speculative carry trades among others are potential sources for deviations from it.

The decrease in the real wage rate does not fit together with the increase in industrial production and the reduction of unemployment at first sight. Even though from a Post Keynesian perspective one would expect the real wage to increase, one has to keep in mind the drastic labor market reforms which were implemented beginning in the 1990s in Germany. However, falling wages and increasing output growth are not only in line with standard neoclassical reasoning but also fit to an alternative explanation of the German growth model. After the introduction of the Euro, growth was mainly driven by current account surpluses due to increasing price competitiveness (see TRADE_COMP[11] Figure 4.6) thanks to moderate wage increases. This argument is also in line with increasing net exports.

The response of the banking sector series is puzzling. First of all, the balance sheet total of German banks declines and after 48 periods is still below its initial value. On the asset side of the aggregate banking sector balance sheet, lending to non banks (≙ LENDNOBASHARE) decreases

[11] Since TRADE_COMP is a series of unit labor costs, a decrease is equivalent to an increase in competitiveness.

as well as participating interests (≙ PARTINTSHARE). In contrast, lending to banks (≙ LENDBANKSHARE) and cash holdings (≙ CASHSHARE) increase relative to the balance total. These results suggest that despite an output expansion, banks cut their lending to non-banks, while increasing bank lending and cash holdings relative to the balance total. Accordingly, on the liabilities' side, borrowing from banks (≙ DEPBANKSHARE) increases as well as borrowing from non banks (≙ DEPNOBASHARE), while outstanding bonds (≙ BONDBANKSHARE) and capital (≙ CAPSHARE) decrease, again relative to the balance total. This indicates that inter-banking-sector finance relationships become more important while non-financial firms cut back on bank lending and at the same time increase their receivables towards the banking sector. So non-banks

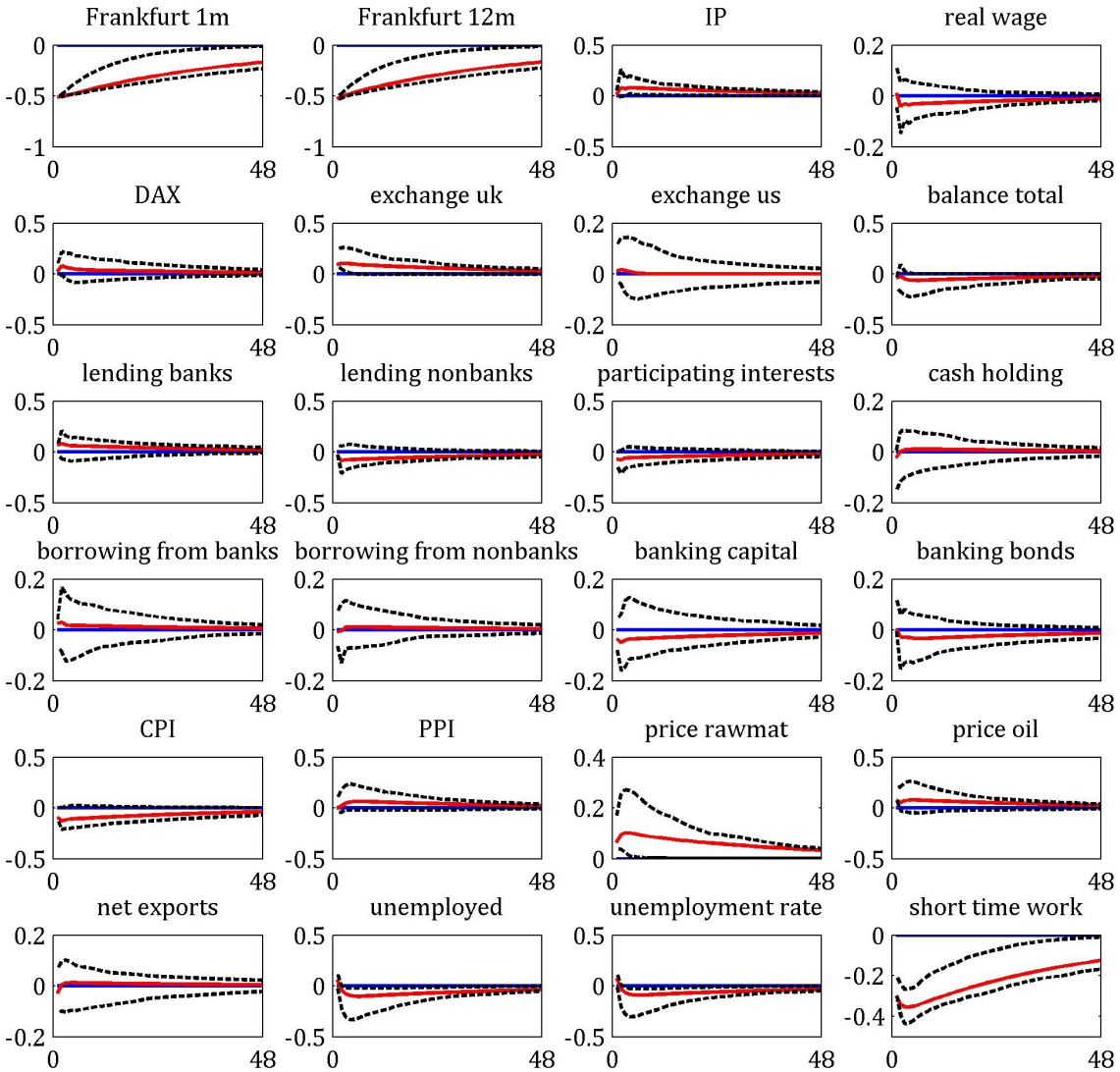

Figure 5.1: Baseline scenario, including 80% confidence intervals

increase the use of internal funds for financing production. Even if unexpected, this interpretation is backed by the long term development of the German banking sector. The Bundesbank reports that especially in the boom phase between the new-economy bubble and the recent financial crisis where interest rates were low, firms became net-savers (Bundesbank 2012:18). Nevertheless, since this report also shows the important structural changes in corporate financing the corresponding IRFs might not be interpreted strictly causally, since it is not unlikely that they are driven by these structural forces which for their part are not necessarily driven by changes of the interest rate.

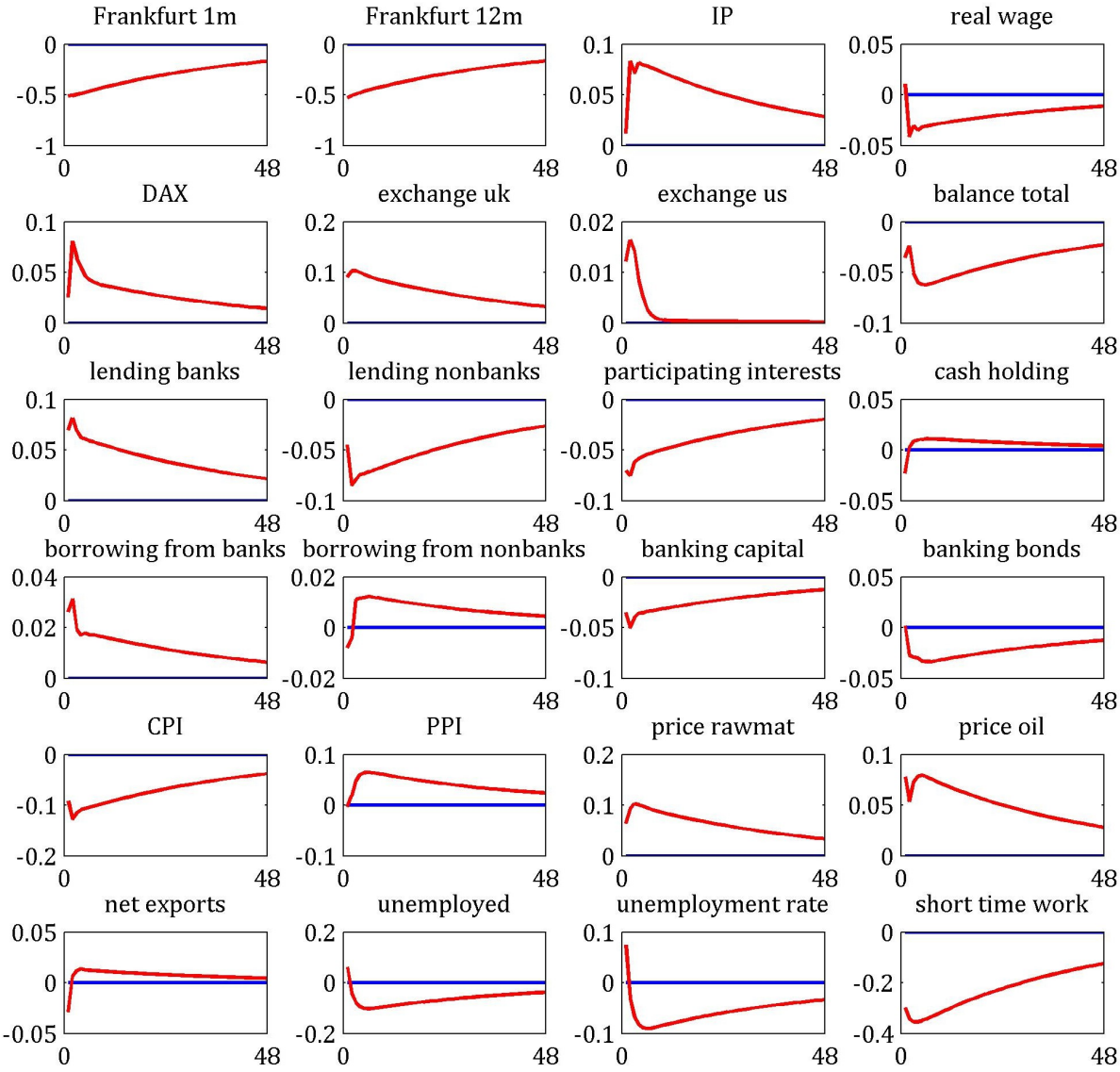

Figure 5.2: Baseline scenario, without confidence intervals

Finally, the IRFs of the price indices remain to be discussed. Though insignificant, the response of the CPI indicates that inflation initially decreases and then returns to its original value. A deflationary process accompanied by an increase in industrial production does not seem plausible, however. One potential explanation of such a price puzzle is that the interest rate is mainly set in response to changes in the price level and thus is not an exogenous variable. If, additionally, the FAVAR model does not correctly capture signs of future inflation through the extracted factors, the result can be a positive relation between the price level and the interest rate since the model interprets preemptive interest rate policy as causing inflation. The very reason BBE introduced the FAVAR approach was to tackle this problem by including more information. However, it seems that the sample period also plays an important role: Figure 5.3 displays the impulse response functions of the consumer price index to a 0.25% interest rate decrease from the original specification of BBE (three factors, 13 lags) on the left and thus using US data ranging from 1959:01 to 2001:08. The graph in the middle displays the response after changing the sample period to 1981:09 – 2001:08 and the graph on the right is based on the sample period 1990:10 – 2001:08. So one can clearly see that cutting the sample period leads to increasingly implausible IRFs. Unfortunately, the driving force behind these results remains unclear. Shorter samples beginning in the 80s or 90s might exclude many of the high inflation observations due to oil price shocks in the 70s and the beginning 80s. On the other hand my IRFs of the remaining price indices are in line with the results in the literature and economic theory. The producer price index, for example, increases which can be driven by rising input prices. As in BBE, the raw materials and oil price indices increase after the interest rate shock. So given these results, the

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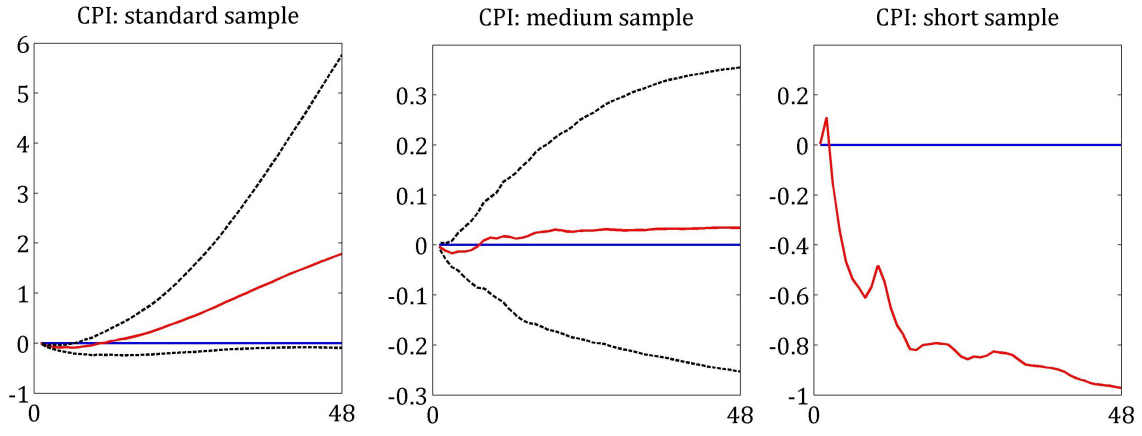

Figure 5.3: CPI impulse responses of BBE with different sample periods.

Next, the robustness to changes in factor extraction is studied. The results just reported are based on interest rate dependence removed factors $\hat{F}_t$ as described in chapter 3. If the initial factors $\tilde{F}_t$ are used instead, qualitatively nothing really changes especially in the results after 48 periods. The only difference is that the hikes of the IRFs in the first and second period become more pronounced when using the initial factors. Similar to BBE, using the initial factors does not qualitatively change the results. This leads to two possible interpretations: Either the procedure described in chapter 3 was not successful in eliminating the dependence of the initial factors on the interest rate, or this dependence is only of limited relevance for analyzing exogenous interest rate shocks. Table 5.1 shows that the procedure is successful for 7 out of 8 factors: the absolute value of the correlation coefficient between the factors and the Frankfurt 1 month interbank rate is reduced for 7 factors. Even though for factor 8 the correlation in absolute value increases, the results indicate that the procedure is successful, since correlation is limited well below 0.2 in absolute values whereas before the transformation three factors closely moved together with the interest rate as indicated by their correlation coefficients between -0.38 and -0.57. Following these numbers, removing the interest rate dependence from the initial factors is not relevant for studying interest rate shocks, at least over longer horizons. Since short run dynamics are not the focus of this work and results are interpreted mainly qualitatively, the influence of varying slow and fast moving variable definitions can be ignored for now.

	factor 1	factor 2	factor 3	factor 4	factor 5	factor 6	factor 7	factor 8
initial	-0.38	0.23	-0.38	-0.21	-0.57	-0.29	0.31	-0.07
dep. removed	-0.16	0.11	-0.13	0.12	-0.09	0.14	-0.15	-0.18

Table 5.1: Correlation coefficient of factors and Frankfurt 1m

5.2) The Endogenous Effect of Monetary Policy

In a next step, I will attempt to capture the endogenous effect of monetary policy. As already pointed out, the shock studied in the previous section is interpreted as an exogenous shock. However, if one is interested in the effect of a change in monetary policy such as the ECB switching to a more expansionary interest rate policy, then an exogenous shock would not be

appropriate to study this scenario. The reason is that an exogenous shock is defined as an interest rate change which occurs independently of the variables present in the VAR system. Christiano et al. (1999), for example, argue that exogenous policy shocks can be interpreted as changes to the preferences of central bank board members, the result of strategic considerations of the board members or as the result of measurement error and data revision. So in all three cases, the monetary policy strategy, such as how much weight to put on fighting inflation on the one hand and how much on stimulating output on the other, are unchanged. This section aims to assess the effect of such fundamental changes. In particular, the goal is to get an idea about the effect of switching to a more expansionary policy. This task will be tackled along the lines of the following thought experiment: Given the economy is in an equilibrium, the ECB lowers short term interest rates in order to stimulate output but keeps interest rates down more persistently as it did in the past. So basically, I will compare two scenarios: In the baseline scenario the ECB cuts short term interest rates and afterwards slowly increases them back to the initial level (this is the scenario and IRF from last section). In the expansionary scenario, the ECB cuts interest rates too, but will bring them back slower to its initial level. Comparing the outcome of these two scenarios provides an idea about the endogenous effect of monetary policy beyond random exogenous shocks.

In order to perform this experiment and to compute the outcome of the expansionary scenario, the coefficients of the equation with the Frankfurt one month interbank rate as the dependent variable in the system (4.1) are changed. This approach is similar to Sims & Zha (1998), where the authors do not allow any reaction of the interest rate on output in a simple VAR framework and thus demonstrate the endogenous monetary policy component. To see how the expansionary scenario is constructed, suppose (4.1) is rewritten in the following form:

$$(5.1) \qquad [F' \;\; Y'] = W\hat{\beta} + v$$

where F' is the TxK matrix of factors $\hat{F}$, Y' is the Tx1 vector of the interest rate proxy, W is a Tx(K+1)p+1 matrix consisting of a first column of 1s and then the lagged values of the factors and the interest rate, $\hat{\beta}$ is a (K+1)p+1x(K+1) matrix of coefficients and finally v is the Tx1 vector of error terms. So given this setting the interest rate "reaction function" is given by the following equation:

$$(5.2) \quad Y_t = c_0 + \beta_1 F_{1t-1} + \ldots + \beta_K F_{Kt-1} + \beta_{K+1} Y_{t-1} + \beta_{K+2} F_{1t-2} + \ldots + \beta_{(K+1)p+1} Y_{t-p} + v_t$$

where Y_t is interpreted as a single observation of the interest rate proxy at time t. So in order to change the reaction function of the central bank, all coefficients of the last column of $\hat{\beta}$ need to be changed except every $(K+1)^{th}$. Unfortunately, since the factors have no interpretation, it is a priori unclear which elements of the last column of $\hat{\beta}$ should be manipulated and how. This problem is solved by comparing the results of multiplying all of them first by 0.5 and then by 2. It turns out that choosing 0.5 yields a slower increase of the interest rate after the 1% shock and thus this specification was used for the results reported next.

Figure 5.5 shows the IRF of the Frankfurt one month interbank rate in the baseline (black line) as well as in the expansionary (gray-dotted line) scenario. Under the more expansionary monetary policy regime, the interest rate increases slower, especially beginning 5 periods after the shock and lies 0.21 standard deviations (i.e. 41 basis points) below its mean after 48 periods compared to 0.17 standard deviation (i.e. 33 basis points) in the baseline scenario. Thus multiplying the relevant coefficients in equation (4.1) by 0.5 yields an expansionary monetary policy scenario. Figure 5.6 compares the IRFs of the industrial production index (PROD_PROD) as well as unemployment (UNEMPLOYED) for the baseline and the expansionary scenario. In the former case, industrial production growth is 0.047 percentage points above its mean after 48 periods compared to 0.037 in the baseline scenario. Thus, bringing the interest rate back to its initial value slower increases the industrial production growth rate by 27%. Unemployment lies 0.056 percentage points below its mean after 48 periods in the expansionary scenario compared to 0.045 in the baseline case. Both time series indicate that expansionary monetary policy can have substantial effects on real variables. In both cases, the initial effect is amplified by approximately 25% due to the more expansionary monetary policy. Unfortunately, it is not possible to study the policy reaction function in more detail because of the missing interpretation of the factors. Since the expansionary reaction function was derived by manipulating the coefficient on all factors by the same amount, it is likely that there are counteracting effects at work, but in the end the expansionary outcome dominates. Thus, the approach used here is rather approximate and only allows one to observe the overall effect but does not yield any insight into which specific economic forces, represented through the factors, are the most important mechanisms behind the

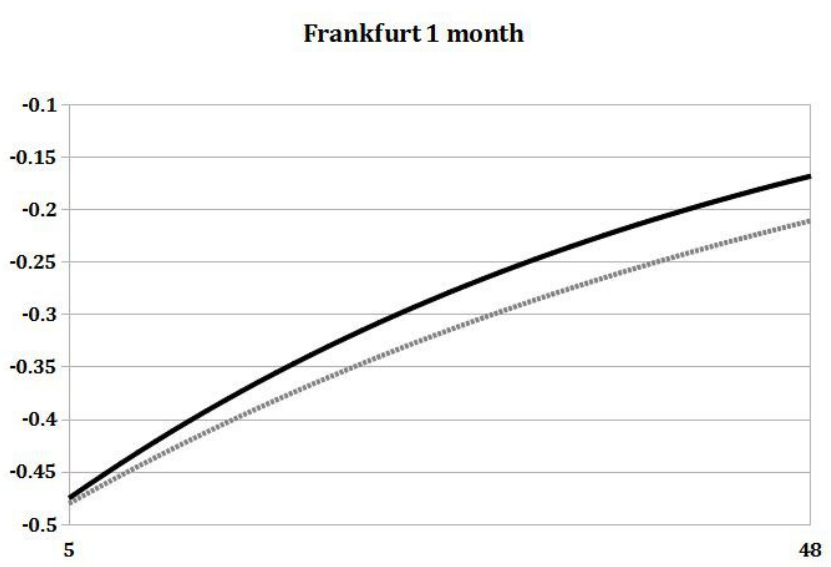

Figure 5.5: Comparison of the IRF of Frankfurt 1m in the baseline (black line) and the expansionary scenario (gray-dotted line).

expansionary outcome. Even though this would be interesting to know, the results so far indicate that allowing for an expansionary policy reaction function stimulates real variables. Before comparing these results with those reported in the literature, it is important to note that the approach of this section is vulnerable to the Lucas critique. Changing the policy reaction function would probably lead households and firms to adjust their behavior and thus the remaining model, describing the dynamics of the other variables in response to the interest rate shock,

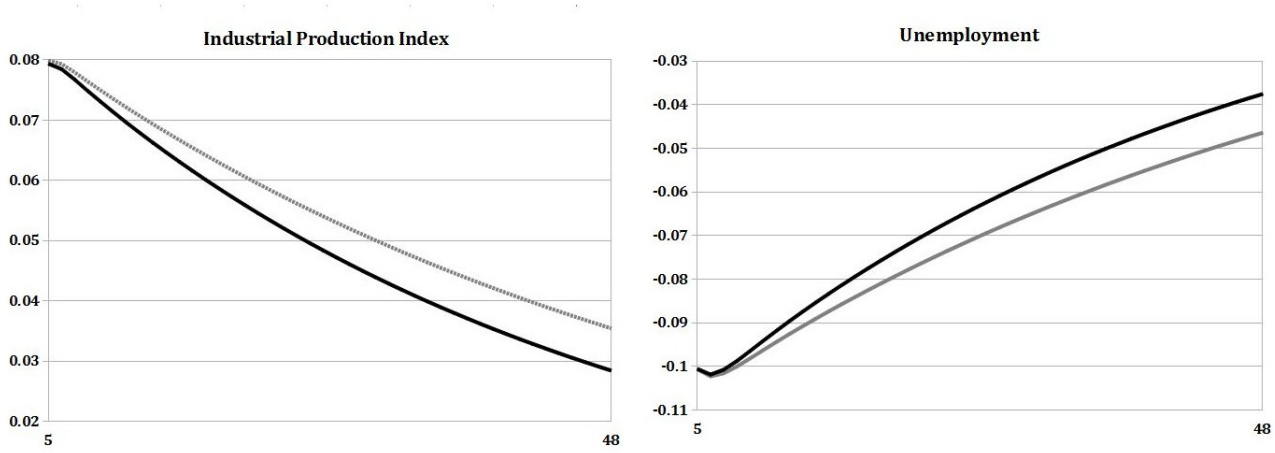

Figure 5.6: Comparing the IRFs in the baseline (black line) and the expansionary scenario (gray line).

would be inappropriate. Nevertheless, there are good arguments to proceed. First, using a model which fully accounts for the adjustments of the private sector would rely on the unrealistic assumption that the policy change is immediately understood by the public and the private sector does not doubt its permanent character (Sims/Zha 1998: 34). Second, there is evidence that autoregressive frameworks are not sensitive to policy regime switches and thus the Lucas critique does not apply to them (Rudebusch 2005). Third, fully micro based approaches which explicitly model the maximization behavior of households and firms are highly stylized. As a result, the advantage of the VAR approach, that one does not need to impose a restrictive theoretical model, would be lost. Based on these arguments, it seems plausible to ignore the Lucas critique for this simple exercise.

5.3) Comparing the Results

There is a huge body of literature dealing with the effects of monetary policy on the economy. Early contributions focused on the question whether monetary policy is neutral in the long run and used cointegration tests to answer this question. Bullard (1999) provides a summary of this approach. In most cases, the results are in favor of long run neutrality; however, the majority of these studies use US or UK data and thus are not directly comparable to the results reported here. In addition, there exist some studies which reject the long run neutrality as reported in Bullard (1999) or for example Atesoglu/Emerson (2009). Coe/Nason (2004) finally argue that these tests suffer from low power and are uninformative.

In recent years, authors shifted towards other questions concerning the transmission mechanism of monetary policy or price stickiness, for example. Additionally, not only the research question, but also the methods changed. Early contributions used small bivariate models. In the mid-1990s, VARs and structural VARs became the standard technique to investigate monetary policy. With the contribution of BBE factor augmented VARs or pure factor models have become more and more important. The literature using VARs to study the effects of monetary policy is summarized by Christiano et al. (1999) and Leeper et al. (1996). The focus of these studies are exogenous shocks to the monetary policy instrument which, especially in the early contributions, was assumed to be some monetary aggregate and later was changed to be some short term interest rate. Especially, results obtained from structural VARs, and thus from models imposing prior restrictions based on economic theory on the econometric system, typically yield small long run

effects of monetary policy. Christiano et al. (1999), for example, report a reduction of approximately 0.2% in GDP 16 quarters after increasing the federal funds rate by about 0.7%. Leeper et al. (1996) argue that exogenous policy shocks are rather unimportant and instead the endogenous response of monetary policy to the state of the economy is the main source of changes in policy instruments. This is very similar to the arguments Sims developed in his lecture he gave in Stockholm when he received the Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel (Sims 2012) as well as to a paper by Bernanke, Gertler and Watson (1997). All of them argue that exogenous policy shocks have rather limited effects while systematic changes of monetary policy, and thus changes to the central bank reaction function, substantially affect the economy.

The so called "narrative approach" uses policy reports from central banks instead of statistical methods to identify monetary policy shocks. Authors following this approach seek to determine periods in which interest rates were changed significantly and the resulting reaction of the economy was due to these changes in monetary policy and not due to changes of other macroeconomic factors. Romer and Romer (1989) thus focus on interest rate increases by the US central bank in order to fight inflation. Christiano et al. (1999) compare their own approach with the one adopted by Romer and Romer as well as other authors using a narrative approach and report qualitatively similar but quantitatively very different results. Sixteen quarters after the initial shock which lead to an increase in the funds rate by approximately 0.8%, output was down by 1.2% in the case of the Romer & Romer approach.

Due to the interpretation problems with IRFs from standardized data, the discussion of results obtained from FAVAR models will be mainly based on qualitative grounds. Looking at the raw IRFs of BBE following a 100 basis points federal funds rate decrease (in their original paper BBE report cumulated responses) reveals that their results are similar to those reported in section 5.1: industrial production growth increases sharply in the first months following the shock and unemployment decreases. Commodity price inflation increases as well as consumer price inflation. So an important difference is that BBE do not report a price puzzle. Interestingly, the Yen exchange rate falls and since BBE define it in Yen per Dollar, it is equivalent with the increasing exchange rates in my example. Despite the price puzzle, the most important difference between the results of BBE and those reported above is that real variables react much stronger in

the first periods after the shock and return to their initial values quicker in the case of BBE. Boivin et al. (2008) report results for Germany based on a sample spanning from 1988-2007 but instead of logarithmic differences they use year on year growth rates. Following a 100 basis points increase in the ECB short term rate, GDP falls as well as exports and employment. Producer price inflation falls too whereas consumer price inflation increases. These results are similar to mine where following an expansionary monetary policy shock, CPI inflation decreases and PPI inflation increases. Given the symmetric nature of VAR results, these outcomes are in line with the price puzzle reported above and indicate that this is a specific "German" problem.

If one still wants to interpret the results numerically, a potential approach is to treat the demeaned data as deviations from some benchmark scenario and thus interpret the IRFs as growth rate deviations from that benchmark. Using this idea, the results reported in section 5.1 are compared to the results from the original BBE specification using an expansionary 100 basis points shock instead of a 25 basis points interest rate increase and to those obtained by Boivin et al. (2008) which study the effects of a 100 basis points shock on the German economy[12]. Deviations from the benchmark following a monetary policy shock are presented for industrial production in the case of BBE and my own results and for GDP in the case of Boivin et al. (2008) in Table 5.2. Probably due to the significant differences in sample sizes and potentially also due to differences in the monetary transmission mechanism between the US and Germany, the results from BBE and Boivin et al. (2008) differ substantially. While BBE report strong effects in the first year which are declining quickly, Boivin et al. (2008) find initially small but steadily increasing effects on the level of real activity. My own findings are pretty much in line with those from Boivin et al. (2008).

	1 year	2 years	3 years	4 years
BBE	2.20%	1.08%	0.43%	0.19%
Boivin et al. 2008	0.77%	1.70%	2.14%	
own	1.10%	2.04%	2.74%	3.27%

Table 5.2: Deviations of IP (BBE, own) and GDP (Boivin et al.) from baseline after monetary shock.

[12] Boivin et al. (2008) study a negative interest rate shock, but given the symmetry of VARs I just use their coefficients with a positive sign.

Given the results from the literature one can see that the effects of exogenous monetary policy shocks are reported to be small, except in the case of factor augmented VARs. However, it remains unclear whether this is just the result of much more intense data manipulation and the corresponding lack of clarity in outcome interpretation in the case of FAVARS[13]. On the other hand, those authors dealing with systematic changes of monetary policy report substantial effects on output and real variables. So despite the remaining problems, the results presented in section 5.1 are in line with existing FAVAR studies and even more importantly also support the finding of substantial effects of systematic changes to monetary policy.

[13] The VAR literature mainly uses logarithmic transformations only (Bernanke/Mihov 1997: 1037) whereas the FAVAR approach requires (logarithmic) differencing and standardization as well.

6) Conclusions

The results presented in chapter 5 indicate that there are permanent real effects of monetary policy. However, before one draws policy conclusions from these results, some important details about the econometric method need to be discussed. First, and potentially most importantly, is the fact that VAR models in general are not able to detect any long run effects or at least become more and more unreliable the longer the observation period of the IRF becomes. The reason is that given the stationarity of the system, any IRF converges to zero as the number of time periods for which the IRF is computed increases (Lütkepohl 2007: 25/53). So even if authors like BBE argue that their results are in line with long run monetary neutrality, it is not convincing since impulse responses come back to zero in any case given a stationary system. Additionally, one should be cautious in interpreting the results numerically because the specific transformation of the data has a substantial impact on the results. In the classical VAR and SVAR literature, it is common to use data in levels or log-levels and ignore any stationarity problems (Bernanke/Mihov 1997: 1037; Lütkepohl 2007: 376). As a result, monetary policy is discussed in level effects which are rather small and tend to fade out completely after 3 to 5 years, as reported in section 5.3. Thus, these papers argue that a small exogenous monetary policy shock has no effect on real variables like GDP, industrial production or unemployment 3-5 years after the shock. In contrast when data is used in logarithmic differences or growth rates, there are persistent level effects, which is the logical implication of temporary changes of the growth rate. Nevertheless, it should not be the case that specifying the model in levels or growth rates, while leaving the remaining structure widely unchanged, leads to strikingly different results.

Beside these fundamental problems in (FA)VAR analysis, there are also minor ones. First, the decision about the "correct" specification of the lag structure and the number of factors is often not based on solid grounds. BBE, for example, use 3 factors and 13 lags and justify their choice only by arguing that using 7 lags or either 5 or 7 factors does not change their results. This seems to be an ad hoc decision and leaves room for concerns whether alternative specifications were not reported because the results changed so dramatically. Indeed, using 6 instead of the 13 lags in the case of BBE results in a severe price puzzle as can be seen in Figure 6.1. Also, 9 factors instead of 3 lead to a decrease in the monetary base as well as in M2 compared to increases in the case of the original specification. This example reveals that it is necessary either to determine the lag and

factor structure of the model based on an objective statistical criterion or to report the counterintuitive results obtained from different specifications. However, if the model outcomes are highly sensitive to changes in the lag or factor specification, also results obtained from "objective" criteria are in question since it would be preferable to decide among competing specifications and results based on economic rather than statistical theory.

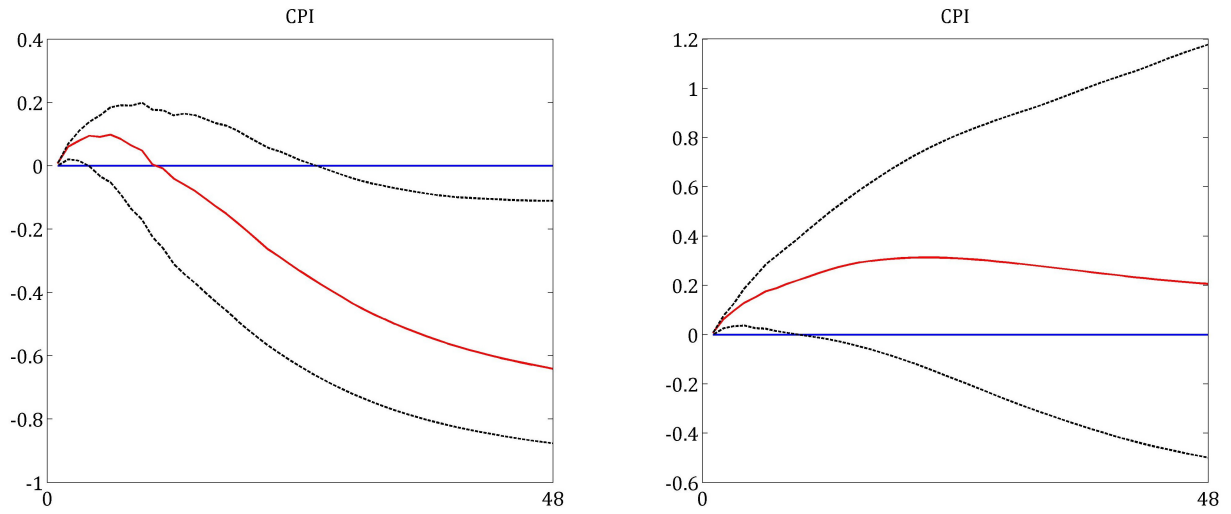

Figure 6.1: CPI response from original BBE specification using 13 lags (left) and 6 lags (right) following a 25 basis points monetary policy shock.

Despite these problems, the results from chapter 5 still do not support the statement that monetary policy does not have real effects in the long run. On the one hand, the VAR literature as well as my own results show that changes to the central bank reaction function have long lasting effects on the economy. On the other hand, the VAR literature reports small long-run level effects whereas the FAVAR literature reports small growth rates effects and thus higher long-run level effects. These later results indicate that the long run neutrality hypothesis does not hold. But, also, if one does not trust the numerical interpretations, one can see that the New Keynesian theoretical prediction about the effects of monetary policy is not in line with impulse responses from VAR models: The New Keynesian argument is that sticky wages and prices allow short run real effects and the absence of wage and price stickiness in the long run leads to nominal adjustments instead of real adjustments. The IRFs from the VAR as well as the FAVAR literature,

however, indicate that the responses of prices and wages are strong shortly after the shock and are strong especially when the movements of real variables are pronounced. In a sticky price or wage framework, however, real variables should move when prices do not. Thus, the empirical as well as the qualitative results from VAR and FAVAR impulse response analysis do not support the New Keynesian paradigms of long run policy ineffectiveness and long run neutrality.

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Appendix 1: Data Overview

Transformation code: 1= no transformation (levels), 2 = first differenced, 5 = logarithmic differences, SA = seasonally adjusted, in 2005 € = denominated in constant 2005 prices. Variable names in red (gray) indicate variables used for impulse response analysis.

	Name	Transformation	Unit	Slow Moving
1	prod_prod	5, SA, in 2005 €	2005=100	yes
2	prod_inter	5, SA, in 2005 €	2005=100	yes
3	proc_cap	5, SA, in 2005 €	2005=100	yes
4	prod_dur	5, SA, in 2005 €	2005=100	yes
5	prod_nondur	5, SA, in 2005 €	2005=100	yes
6	prod_energ	5, SA, in 2005 €	2005=100	yes
7	prod_constr	5, SA, in 2005 €	2005=100	yes
8	realgrwage	5, SA, in 2005 €	2005=100	yes
9	productivityh	5, SA, in 2005 €	2005=100	yes
10	sal_interm	5, SA, in 2005 €	2005=100	yes
11	sal_cap	5, SA, in 2005 €	2005=100	yes
12	sal_nondu	5, SA, in 2005 €	2005=100	yes
13	sal_energ	5, SA, in 2005 €	2005=100	yes
14	sal_dur	5, SA, in 2005 €	2005=100	yes
15	ord_constr	2, SA, in 2005 €	2005=100	
16	ord_constrhouse	5, SA, in 2005 €	2005=100	
17	ord_interm	5, SA, in 2005 €	2005=100	
18	ord_nondu	5, SA, in 2005 €	2005=100	
19	ord_cap	5, SA, in 2005 €	2005=100	
20	ord_dur	5, SA, in 2005 €	2005=100	
21	stock_fr	5, SA, in 2005 €	2005=100	
22	stock_nl	5	2005=100	
23	stock_aut	5	2005=100	
24	stock_uk	5	2005=100	
25	stock_ch	5	2005=100	
26	stock_us	5	2005=100	
27	stock_de	5	1987=1000	
28	ex_nl	2	indirect quot.	
29	ex_uk	5	indirect quot.	
30	ex_it	5	indirect quot.	
31	ex_us	5	indirect quot.	
32	ex_fr	5	indirect quot.	
33	ex_at	5	indirect quot.	
34	ex_ch	5	indirect quot.	
35	mlloan_share	5	share of banktotal	
36	lendbank_share	5	share of banktotal	
37	lendnoba_share	5	share of banktotal	
38	secnoba_share	5	share of banktotal	

	Name	Transformation	Unit	Slow Moving
39	banktotal	5, in 2005 €	Billion	
40	partint_share	5, in 2005 €	share of banktotal	
41	secba_share	5, in 2005 €	share of banktotal	
42	cash_share	5, in 2005 €	share of banktotal	
43	depbank_share	5, in 2005 €	share of banktotal	
44	depnoba_share	5, in 2005 €	share of banktotal	
45	cap_share	5, in 2005 €	share of banktotal	
46	bondbank_share	5, in 2005 €	share of banktotal	
47	price_consfood	5, SA	2005=100	
48	price_consenerg	5, SA	2005=100	
49	price_CPI	2, SA	2005=100	yes
50	price_produceoil	5, SA	2005=100	
51	price_PPI	5, SA	2005=100	yes
52	trade_nx	2, in 2005 €	Billion	yes
53	trade_impprice	5	2005=100	yes
54	trade_imppraw	5	2005=100	
55	trade_imppoil	5	2005=100	
56	trade_comp	5, SA, in 2005 €	2005=100	yes
57	peoplepaid	2, SA	Thousand	yes
58	unemployed	5, SA	Thousand	yes
59	unemplrate	5, SA	Percent	yes
60	short time work	1	Thousand	yes
61	frankfurt3m	1	Percent	
62	frankfurt6m	1	Percent	
63	frankfurt12m	1	Percent	
64	yieldpublic	2	Percent	
65	yieldcorporate	2	Percent	
66	yieldbank	2	Percent	
67	salesmutual	2, in 2005 €	Million	
68	banksecsale	2, in 2005 €	Million	
69	corpbondsale	2, in 2005 €	Million	
70	pubsecsale	2, in 2005 €	Million	
71	changeshare	2, in 2005 €	Million	
72	ifo_climate	5, SA	2005=100	
73	ifo_current	5, SA	2005=100	
74	ifo_exp	5, SA	2005=100	
75	frankfurt1m	1	Percent	

Appendix 2:

Abstract

This thesis compares New Keynesian and Post Keynesian predictions of the long run effects of monetary policy. An econometric model is used to falsify theoretical statements. In chapters 2 and 3 the different approaches and their implications for monetary policy are presented. Chapter 4 discusses the factor augmented vector autoregressive (FAVAR) model of Bernanke, Boivin and Elisasz (2005) which is used to estimate the effect of monetary policy on the German economy. The results are presented in chapter 5 and can be summarized as being not compatible with New Keynesian theory of long run neutrality and price stickiness. Other important insights, which are discussed in the concluding chapter 6, are the poor performance of VAR models in studying long run effects and the high degree of sensitivity of the FAVAR model to changes of the lag order specification.

Zusammenfassung

Die vorliegende Arbeit vergleicht die Neu-Keynesianische und Post-Keynesianische Literatur hinsichtlich ihrer Aussagen über die langfristigen Effekte der Geldpolitik. Mit Hilfe eines ökonometrischen Modells wird untersucht ob diese theoretische Aussagen falsifizierst werden können. In den Kapiteln 2 und 3 werden die beiden unterschiedlichen theoretischen Ansätze vorgestellt. Kapitel 4 beschäftigt sich mit dem faktor-erweiterten VAR Modell von Bernanke, Boivin and Elisaz (2005), das auf ein Datenset bestehend aus deutschen Zeitreihen angewendet wird. Die Ergebnisse werden in Kapitel 5 vorgestellt und sind nicht mit den Aussagen der Neu-Keynesianischen Literatur über die langfristige Neutralität der Geldpolitik und Preisrigiditäten vereinbar. Darüber hinaus wird im abschließenden Kapitel 6 festgestellt, dass VAR Modelle nur sehr eingeschränkt geeignet sind um langfristige ökonomische Zusammenhänge zu untersuchen und die Ergebnisse dieser Modelle äußerst sensibel auf Veränderungen der Verzögerungseffekte reagieren.

Appendix 3: CV

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Personal Information

Nationality: Austrian
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Education

2010-2013: Master in economics at the University of Vienna. Main subjects: macroeconomics, econometrics and statistics. Merit scholarship in 2011/2012.

2011: From January – June semester abroad at the University of Chicago, IL USA. Main subjects: monetary macroeconomics, econometrics, industrial organization.

2006-2010: Bachelor in economics from the University of Vienna. First year at the Johannes Kepler University, Linz.

2005-2006: Mandatory social service instead of military service.

Publications

2012: How effective are central counterparties for risk reduction? *Momentum Quarterly, 1 (2),122-138,* [http://momentum-quarterly.org/MQV1N2/MQV1N2-wildauer.pdf].

2012: Internship at "Institut für Makroökonomie und Konjunktur". Participation in „Fiscal Multipliers: A Meta Regression Analysis". *IMK Working Paper No. 97* as well as in „Eine Finanzpolitik im Interesse der nächsten Generationen". *IMK Study No. 24.*

2010: Second bachelor thesis „Die monetäre Analyse des John Law und sein Wirken in Frankreich im 18. Jahrhundert"

2009: First bachelor thesis „Vermögensbesteuerung in Österreich - Ein internationaler Vergleich"

Voluntary and Social Engagement

2008/06-2010/06: Financial secretary of the national union of students at the University of Vienna.

2004/05-2006/06: Chairman of the school students organization „Aktion Kritischer SchülerInnen Linz"

2004/10-2005/06: Member of the school students representative board of Upper Austria.