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Summary

Prior to the Asian crisis, benign liquidity conditions contributed to credit expansion and overinvestment in the East Asian economies until they were hit by a deep recession (Saxena and Wong 2002). Similarly to the developments in the tiger economies in the nineties, the CEE economies grew rapidly from 2001 to 2007, due to foreign capital inflows. But the current global financial turmoil and economic downswing also pulled the CEE economies into the maelstrom of the crisis. With the Asian experience in mind, the aim of this paper is to analyze whether overinvestment due to benign liquidity conditions possibly emerged and contributed to the crisis in CEE.

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1 Introduction

Prior to the Asian crisis of 1997/98, benign world liquidity conditions contributed to credit expansion and *overinvestment*[2] in the East Asian economies until they were hit by a deep recession that revealed unsustainable investment projects (Saxena and Wong 2002). Similarly to the tiger economies in the 90s, the Central and Eastern European (CEE[3]) economies grew rapidly from 2001 to 2007. But the current global financial turmoil and economic downswing pulled the CEE economies into the maelstrom of the crisis. With the East Asian experience in mind, the main aim of this paper is to analyze whether easy outside (EMU) liquidity conditions possibly triggered a credit-induced overinvestment boom that culminated in the current crisis in CEE.

A substantial number of papers focus on identifying how sudden liquidity shocks affect inflation and growth in small open economies. Therefore, several variations of Sims (1980)'s VAR methodology are applied throughout the literature (e.g. Mojon and Peersman 2003, Canova 2005 and Schneider and Fenz 2008). For CEE, for instance Arnostova and Hurnik (2004) find that changes in EMU liquidity conditions affect inflation in the Czech Republic. And Kuijs (2002) finds a quick response towards EMU liquidity shocks on prices in Slovakia.

Although previous research shows that liquidity shocks affect inflation and growth in CEE, it does not come up with an explanation of how benign liquidity conditions can build up a crisis potential during the boom period. To explain the emergence of a crisis, most current research assumes that an exogenous shock changes aggregate supply, demand or liquidity conditions. Then, the rational and fully informed agents adjust to the new situation. The assumption of price stickiness allows for an adjustment period that is interpreted as a business cycle (De Grauwe 2008, Lombari and Sgherri 2007).

In contrast, Hayek (1929) and Mises (1912) argue that exuberated credit growth causes an overinvestment boom that endogenously leads to a bust (in a closed economy). The reasons for buoyant credit growth are irrational behavior and benign liquidity conditions of the banking sector.[4] Robbins (1934) most prominently applies their theory to explain the causes

[2] Mal- or overinvestment labels investment projects that seem to pay-off (due to ignoring risks or excessive lending), but eventually do not pay-off.
[3] In this paper the new member states of the European Union, except of Cyprus and Malta, are denoted as CEE.
[4] Several other theories depart from rational expectations and full information assumptions to explain business cycles, but without particular emphasis on the importance of the credit conditions. They explain overinvestment

of the Great Depression. Furthermore, Eichengreen and Mitchener (2003) use quantitative tools to find evidence of whether a credit boom contributed to the Great Depression, approving the main arguments of the Mises-Hayek theory.

For (small) open economies, White (2006) argues that the credit boom explanation of the business cycle may even be more applicable, as capital in- and outflows can bring about booms driven by foreign credit. Also, McKinnon and Pill (1997) explain that buoyant foreign borrowing may cause overinvestment in small open economies. In this sense, Krugman (1998) and Corsetti et al. (1999) find overinvestment and over-borrowing (due to moral hazard of banks) to be causes of the East Asian crisis. And more recently, Schnabl and Hoffmann (2008) and McKinnon and Schnabl (2009a) argue that easy liquidity conditions after 2001 contributed to investment booms around the world, especially in small open economies.

As the aim of this paper is to analyze whether easy (EMU) liquidity conditions triggered a credit-induced boom-and-bust cycle in CEE, it is necessary to understand how overinvestment can emerge due to benign credit conditions. Therefore, the paper starts with an introduction of the overinvestment theory of Mises (1912) and Hayek (1929) (section 2). Then, augmenting the overinvestment theory to a small open economy framework shall help with understanding possible causes of buoyant credit growth and overinvestment in the small open economies of CEE. Section 4 provides an analysis of whether easy EMU liquidity conditions transferred to CEE and caused a credit boom that culminated in the current crises.

by "animal spirits" (Keynes), herding and self-fulfilling prophecies (see Akerlof and Shiller (2009), Shiller (2000), De Grauwe (2008) and Minsky (1982)).

2 Overinvestment in closed economies

2.1 The Mises-Hayek overinvestment theory

The overinvestment theories of Ludwig von Mises (1912) and Friedrich August von Hayek (1929, 1934) explain overinvestment and crisis due to positive expectations and benign liquidity conditions in a closed (advanced) economy framework.

Assumptions and causes of the business cycle

Building upon Wicksell (1898) and Schumpeter (1912), Mises and Hayek base their overinvestment theories on the distinction between three types of interest rates: First, the "*internal interest rate*", reflecting the expected return of investment projects. Second, the "*natural interest rate*", equivalent to an equilibrium interest rate which balances supply (saving) and demand (investment) on capital markets. Third, the "*the money market rate*" which is set by the banking sector. In equilibrium, the natural rate of interest is equal to the money market rate. Then, the capital and the goods market are in equilibrium as well.

According to Mises and Hayek, boom-and-bust cycles along the long-term equilibrium path are initiated by buoyant credit expansions that lead to overinvestment. There are two reasons for excessive credit expansion:

> (1) easy credit conditions
> (2) positive expectations (innovations) (Hayek 1976 [1929]: 99).

In the first point, Mises and Hayek follow Wicksell (1898), who introduces the idea of a money market rate fluctuating around an equilibrium interest rate (natural rate of interest), which is defined as the interest rate where savings match investment. As in Wicksell's (1898) framework, the banking sector has to hold market rates equal to the natural rate of interest to keep the economy in equilibrium. Whereas, if the banking sector holds market rates below the "natural rate", investors are able to get more credit as capital is relatively cheap. This induces an investment boom and causes wage growth that eventually leads to inflation.

In the second point, Mises and Hayek follow Schumpeter's concept of "new combinations" (i.e. innovations) as a possible cause of positive expectations (Hayek, 1929; and Hayek, 1976:

95). According to Schumpeter, an innovation is the result of competition, where "dynamic entrepreneurs" try to create an advantage over the other market participants to achieve higher profits. An innovation can be the implementation of a new production process, a new product, access to new supply and demand markets or a new organisational structure (Schumpeter 1912: 100-103). Other market participants soon realize the gains from this innovation and adopt it. Then profits shrink again and a new equilibrium at a higher level is achieved (Schumpeter 1928: 36). As technological changes or access to new markets brings about higher returns (internal interest rates) and more output, they are not a reason for an unsustainable boom. But they can initiate irrational credit demand when expectations for future profits are over-optimistic due to imperfect information.[5]

The upswing

The boom may start, with a rise in capital demand due to positive expectations about future income (internal interest rate rises). Then the "natural rate of interest" increases as capital supply (which is equal to savings) remains constant. If banks provide credit at an unchanged money market rate, the money market rate falls below the "natural rate." Hayek and Mises argue that banks have the tendency to expand credit too far at unchanged rates, due to competition for the greatest market share (Mises 1912: 409, 417, 420, 428, 430 und Hayek 1976 [1929]: 99).[6] This is often referred to as the *"perverse elasticity of the banking sector."*[7]

If a central bank increases interest rates following a rise in capital demand, this slows down the credit expansion as it restricts the liquidity conditions for banks. Therefore they increase the money market rate. But assuming the central bank keeps liquidity conditions unchanged in this situation[8], commercial banks can keep the interest rates unchanged and directly transfer the loose liquidity conditions to the private sector (Hayek 1976 [1929]: 99-103;

[5] This point was also stressed by Robert Shiller (2000) in "Irrational Exuberance" and recently by George Akerlof and Robert Shiller (2009) in "Animal Spirits". They argue that psychology, herding and irrational expectations lead to speculation, overinvestment and crisis. Similarly Minsky´s (1982) financial instability hypothesis argues that positive expectations drive the upswing.

[6] Rotemberg and Saloner (1987) found that oligopolistic competition provides incentives to not adjust prices straight away and may provide a theoretical model for this behavior.

[7] Also Minsky (1982) argues that the credit system exceeds credit lines too far. His finance scheme can be seen as a further explanation of the possible excesses during the boom.

[8] This may be due to imperfect information or irrational expectations about future output. Furthermore Mises and Hayek often argue that central banks want to initiate an upswing via artificially lowering interest rates to enhance credit growth, investment and reduce unemployment during the recession. Under such conditions, lowering interest rates, although savings have not increased, can contribute to an artificial upswing that faces the same problem as a monetary policy mistake. Inflation will set in as preferences of households have not changed from consumption towards savings beforehand (see e.g. Mises 1928).

Mises 1912: 417-430). Furthermore, new financial instruments may allow for more lending at unchanged rates, if this is not restricted. Thus, if supervision is not sufficient, for instance due to a lack of information, monetary policy may lose control over liquidity conditions and banks can satisfy any credit demand at unchanged rates.

If the banking sector holds money market rates below the natural rate, investment that would not be profitable under "equilibrium interest rates" is undertaken (Böhm-Bawerk 1884: 400, Mises 1912: 429). Building upon Böhm-Bawerk's capital theory (1884, 1923), Hayek (1967 [1934]) argues that money market rates which are below the natural rate change the investment structure in an economy. A lower money market rate implies that households and firms save a larger share (capital supply is high) and consume fewer of their income than they actually do. Therefore lower money market rates bring about relatively more "roundabout ways of production" and thus more capital goods than consumer goods. As the production becomes more capital intensive, the capital stock of an economy grows.

Increased investment in capital goods goes along with higher wages. As the amount of consumer goods does not increase and preferences of consumers do not change towards savings, higher wages lead to overconsumption and bring about rising consumer prices (Mises 1912, 430, 431) to close the inflationary gap that comes along with an investment overhang. Mises argues that this is equivalent to forced savings or wealth redistribution from workers (who intended to save a small amount of their income) towards investors (who save more) (Garrison 2004). Therefore the boom is characterized by overinvestment and overconsumption (Garrison 2006: 72).

The positive economic expectations can be transmitted to the asset markets where speculation may set in. This may be the case if households start buying stocks of the booming enterprises from the additional income to profit from the boom, instead of (forced) saving at lower interest rates. Then, consumer prices may not immediately increase. According to Schumpeter (1983 [1912]: 237) price expectations of stocks and other real assets can depart from the real economic development. A speculative mania may emerge, in which speculative price projections and "the symptoms of prosperity themselves finally become, in the well known manner, a factor of prosperity" (Schumpeter 1983 [1912]: 226).

The turnaround and downswing

But when inflation accelerates and central banks start to increase interest rates, the turnaround is inevitable. Then, the banking sector does not renew credit lines and reassesses the risk (Hayek 1976 [1929]: 101). The rising money market rate lifts the threshold for the profitability of all previous investment projects. Especially the production of capital goods is not profitable anymore. This dismantles investment projects with an internal interest rate below the risen money market rate. As the demand for capital declines during the recession, the natural interest rate falls.

Due to higher money market rates and negative expectations, investors start few new investment projects. On the other hand, more and more investment projects become unprofitable with general demand declining (negative multiplication effect). The capital stock of the economy shrinks. A recession follows which will be the deeper the larger the "exuberance" has been. Previous overconsumption turns into abstinence of consumption as the losses due to mal-investment have to be digested. The price level falls, especially in markets that have seen overinvestment and -consumption. In the last stage of the bust, when overinvestment has been dismantled and the misallocated production factors have been released, prospects for investors become better: First, the central bank can ease its liquidity conditions due to the falling inflation rate and capital demand and banks can provide credit more easily. Second, the demand for capital increases until the economy is in equilibrium again.

2.2 Implications

The structural adjustment after the turnaround is a necessary prerequisite for the recovery after the slump. According to Mises and Hayek the "crisis will heal the market" (Mises 1912: 431) as it separates profitable investment projects (with high internal interest rates) from investment projects with low profitability (low internal interest rates). In a crisis, market participants restore the disequilibrating effects of an expansionary credit policy to equilibrium. This implies the existence of an internal impulse towards equilibrium (Rizzo 1990).

Without such a cumbersome process, investment projects with low internal interest rate would be maintained, the necessary restructuring would be postponed, and the following upswing would not be sustainable. As further credit expansions during a crisis can delay the tendency to equilibrium, Mises and Hayek do not see them as useful tools against a crisis. Therefore, the economic policy implication for central banks is to hold market rates close to the "natural rate of interest" and closely watch the liquidity conditions of the banking sector to safeguard the economy against volatility and severe crisis, because the longer market and natural rates differ, the bigger the catastrophe (Mises 1912, 436).

However this does not solve the problem of the business cycle as a whole, because due to the *"perverse elasticity of the banking sector"*, banks always tend to increase credit lines too far (capital supply) and thereby cause overinvestment. But holding interest rates close to equilibrium and supervising the banking sector smoothens the cycle (Hayek 1929) around the long-term growth path.

3 Overinvestment in small open economies

Mises (1912) and Hayek (1929) explain how the domestic banking sector can cause excessive credit growth and overinvestment in a closed economy. In this part, introducing more recent research shall help with explaining the causes of buoyant credit growth and overinvestment in a small open economy largely depending on foreign credit under consideration of the exchange rate regime.

3.1 Foreign credit and overinvestment

Foreign credit and growth

With closed capital markets, entrepreneurs can only raise money from domestic banks. In this context underdeveloped financial markets in emerging market economies are by definition characterized by high interest rates and risk (*original sin)* (Eichengreen and Hausmann 1999). Therefore the expected return of planned investment projects has to be high to be realized. According to overinvestment theories of Mises and Hayek the investment activity is sluggish in this scenario.[9]

Free access to international capital markets lowers money market rates and thereby accelerates investment and growth (McKinnon 1997). In this scenario, lower interest rates from abroad can boost investment. Low world interest rates promote investment in the domestic market because they are tantamount to lower costs of investment, as investors can use foreign savings to finance projects in the domestic market. Due to capital inflows the interest rate level converges towards the international level (plus a risk premium). According to Mises and Hayek this drop in interest rates must initiate an upswing.

Figure 1 explains the effects of opening capital markets for instance for the CEE economies. It shows that after opening capital markets world liquidity conditions, especially EMU interest rates, affect investment decisions in CEE. When borrowing from abroad capital supply in CEE increases as foreign savings become available via capital imports. On the other

[9] The CEE economies faced an even greater problem. They had no market economy, needed to accumulate capital (Böhm-Bawerk 1884).

hand, as the CEEC are relatively small, they do not affect capital supply in the EMU. Thus, capital inflows lower interest rates in CEE. Investment projects in CEE can be financed with capital at the cost of i_{mEU} (plus a risk premium). The investment activity increases. The catch-up process starts.

[Figure 1][10]

This is equivalent to a drop of interest rates in the closed economy framework of Hayek and Mises, which allows for additional investment. Similarly to a credit expansion of banks in a closed economy, the interest rate drop will bring about lower saving preferences and higher consumption preferences of households. As in a small open economy where goods are available via imports, the current account balance turns negative. In this case, households borrow against future income (McKinnon and Pill 1997). But because the capital stock of economies in the catch-up process grows, the marginal rate of capital declines and the economic growth rates converge towards the level of the advanced economy. Thus the natural rate declines as well.

Due to higher production and income, investors are able to repay foreign credit lines in the future unless malinvestment is made. Thus, the short-term drop in savings is not troublesome. The current account deficit rather reflects an intertemporally efficient allocation of resources (McKinnon and Pill 1997), bringing about higher production, wages and savings in later periods. Hence, getting rid of financial repression (McKinnon and Shaw 1973) and opening capital markets (McKinnon 1997, McKinnon and Pill 1997) increase investment and growth.

Foreign credit and overinvestment

Overinvestment in a small open economy is likely to emerge if world interest rates are "too low" (below their natural rate). Central banks may contribute to this by holding interest rates too low. Further, they may lose control over liquidity conditions due to credit creation of the banking sector that is (widely) independent from the money supply of central banks. Then capital flows can transfer benign world liquidity conditions to a small open economy via foreign credit and bring about boom-and-bust cycles along the long-term growth path (Schnabl and Hoffmann 2008) as outlined by Mises and Hayek for a closed economy.

[10] See Appendix A

Overinvestment driven by buoyant capital inflows is most likely if positive expectations about the future income (high expected internal interest rates) in the small open economy lead to exuberate lending by banks or the volatility risk of the small economy is neglected (Saxena and Wong 2002). Moral hazard may signal lenders too high pay-offs and lead them to finance investment projects that are not lucrative under rational expectations (McKinnon and Pill 1997). This causes over-borrowing of households and investors, increases consumption and decreases savings below a point that is sustainable. Then the economy faces overinvestment, overconsumption and unsustainable current account deficits. Therefore opening capital markets and allowing for capital in- and outflows increases investment and growth, but also the possibility of credit cycles as outlined by Mises and Hayek (White 2006).

For instance in the 1990s, over-optimism about the future growth-path and false fiscal policy were incentives for neglecting the volatility risk and for rising credit demand in East Asia. The availability of cheap U.S. and Asian monies allowed for exuberate credit growth and over-borrowing (Saxena and Wong 2002). In the mean time, central banks implicitly guaranteed the banks to act as a lender of last resort in case of default and crisis. Therefore banks ignored risks of default because they believed that possible losses would be covered by an insurance system (Krugman 1998, Corsetti et al. 1999). Thus an artificially lowered risk premium further reduced the costs of capital for investors, and overinvestment emerged.[11]

Similarly, the Federal Reserve provided low cost liquidity as it kept interest rates *"too low for too long"* after the burst of the dot-com bubble in 2001, contributing to excessive borrowing and the US housing market bubble (Taylor 2008, Lombari and Sgherri 2007). The Fed's overreaction accompanied by loose regulation further led to dollar *carry trades* to markets around the world, especially in 2005 and 2006 (McKinnon and Schnabl 2009a) and translated to monetary expansion worldwide. Especially countries that pegged their currencies to the dollar experienced foreign reserve growth, and thus monetary expansion. But also the ECB that tried to prevent the euro from appreciating too much, reluctantly followed the US monetary expansion until 2006 (Belke and Polleit 2006, Hoffmann 2009).

Additionally, new unregulated financial products (derivatives) seemed to allow for unlimited credit creation at unchanged rates as banks could pass on the risks of investment via AAA

[11] This is caused by "too big to fail" policies of central banks in case of default Other implicit insurance systems are IMF bail-outs.

rated derivatives to investors worldwide. Thus, the investment activity further increased and lifted the natural rate above the respective money market rate. This can be interpreted as signs of the *"perverse elasticity of the banking sector."* With central banks losing control over liquidity conditions, global excess liquidity after 2001 led to credit growth, inflation and real estate booms in several markets (Belke et al. 2008). This contributed to hiking asset prices around the world (Borio 2008), in particular in new and emerging markets as additional liquidity is likely to *"vagabond"* to the high-yielding markets (Schnabl and Hoffmann 2008).

3.2 Overinvestment with respect to the exchange rate framework

The emergence of overinvestment cycles due to speculative capital inflows depends on the exchange rate regime of the small open economy. Under both, fixed and flexible exchange rate regimes, overinvestment cycles can emerge, although causes and transmission differ.

Fixed exchange rates may attract speculative capital inflows as the exchange rate risk seems to diminish (Fischer 2001). Without this risk foreign borrowing only depends on the interest rate differential with the anchor economy. Thus, capital flows to countries with fixed exchange rates should increase their exchange reserves as well as stock and real estate prices. Overinvestment can emerge if banks borrow money denominated in foreign currency to give it to the domestic investors, without consideration of the exchange rate risk. According to Herzberg and Watson (2007) hard pegs "accelerate the expansion of un-hedged borrowing in foreign currencies." Thus, banks have incentives to expand credit lines too far as in the closed economy framework of Mises and Hayek. Maturity mismatches enhance the danger of overinvestment. This was the case in the run-up to the Asian crisis.

Further, in currency board arrangements, monetary expansions of the anchor economy directly transfer into monetary expansions in the anchoring economy. Therefore, an asymmetric shock in an anchor economy can bring about an overinvestment boom in small open economies with a currency board. If the small open economy is in a boom and the anchor economy experiences a cyclical downturn, the optimal money market rate (natural rate) in the small economy will be higher than in the anchor economy. This can fuel the boom in the small economy and bring about investment that only pays-off until interest rates in the

anchor economy start to increase. But if business cycles are highly synchronized, as in the case of CEE and the euro area (Fidrmuc and Korhonen 2006), this scenario is rather unlikely.

On the other hand, flexible exchange rates can attract speculative capital due to "one-way bets" on appreciation, especially in economies that are in the process of catching-up (McKinnon and Schnabl 2009b). "One-way bets" on appreciation may also endanger price stability in volatile small open economies (Merza 2004). Furthermore, if banks know that the domestic currency appreciates due to the Balassa-Samuelson effect, they may borrow in the currency of the anchor economy and convert it into the domestic currency. When the domestic currency appreciates, the value of foreign liabilities declines (in terms of domestic currency). In this situation, the central bank faces the revaluation loss and allows for more speculative investment and consumption of the private sector (Schnabl 2008a). Herding behavior can make appreciation expectations reinforcing and bring about a highly overvalued currency (Schnabl 2008a). In periods of contraction this effect is well-known. During the Asian crisis 1997/98 investors expected a strong depreciation and withdrew capital.

As in both exchange rate strategies, volatility of the economy increases with the amount of capital attracted. Most emerging market economies intervene in the foreign exchange market and accumulate reserves to safeguard the economic stability, even though they announce the exchange rates to be flexible (Schnabl 2008a). When reserves are accumulated, speculative capital inflows translate into additional monetary expansions. Thus, the money market rates fall below the natural rate. Following Hayek and Mises the monetary expansion eases credit conditions for the banking sector and translates into additional credit to the private sector, due to the competition among banks. The credit boom is characterized by falling interest rates and a rising number of low-yielding investment projects.

In both cases imports increase relative to export. On the one hand, exuberate capital inflows to economies that peg their currency to an advanced economy translate into higher wages and inflation (Schnabl and Ziegler 2008), improving the purchasing power of consumers in the small open economy. On the other hand, under a flexible exchange rate regime, the purchasing power increases relatively as the domestic currency appreciates. Both transmission channels lead to an appreciation of real exchange rates (De Grauwe and Schnabl 2005). As in the theory of Hayek and Mises, savings are unlikely to increase with declining interest rates. Therefore the wealth effect from overinvestment contributes to higher

consumption and increases imports as they become relatively cheaper. Thus, in both cases, imports tend to increase relative to exports due to the capital inflows into the economy. Overinvestment is followed by overconsumption.

4 Benign liquidity conditons and overinvestment cycles in CEE

In this section, an empirical analysis shall provide evidence of whether easy liquidity conditions in the EMU affected liquidity conditions in CEE as suggested in section 3. Furthermore, it is elaborated, whether a credit-induced overinvestment boom possibly emerged due to a divergence of the money market from the natural rate that led to the current crisis in CEE (in the sense of the augmented Mises-Hayek theory).

4.1 Impact of easy EMU liquidity conditions on CEE

Foreign capital inflows and liquidity conditions in CEE

Opening capital markets brought about capital inflows to CEE due to two reasons: First, positive growth expectations attracted FDI as well as portfolio investment from international investors financed at the cost of low world interest rates. Second, as most banks in CEE are foreign owned, they were considered to be safe lenders. For instance in Estonia, Swedish banks dominate the banking sector. Similarly, Austrian banks play a significant role in Hungary. This domination of western subsidiaries and foreign owned banks raised the credibility of the financial sector and allowed for an easy access to international capital (Ehrlich et al. 2002, Sepp and Randveer 2002). Both, FDI and foreign owned banks seemed to provide an insurance against financial instability.

Foreign borrowing of banks increased in CEE, because the interest rate spread between the euro area and CEE was high (Figure 2 and 3). This was especially the case after 2002 when world interest rates were abnormally low (Taylor 2008, Lombari and Sgherri 2007) and CEE improved its macroeconomic stability as a prerequisite for EU accession. Foreign borrowing brought about falling lending rates and a dependency on foreign credit. The banking sector passed on the currency risk from borrowing in euro to the private sector. The capital inflows

squeezed the spread between deposit and lending rates in CEE close to the spread in the euro area (Figure 4). This provided an incentive to take higher risks to both borrowers and lenders.

Although the exchange rate risk adds to the risk premium, the falling lending-loan rate spreads (that can be seen as measures of risk) reflect that investors neglected this risk as EU membership and guaranteed euro adoption seemed to make depreciations unlikely. The exclusion of the risk further lowered loan rates. Therefore, especially in countries with exchange rate pegs, interest rates converged towards the EMU level (Figure 2) In Estonia the interest rate differential to the euro area was close to zero after 2004. In Poland the differential disappeared after joining the EU. The increases of the share of banks' foreign liabilities after 2003 reflect this interest rate convergence (Figure 3). This provides evidence of a transmission of EMU liquidity conditions and interest rates to the small open economies in CEE.

[Figure 2] [Figure 3] [Figure 4][12]

Transmission of benign liquidity conditions in the EMU to CEE

Granger causality tests can help with finding evidence of a transmission of benign liquidity conditions from the EMU to CEE (Granger 1969). Following the augmented overinvestment framework, easy liquidity conditions are a deviation of the real money market rate from the natural rate. Therefore, the null hypothesis of the Granger causality test is that the deviation of the real money market rate from the natural rate in the EMU *does not Granger Cause* the deviation in the NMS. If the test rejects the null, this provides evidence of a transmission. The Schwartz criterion is used to select the correct lag length for the Granger causality test.

For the analysis, monthly data is taken from the International Financial Statistics of the IMF provided by the Reuters EcoWin database. The data set starts in 1998 as before data is not completely available and the countries were in the transition from a socialist to a market economy. The data includes money market rates, consumer price inflation and industrial production for the NMS and the EMU, respectively. Industrial production replaces GDP because GDP aggregates are not available on monthly basis. Quarterly data would only allow a regression of 40 observations (10 years) and not provide a sufficient sample size.

[12] See Appendix A.

Furthermore using quarterly data means a further aggregation and a loss of information. As industrial production is very sensitive to the business cycle and highly correlated with GDP, the data should be sufficient for the estimations.

The real money market rate is calculated by subtracting consumer price inflation from the money market rate for each economy. Most commonly, the natural rate of interest is seen as a long-term real growth trend of GDP (HP filter). This is a derivation from the Ramsey model where the equilibrium interest rate is equal to the rate of technological progress, and thereby equal to the rate of long-term growth. Therefore in this paper the natural rate is the trend of real growth (industrial production).[13] Thus, the deviation from the natural rate is equal to real growth trend minus the real interest rate. The HP filter with a lambda of 14400 is applied to calculate the trend using monthly data. The deviation from the trend is further labelled as *"gap"*. At the 10 percent significance level, the Dickey-Fuller test does not identify unit roots in the calculated *gaps*.

The Granger causality test approves that the *gap* in the EMU *Granger causes* the gaps in Bulgaria, the Czech Republic, Estonia, Hungary, Poland and Slovenia as it rejects the null of no causality. Past values of the *gap* between the money market and the natural rate in the EMU explain the *gaps* in these countries. In Latvia and Lithuania, this is only true for the sample starting after 2001. As before 2002 these countries pegged their currencies to the dollar or a basket of currencies, this finding reflects the switch in the exchange rate regime to pegging to the euro (Table 1). Therefore easy liquidity conditions from the EMU, as defined here, transferred to these CEE economies.

In contrast, the EMU *gap* does not Granger cause the gaps in Slovakia and Romania. This is surprising as both countries have had only partly flexible (RO, SK) exchange rate regimes. Therefore it seems interesting whether EMU money market rates Granger cause money market rates at all. In Slovakia, the null of no Granger causality is only rejected if more lags (following the Akaike criterion) are included. However this is not the case for Romania, other factors (for instance the domestic banking sector) drive the money market rates in Romania.

[13] There are several ways to calculate the natural rate of interest (Williams 2003). For instance, the long-term average real rate is a proxy of the natural rate. Also the Kalman filter may help to calculate the natural rate. The proxy in use brought about the same results as the trend of long-term interest rates (government bond yield). As long-term rates were not available for all countries, the proxy was not chosen for explanation.

[Table 1] [Table 2][14]

4.2 Possible signs of an overinvestment cycle

The credit boom?

Capital inflows and increased foreign borrowing of banks went along with high growth in output, credit growth and current account deficits in CEE, especially in the economies with exchange rate pegs. Figure 5 shows that in the CEE economies credit to the private sector as share of all assets has increased strongly after 2002. Further, the credit-deposit ratios of banks in 2007 are high above their past averages, especially in the Baltics, Romania and Bulgaria (Figure 6), which can be seen as a financial deepening indicator but also as a sign of more risk-taking by banks (Beck et al. 2000). Similarly, credit to the private sector as percent of GDP increased especially in countries with pegs to the euro (Figure 7).

[Figure 5] [Figure 6] [Figure 7][15]

Following the augmented overinvestment framework, these are the typical ingredients of a credit-induced overinvestment boom. Accordingly, a substantial number of studies stressed the danger of excessive credit growth and overheating for stability in the CEEC prior to the current crisis. (Egert and Backe 2006, Sopanha 2006, Duenwald et al. 2005, Mendoza and Terrones 2004, Sopanha 2006, Hoffmann and Schnabl 2007, Bini-Smaghi 2007, Schnabl 2008b).

However, there is a broad consensus that credit booms are hard to spot before the event of the crisis, because high growth rates of output and credit to the private sector may also be justified by financial deepening (Beck et al. 2000), new technology, institutional change (as explained by Hayek and Schumpeter) or - as in the case of CEE - the accession to the EU and the expectation of euro adoption. Thus, excessive credit growth itself does not provide *ex ante* evidence of a credit boom (Eichengreen and Mitchener 2003, 15), even though loose credit conditions and credit growth are prerequisites of a credit boom. Thus, Eichengreen and Mitchener (2003) use three measures for an *ex post* quantitative analysis of whether an

[14] See Appendix A.
[15] See Appendix B.

overinvestment may have occurred prior to the Great Depression: 1. the development of asset prices, 2. the investment/GDP, and 3. the money/GDP ratio. These indicators are analyzed in the following:

First, Figure 8 shows that share prices (broad index from the IMF statistics) increased in all CEE economies especially after 2001 when credit growth increased and interest rates were low. In Figure 8 the development in Poland, Estonia and Romania is shown as representatives for the different exchange rate strategies. Since 2007 share prices have been falling sharply. The share price index follows the Eichengreen-Mitchener scheme for a credit boom.

[Figure 8][16]

Second, the development of the investment/GDP ratio is illustrated in Figure 9 using data of quarterly capital formation. Figure 9 indicates an increase of this ratio up to 2007 in Bulgaria, Romania, Estonia, Latvia, Lithuania and Slovenia. In the Slovak Republic, Czech Republic and Poland this cannot be found, even though the investment/GDP share increased after 2004 in accordance with the interest rate convergence. Hungary, troubled by instability did not see increases in the investment/GDP ratio, although share prices in Hungary have a similar trend to those in the other CEE economies. As increases in credit and investment were most pronounced among countries with tight pegs to the euro, e.g. the Baltic States, Bulgaria and Slovenia (Figure 7, 8 and 9), exchange rate pegs contributed to higher investment and growth rates in CEE countries from 1994 to 2007 (Hoffmann and Schnabl 2009, Schnabl 2008b).

[Figure 9][17]

Following Eichengreen and Mitchener (2003) a rising money/GDP ratio is the third indicator for an overinvestment boom in the sense of the Mises-Hayek theory. Figure 10 illustrated that the money/GDP share increased in all CEE economies during the boom. Especially from 2003-2007 the money/GDP share grew rapidly as capital inflows caused a fast accumulation of reserves in all CEE economies (that translated into additional monetary expansions). Figure 11 shows that countries with more flexible exchange rates did not stay behind exchange rate stabilizers in accumulating reserves. Countries with *de jure* intermediate exchange rate regimes like Romania and Slovakia even experienced the fastest reserve

[16] See Appendix B.
[17] See Appendix B.

accumulation. In accordance with the reserve accumulation, real appreciation accelerated in all new member states. Figure 12 indicates that there was no difference between the countries with flexible and fixed exchange rates. Although nominally the exchange rate was stable, for instance in Estonia, capital inflows led to wage and (asset) price increases, which appreciated the currency in real terms during the boom period.

[Figure 10] [Figure 11] [Figure 12][18]

The construction of a composite indicator of the three credit boom indicators may provide evidence of an interrelation of the credit boom indicators (Eichengreen and Mitchener 2003; Borio and Lowe 2002). Therefore the deviation of the money/GDP and investment/GDP ratios as well as of the development of share prices (growth) from their HP trend are added with equal weights for the average share prices growth, money/GDP and investment/GDP ratios in CEE. Figure 13 indicates that after 2005, the composite indicator signals a credit boom. Figure 14 shows the development of each indicator separately. As share prices seem to fluctuate heavily, even though they provide the same notion, the composite indicator without shares is constructed as well. The indicator widely remains unchanged. This provides *ex post* evidence in favor of the strand of literature that warned from overheating pressure in CEE due to credit booms since 2005, such as Egert and Backe (2006), Sopanha (2006), Duenwald et al. (2005), Mendoza and Terrones (2004) and Hoffmann and Schnabl (2007).

[Figure 13] [Figure 14][19]

The turn-around and downswing

According to the overinvestment theory, the pick up of inflation is the first indicator for overheating pressures (Figure 15) and brings about the turn-around. Similarly in CEE, the increase in inflation was followed by a bust. While until 2004 countries with fixed exchange rates outperformed countries with flexible exchange rates, inflation increased in these countries from 2005 to 2007. At the same time inflation in the euro area increased. This dampened the macroeconomic outlook and thereby the stability of the markets, especially after the ECB started to raise interest rates due to inflationary pressure in 2006. Then asset prices and credit growth stagnated. This provides evidence in favor of an unsustainable credit

[18] See Appendix B.
[19] See Appendix B.

boom.

[Figure 15][20]

Additionally, the emergence of the crisis in the US in 2007 and its transmission to Europe led to higher interest rates and falling output as investors invest less in emerging markets when they need liquidity in the safe havens. Due to fewer capital inflows the CEE economies faced a strong depreciation pressure. Therefore, the risk premium for investment projects increased dramatically. Thus, the lending-deposit rate spread increased from 2007 to early 2009. The inclusion of the risk raised costs of investment *(volatility and exchange rate risk)*. Interest rates increased (Figure 2). Therefore many investment projects that seemed profitable before were not sustainable anymore. The investment activity stagnated and asset prices fell. (Figure 8).

Because less capital is available at higher costs, the countries in CEE see a strong contraction and real depreciation in the current crisis. In countries with fixed exchange rates, wages have to decline to keep up competitiveness. For instance in Estonia, where wages are relatively flexible, a wages cut is expected for 2009. Countries with rather floating exchange rates like Poland depreciated strongly to adjust to the new situation. In this case, repaying credit lines denominated in euro becomes more expensive. Up to now, the crisis has hit Latvia and Hungary the most. They have had to ask for IMF money because of rising deficits bringing the countries close to insolvency.

4.3 Did easy liquidity contribute to boom-and-bust cycles?

Thus far the paper has shown that easy EMU liquidity conditions transferred to CEE and provided signs of a possible overinvestment boom prior to the current bust. In this part the analysis follows Carilli and Dempster (2008) to test whether easy credit conditions caused the boom that endogenously led to a bust, using a polynomial distributed lag model.[21] They show that a deviation of the money market from the natural rate in the United States increases GDP growth only for some periods, but in the long-run it causes a bust.

[20] See Appendix B.
[21] A polynomial distributed lag model is chosen as the overinvestment theories suggest that the relationship between the deviation and growth is quadratic (Carilli and Dempster 2008).

PDL-models are first introduced in Almon (1965) and most prominently used in Anderson and Jordan (1968) and Batton and Thornton (1983). The advantage over estimating a VAR is that the model estimates only few coefficients although it includes many lags in the estimation and derives their coefficients in a second step. Thus, it allows for a calculation of the coefficients with many lags and relatively few observations.[22]

Applying this technique to CEE, the lags of the deviation of the money market rate from the natural rate in CEE should explain the movements of industrial production. Here, more recent innovations in the interest rate should have a positive impact on growth, while more distant movements have a negative impact. The data in use remains the same. Granger causality tests verified the direction of transmission from the interest rate gap to the growth rates for all CEE economies.

In Appendix B the results for each country are illustrated separately using 24 lags (two years) in Tables 3 to 12. This lag length brings about better values of the Schwartz criterion than shorter lag length. Although more lags improve the Schwartz values slightly, they lower the robustness of the estimates as the number of observations included in the regression shrinks. Further, the error term is white noise using 24 lags and the lag length corresponds to the widely acknowledged lagged impact of changes in the interest rate on inflation and output.

Due to the lag length, the estimated coefficients feature the time period from January 2000 to December 2008.[23] The output tables provide the estimated coefficients for Z on top and the derived coefficients β_i for each lagged gap in the tables on the bottom. The curves show the distribution of the lags. A sign change of the coefficients β_i from positive to negative indicates that a lower market than natural rate has a positive short-term impact on growth, while a bust will follow the boom in later periods. This provides evidence of a turning point endogenous to the gap (Carilli and Dempster 2008).

The contemporaneous impact of the gap varies in the signs of the coefficients. But this impact is not significant for most economies. Only for Slovakia, Romania, Poland and Latvia there is a significant immediate effect. While this effect is positive for Slovakia, Latvia and Romania, it is negative for Poland. But for all countries the effect of a 3 to 4 lags of the gap is positive

[22] For the calculation of second order PDL models see Appendix C.
[23] Different lag lengths do not change the results.

and significant. Thus, a deviation of the money market rate from the natural rate has a positive effect on growth after 3 to 4 months.

Further, the exchange rate regime does not play a role for inducing boom-and-bust cycles due to a deviation of the market and the natural rate. However, the explanatory power is the highest for countries with hard pegs such as Estonia, Bulgaria and Latvia. Furthermore, the explanatory power of the regression is relatively high for Poland and Hungary (see Appendix D). For different lag lengths also the explanatory power for Romania and Lithuania is high. This signals that a deviation from the natural rate contributed to boom-and-bust-cycles in these countries.

5 Economic policy implications

This paper has focused on explaining how overinvestment due to easy liquidity conditions in the EMU and buoyant (foreign) credit growth can emerge in the small open economies of CEE. The empirical analysis has provided evidence in favor of a liquidity transmission from the EMU to CEE. At the same time there are some signs of a credit boom prior to the current crisis. This may signal overinvestment in the sense of the augmented Mises-Hayek theory which may have endogenously (by itself) led to the cyclical downturn.

Even though there is not a full insurance against speculation and false risk assessment, to lower the probability of economic turmoil in the future and cope with the current crisis the following policy implications arise from the paper:

First, as outlined by the overinvestment theory, the money market rate has to be close to its natural rate to reduce the risk of overinvestment cycles in the EMU and CEE, respectively. Thus, credit creation (banking sector) has to be brought under control by improved risk assessment and supervision. From this perspective, the current measures for a better supervision of the banking sector and the ECB paying attention to monetary aggregates provide hope for the future. But as credit creation may increase even without additional money supply from the central bank, future monetary policy models could consider taking into account asset prices and credit aggregates (Borio 2008), or departing from assumptions

of perfect information of the banking sector (Lombari and Sgherri 2007) to improve the prediction of future natural rates and keep credit conditions under control.

Second, from Mises's and Hayek's point of view, policy-induced credit expansions are not adequate to counteract a crisis as they delay the structural adjustment and prevent the reallocation of resources. Likewise, the events during the Asian crisis and following the dot-com bubble show that expansionary fiscal and monetary policies may cause moral hazard of the private sector, new distortions and new overinvestment cycles (Saxena and Wong 2002, Schnabl and Hoffmann 2008). In this sense, the current Bundesbank/ECB strategy is promising as it seems to acknowledge these findings. For instance, Jürgen Stark (member of the executive board of the ECB) recently announced that "the financial crisis can't be solved with rate cuts" and "the lower rates are the less incentive banks have to clean up their balance sheets and carefully monitor their credit risks" (Bloomberg 2009). Furthermore, Axel Weber (2008) argues that in the future liquidity conditions have to be restricted as they were loosened in the crisis (more symmetrically than before) to lower the probability of new bubbles or inflation.

Third, as the CEE countries with floating exchange rates have seen strong depreciations in the current crisis, exchange rate stabilizers should keep the peg to prevent their economy from further credit defaults. The IMF further promotes a fast euro adoption (The Baltic Times 2009). Instead of depreciating the countries' currencies, as widely suggested following the Asian crisis, wages should be reduced to adjust to the new situation and to regain competitiveness as currently done in Estonia.

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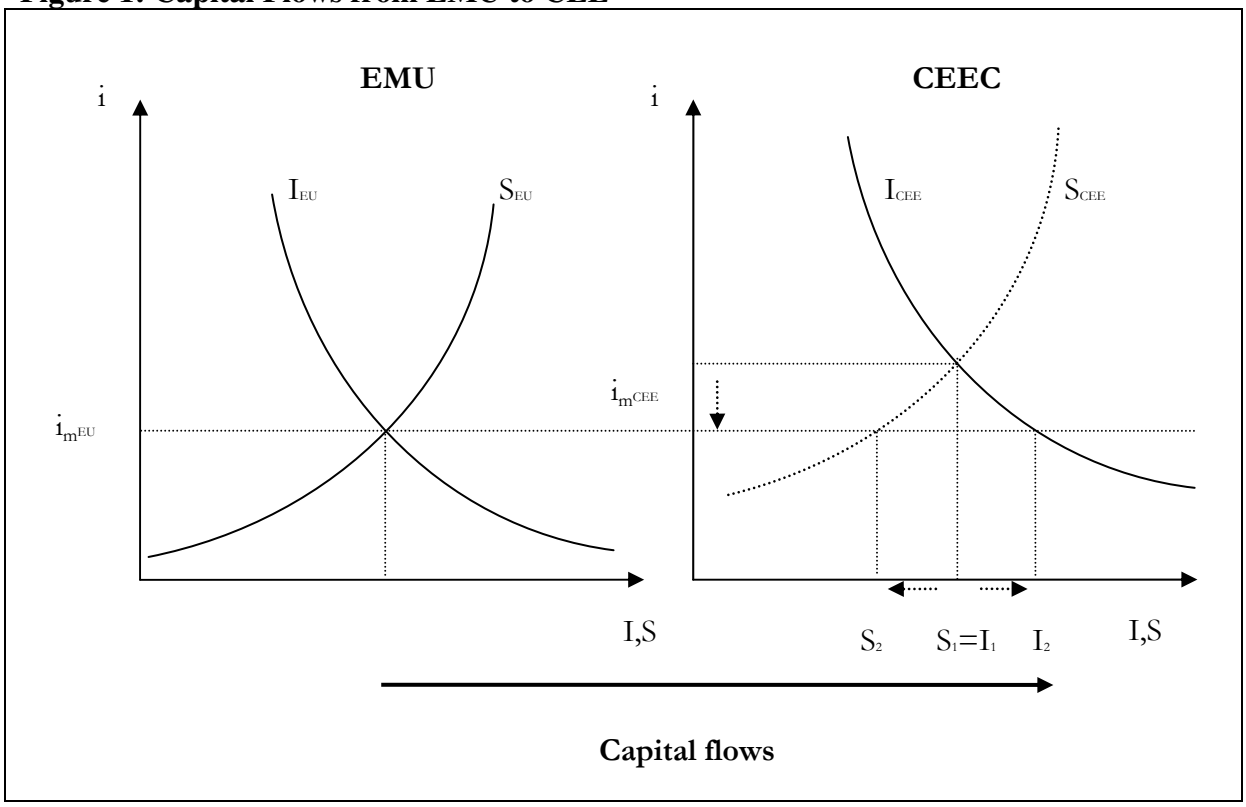
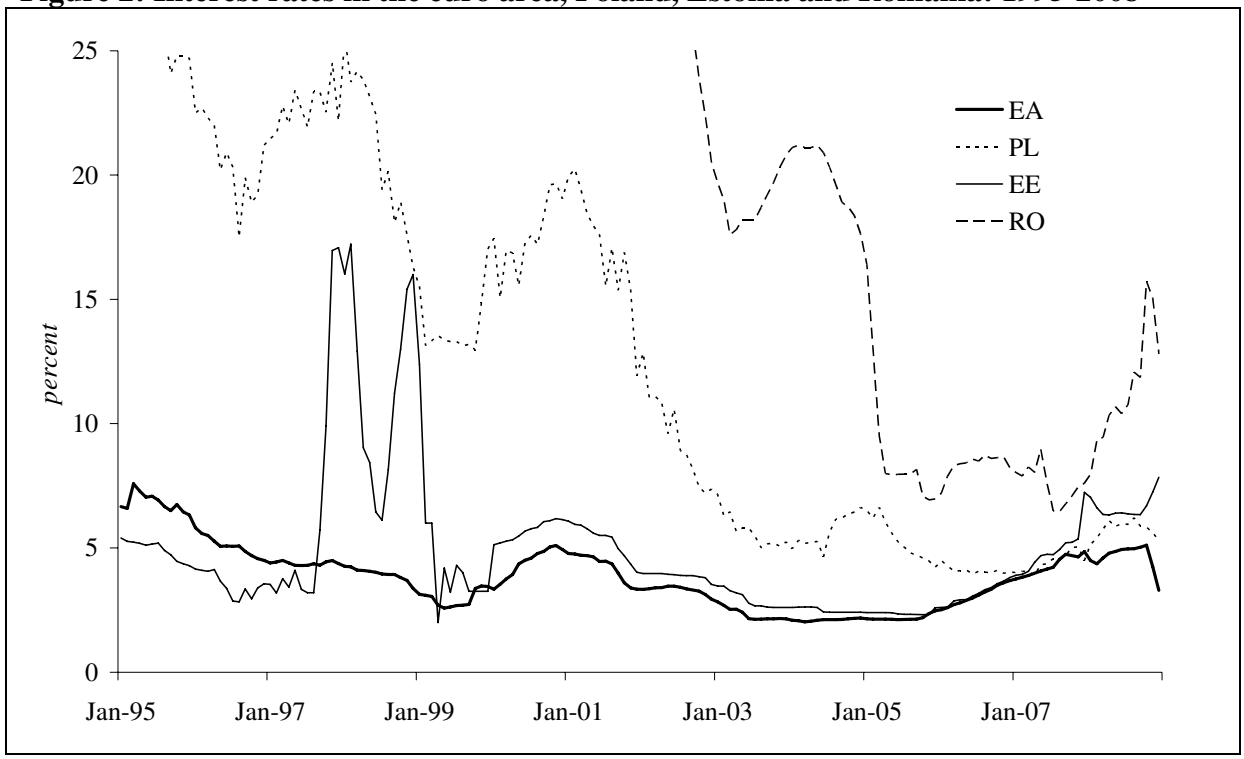
Appendix A

Figure 1: Capital Flows from EMU to CEE



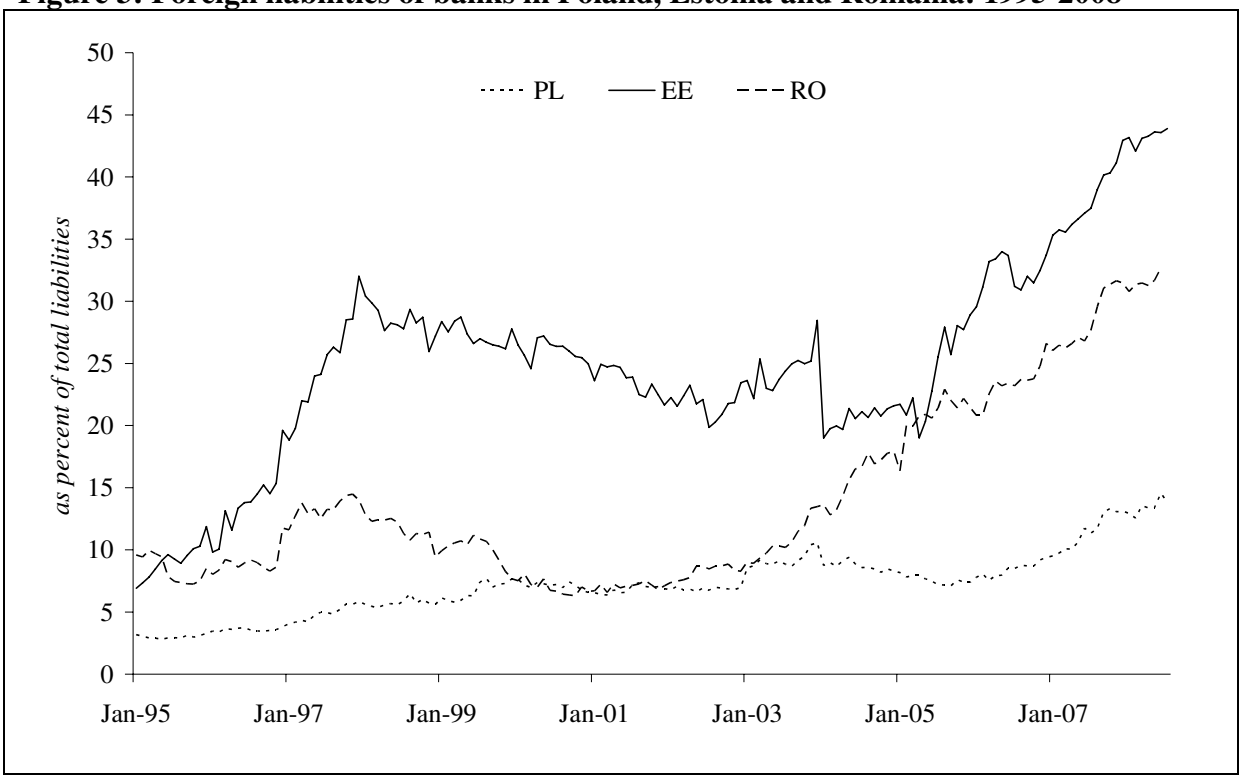
Source: Own drawing.

Figure 2: Interest rates in the euro area, Poland, Estonia and Romania: 1995-2008



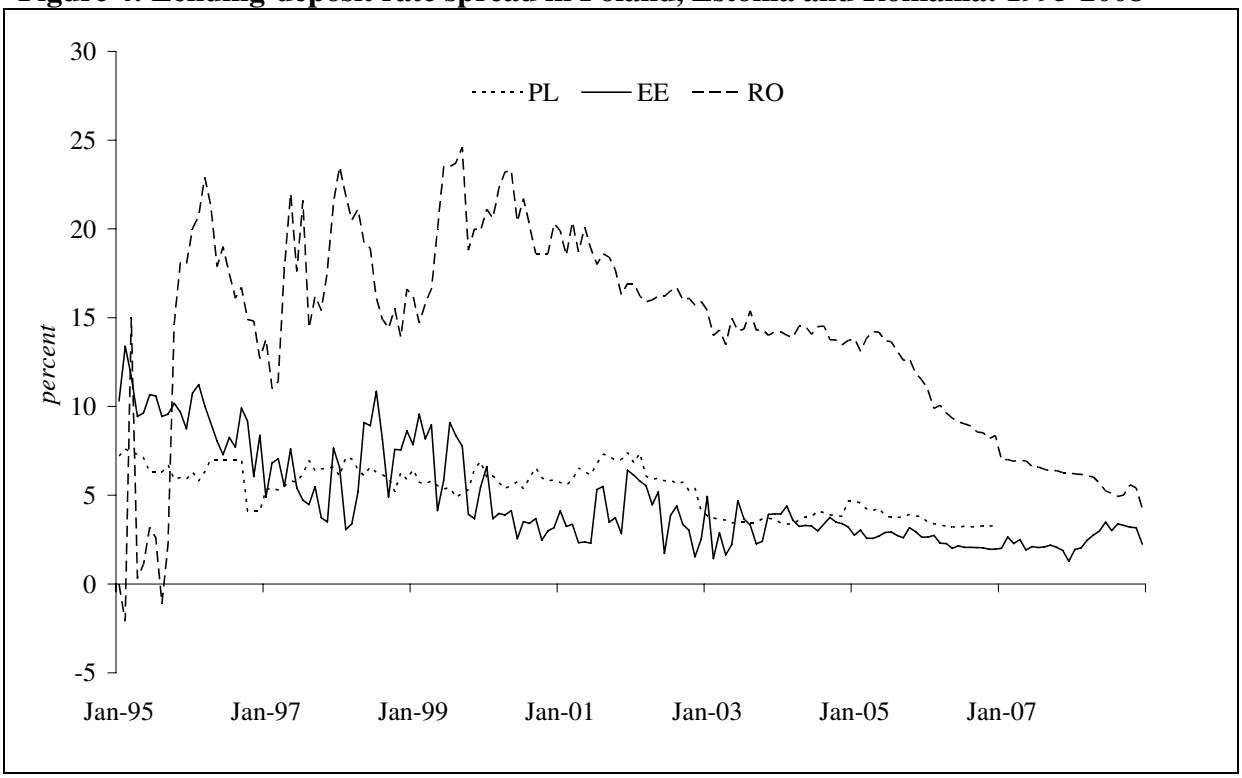
Source: IMF, IFS 2009 (Money market rates). PL, EE and RO represent the different exchange rate strategies of the CEE.

Figure 3: Foreign liabilities of banks in Poland, Estonia and Romania: 1995-2008



Source: IMF, IFS 2009. PL, EE and RO represent the different exchange rate strategies of the CEE.

Figure 4: Lending-deposit rate spread in Poland, Estonia and Romania: 1995-2008



Source: IMF, IFS 2009. PL, EE and RO represent the different exchange rate strategies of the CEE.

Table 1: Granger Causality of the interest rate gaps in the EMU and CEE

Causality relation tested	Obs. (lags)	F-statistics	Prob.
EMU gap do not GC *BU* gap	131	2.745	**0.069***
BU gap do not GC *EMU* gap	(2 lags)	4.172	0.019**
EMU gap do not GC *CZ* gap	129	8.371	**0.000*****
CZ gap do not GC *EMU* gap	(2 lags)	0.231	0.794
EMU gap do not GC *EE* gap	129	10.245	**0.000*****
EE gap do not GC *EMU* gap	(2 lags)	0.276	0.759
EMU gap do not GC *HU* gap	128	2.429	**0.092***
HU gap do not GC *EMU* gap	(2 lags)	0.022	0.978
EMU gap do not GC *LT* gap	128	0.797	***0.453******
LT gap do not GC *EMU* gap	(2 lags)	0.883	*0.416*
EMU gap do not GC *LV* gap	128	1.135	***0.325*****
LV gap do not GC *EMU* gap	(2 lags)	1.273	*0.284*
EMU gap do not GC *PL* gap	129	15.295	**0.000*****
PL gap do not GC *EMU* gap	(2 lags)	0.243	0.785
EMU gap do not GC *SI* gap	129	7.516	**0.000*****
SI gap do not GC *EMU* gap	(2 lags)	0.201	0.818
EMU gap do not GC *SK* gap	129	0.186	0.830
SK gap do not GC *EMU* gap	(2 lags)	0.246	0.782
EMU gap do not GC *RO* gap	129	0.148	0.865
RO gap do not GC *EMU* gap	(2 lags)	0.695	0.501

***, ** and * indicate levels of significance at the 10, 5 and 1 percent level. As Granger causality is also found for Latvia and Lithuania after 2001, *** indicates significance at the 1 percent level (after 2001).

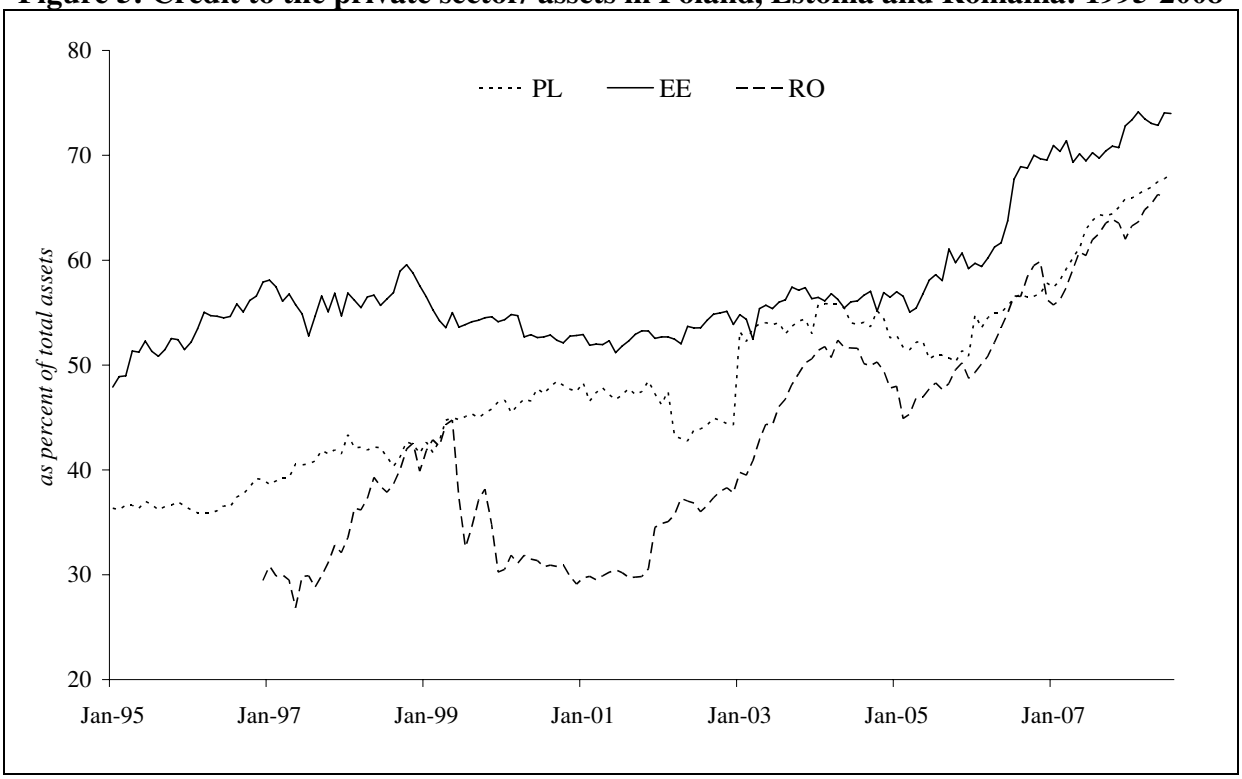
Table 2: Granger causality of EMU rates and Rates in NMS

Money market rates	Obs	F-statistics	Prob.
EMU rates do not GC *EE* rates	131	6.147	**0.003*****
EE rates do not GC *EMU* rates	(2 lags)	0.329	0.720
EMU rates do not GC *BU* rates	131	6.974	**0.001*****
BU rates do not GC *EMU* rates	(2 lags)	0.605	0.548
EMU rates do not GC *CZ* rates	132	2.450	**0.090***
CZ rates do not GC *EMU* rates	(2 lags)	0.015	0.985
EMU rates do not GC *HU* rates	132	5.689	**0.000*****
HU rates do not GC *EMU* rates	(2 lags)	2.620	0.077*
EMU rates do not GC *LT* rates	131	0.685	0.506
LT rates do not GC *EMU* rates	(2 lags)	0.055	0.946
EMU rates do not GC *LV* rates	131	7.220	**0.001*****
LV rates do not GC *EMU* rates	(2 lags)	1.493	0.229
EMU rates do not GC *PL* rates	132	10.010	**0.000*****
PL rates do not GC *EMU* rates	(3 lags)	1.798	0.151
EMU rates do not GC *SK* rates	131	0.050	0.951
SK rates do not GC *EMU* rates	(2 lags)	1.491	0.229
EMU rates do not GC *SI* rates	132	0.430	0.651
SI rates do not GC *EMU* rates	(2 lags)	0.204	0.816
EMU rates do not GC *RO* rates	131	0.897	0.410
RO rates do not GC *EMU* rates	(2 lags)	3.407	0.036**

The lags used are taken from the Schwartz test. For more lags as suggested by the Akaike criterion, the results remain unchanged and significance improves. The Slovakian interest rate is then Granger caused by the EMU rate. Lithuanian and Slovenian interest rates are Granger caused by EMU rates after 2001. But no causality can be found between the EMU and the Romanian interest rates.

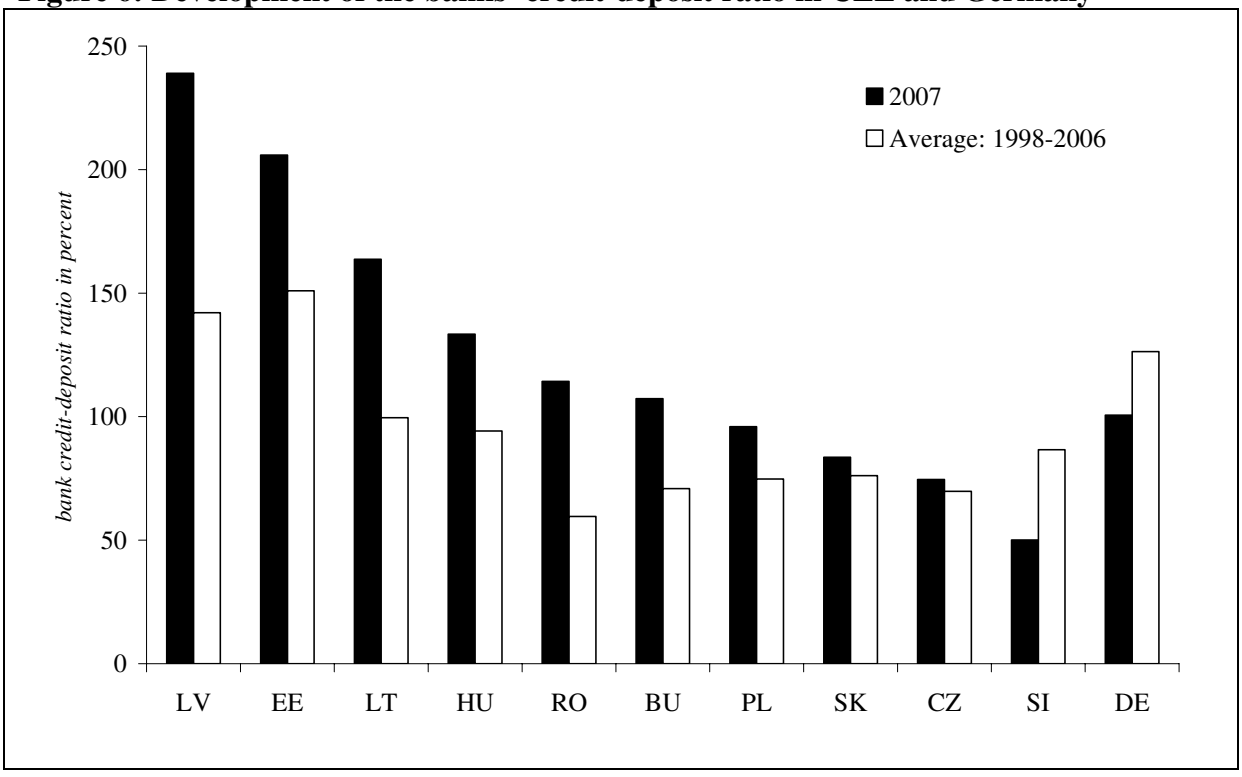
Appendix B

Figure 5: Credit to the private sector/ assets in Poland, Estonia and Romania: 1995-2008



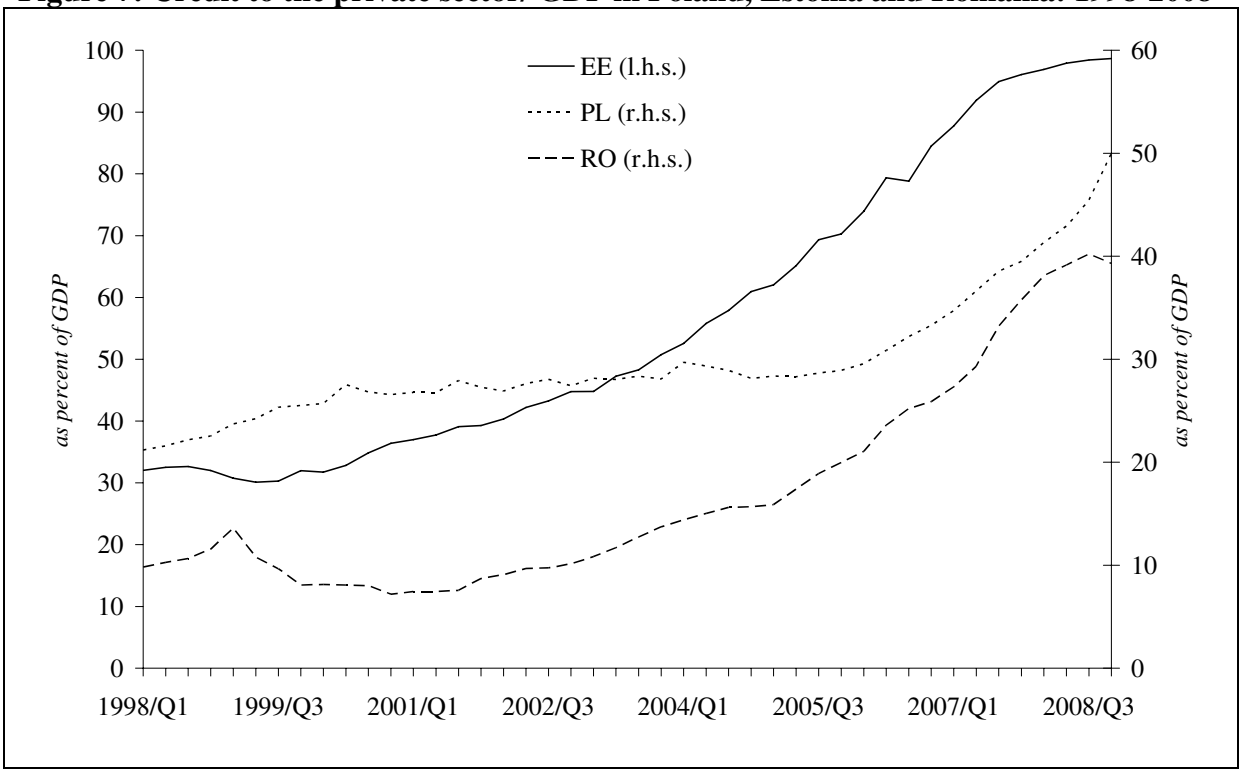
Source: IMF, IFS 2009. PL, EE and RO represent the different exchange rate strategies of the CEE.

Figure 6: Development of the banks' credit-deposit ratio in CEE and Germany



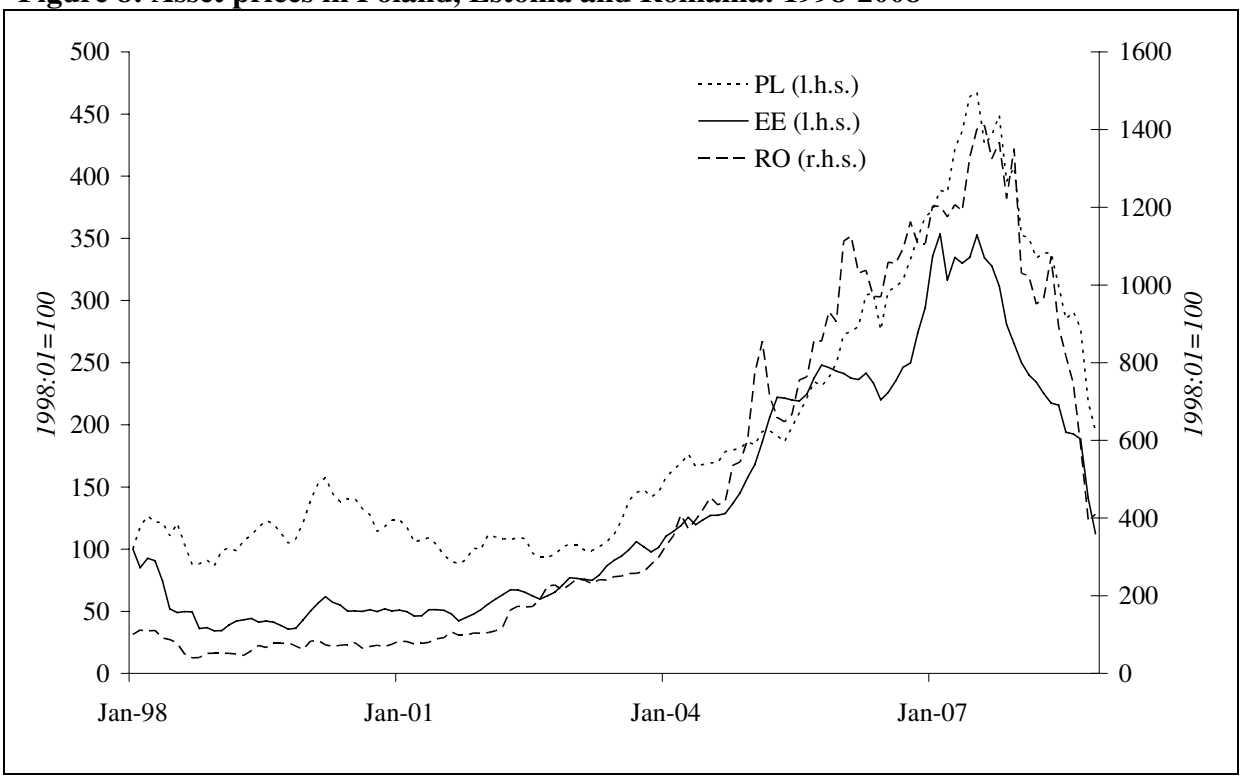
Source: World Bank, 2009.

Figure 7: Credit to the private sector/ GDP in Poland, Estonia and Romania: 1998-2008



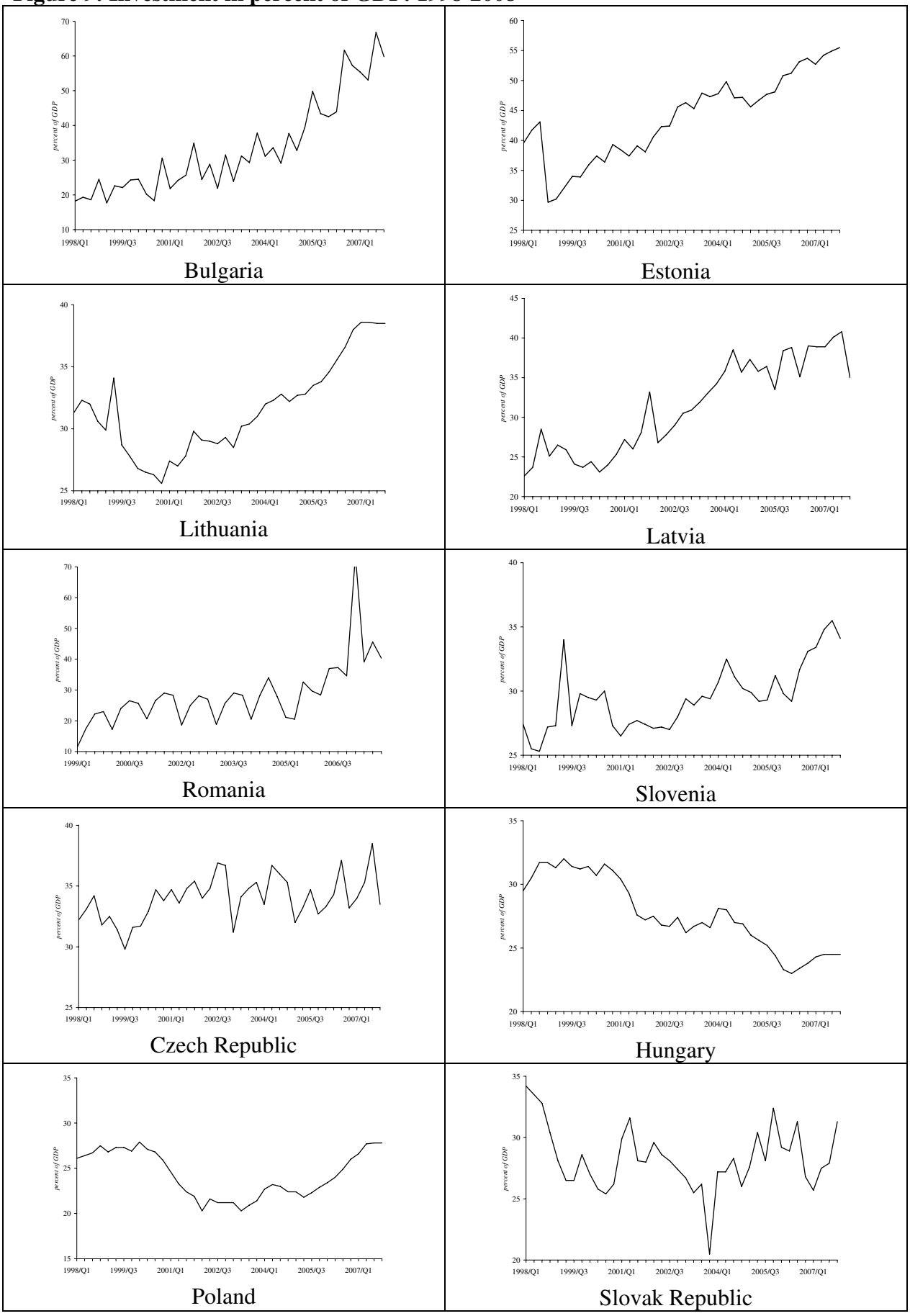
Source: IFS, 2009. PL, EE and RO represent the different exchange rate strategies of the CEE.

Figure 8: Asset prices in Poland, Estonia and Romania: 1998-2008



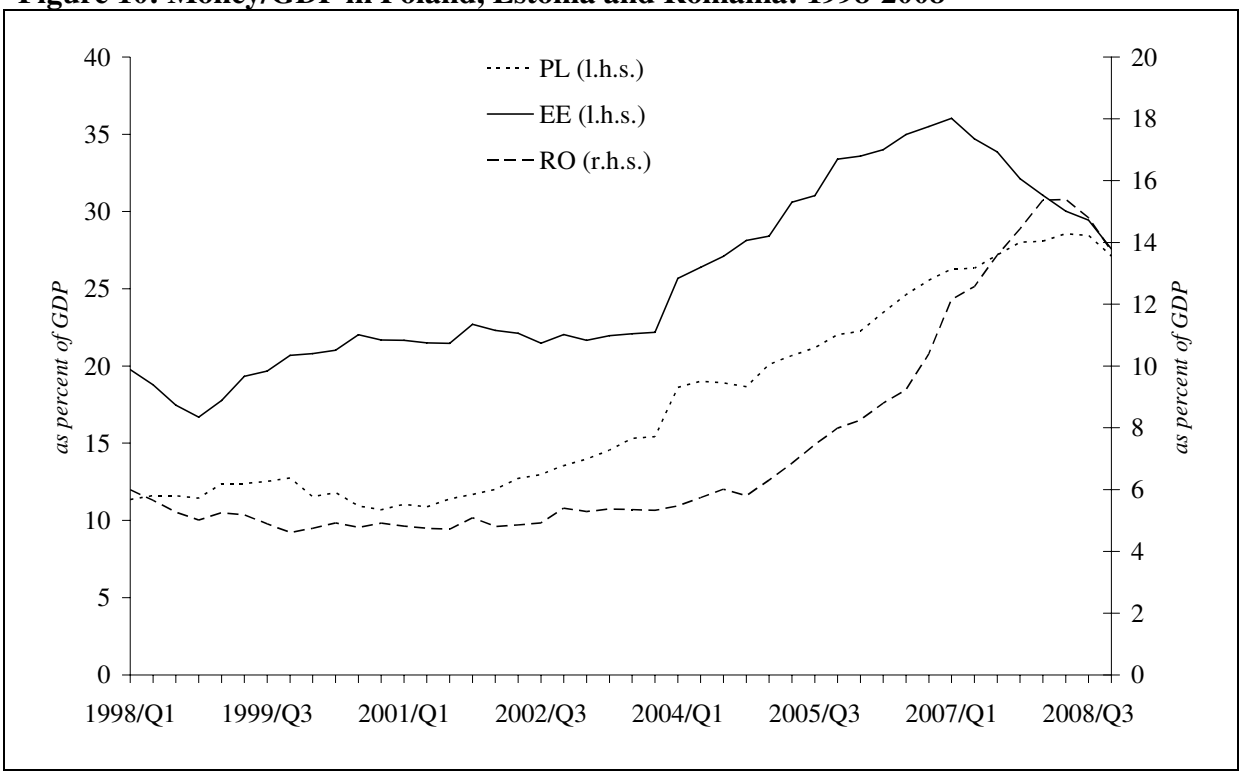
Source: IMF, IFS 2009. Share prices. PL, EE and RO represent the different exchange rate strategies of the CEE.

Figure 9: Investment in percent of GDP: 1998-2008



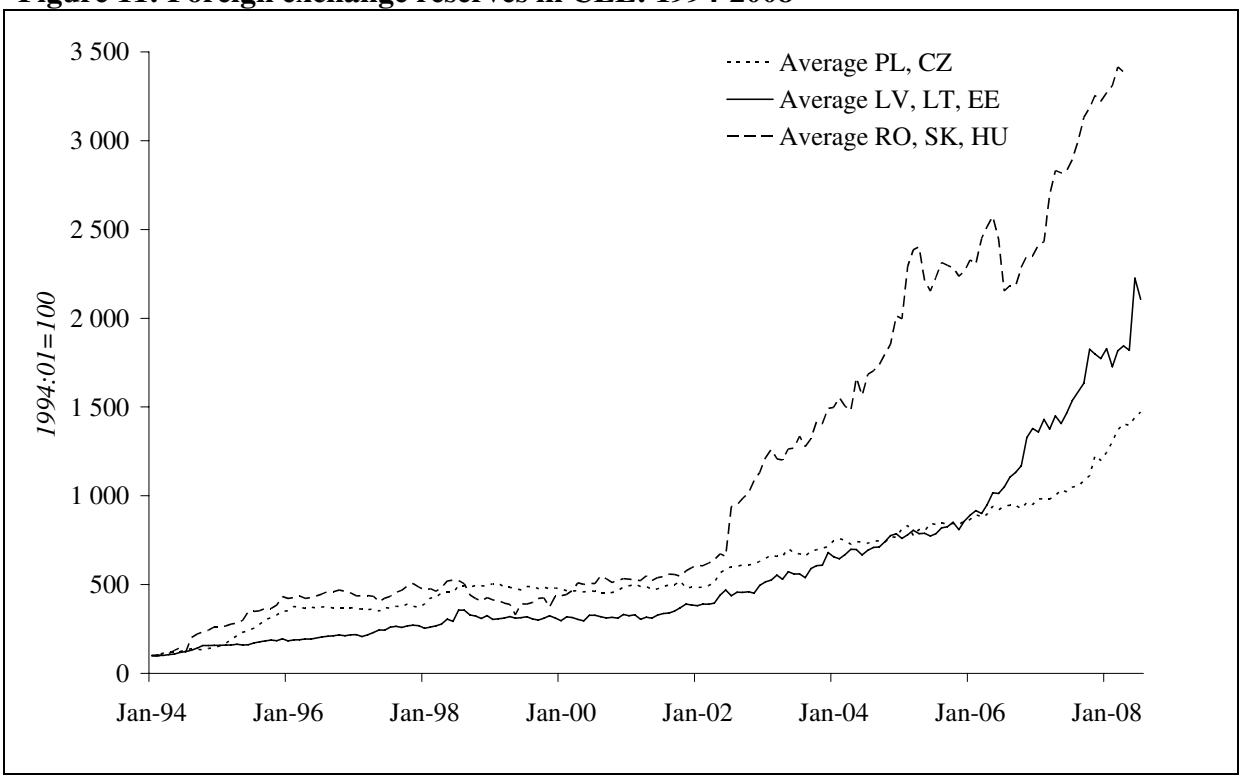
Source: Eurostat, 2009.

Figure 10: Money/GDP in Poland, Estonia and Romania: 1998-2008



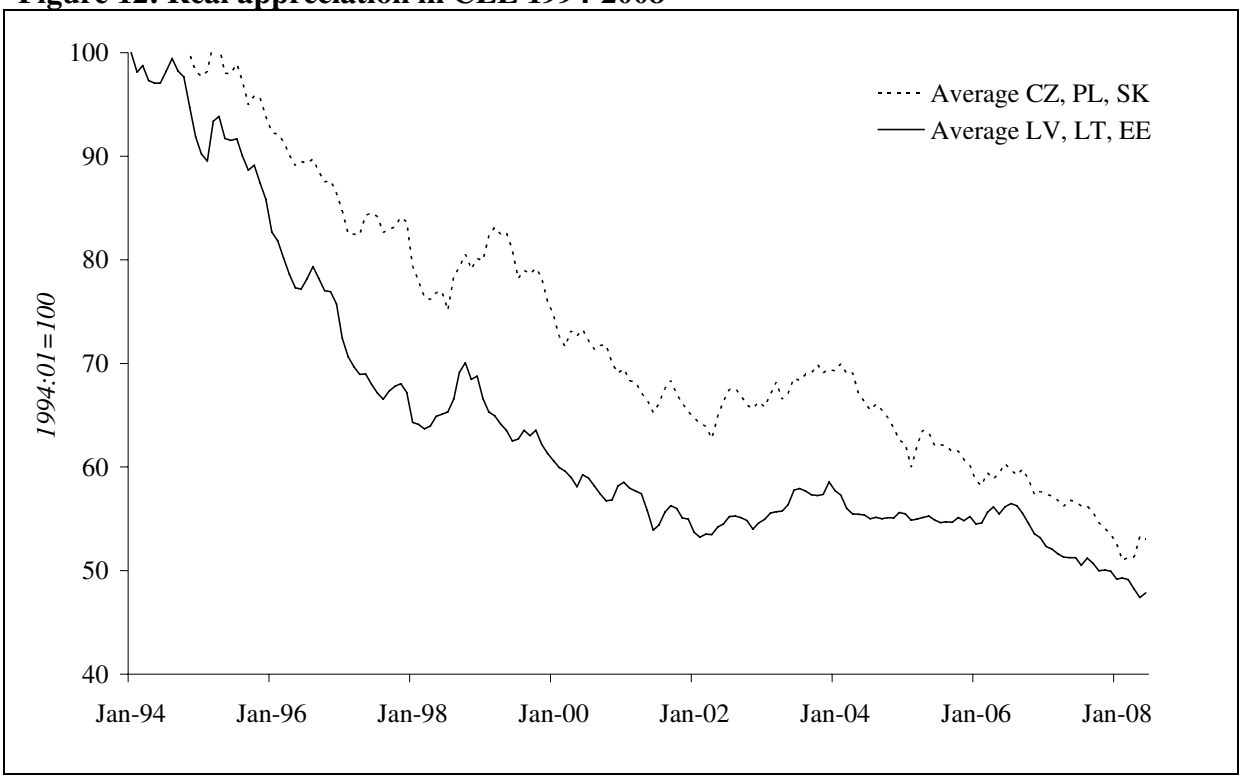
Source: IMF, IFS 2009. PL, EE and RO represent the different exchange rate strategies of the CEE.

Figure 11: Foreign exchange reserves in CEE: 1994-2008



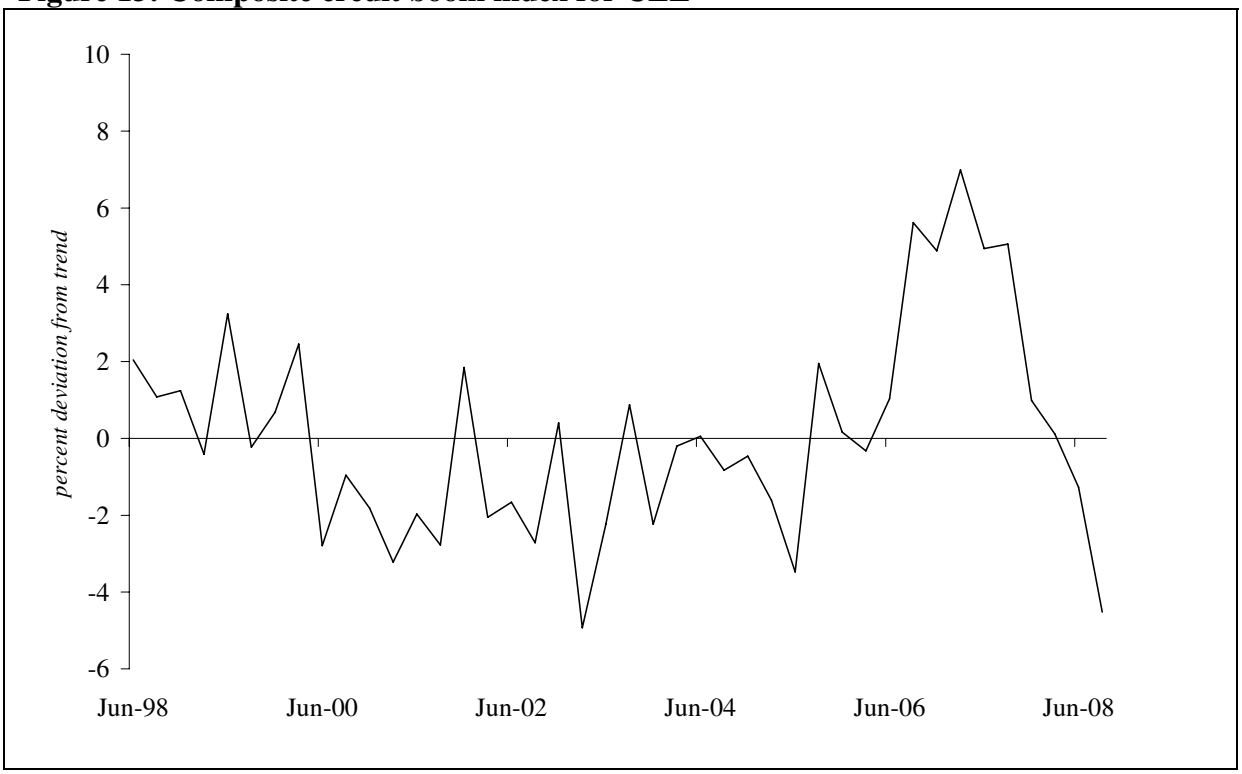
Source: IMF, IFS 2009. Averages represent different exchange rate regimes.

Figure 12: Real appreciation in CEE 1994-2008



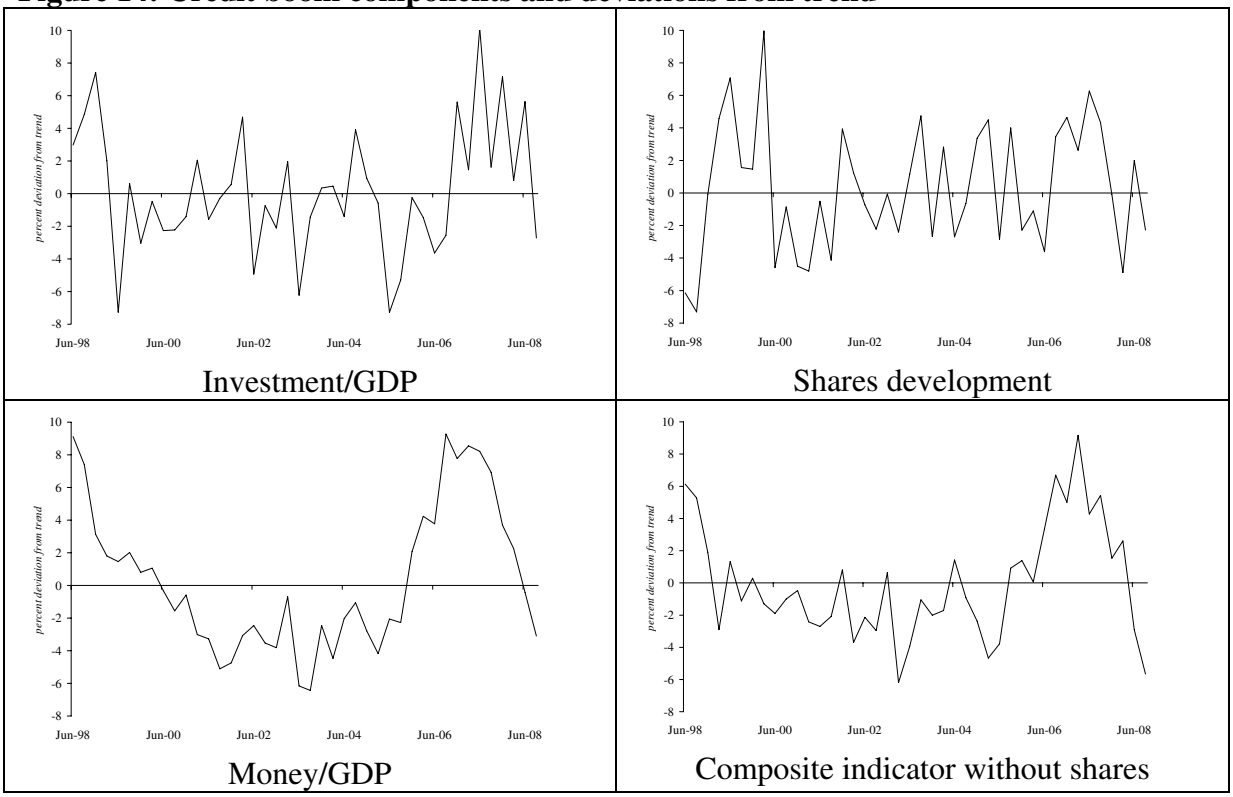
Source: IMF, IFS 2009. Averages represent countries with rather flexible and fixed exchange rate regimes.

Figure 13: Composite credit boom index for CEE



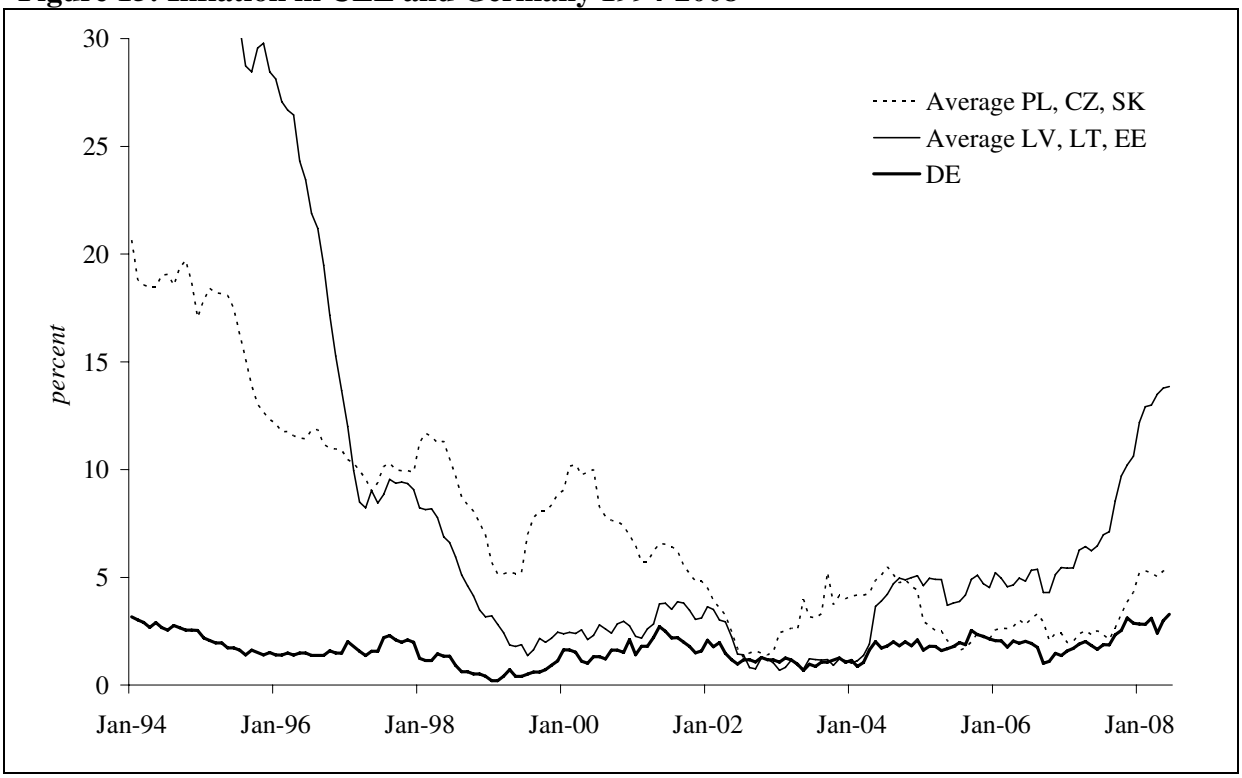
Source: IMF, IFS 2009. Average index for the CEE of investment/GDP, money/ GDP and asset price development from the hp-trend.

Figure 14: Credit boom components and deviations from trend



Source: IMF, IFS 2009. Average index for the CEE of investment/GDP, money/ GDP and asset price development from the hp-trend.

Figure 15: Inflation in CEE and Germany 1994-2008



Source: IMF, IFS 2009. Averages represent rather flexible or fixed exchange rate regimes.

Table 3: Bulgaria

Sample (adjusted): 2003M01 2008M11
Included observations: 71 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.090914	0.005934	15.32133	0.0000
PDL01	0.066145	0.019353	3.417778	0.0011
PDL02	-0.005666	0.000960	-5.904112	0.0000
PDL03	-0.001024	0.000366	-2.799115	0.0067
R-squared	0.498509			

Lag Distribution of BU_GAP	i	Coefficient	Std. Error	t-Statistic
*. |	0	-0.01333	0.03516	-0.37920
* |	1	0.00456	0.02700	0.16879
.* |	2	0.02040	0.01971	1.03492
. * |	3	0.03419	0.01346	2.53932
. * |	4	0.04593	0.00878	5.23253
. * |	5	0.05563	0.00698	7.97028
. * |	6	0.06327	0.00851	7.43803
. *|	7	0.06887	0.01129	6.10266
. *|	8	0.07242	0.01401	5.16951
. *|	9	0.07393	0.01627	4.54250
. *|	10	0.07338	0.01795	4.08874
. *|	11	0.07079	0.01898	3.72982
. * |	12	0.06614	0.01935	3.41778
. * |	13	0.05945	0.01907	3.11719
. * |	14	0.05072	0.01816	2.79292
. * |	15	0.03993	0.01666	2.39713
. * |	16	0.02709	0.01467	1.84696
.* |	17	0.01221	0.01243	0.98263
*. |	18	-0.00472	0.01048	-0.45035
* . |	19	-0.02370	0.00997	-2.37792
* . |	20	-0.04473	0.01200	-3.72728
* . |	21	-0.06780	0.01638	-4.14041
* . |	22	-0.09293	0.02235	-4.15840
* . |	23	-0.12010	0.02947	-4.07555
* . |	24	-0.14932	0.03754	-3.97781

Table 4: Czech Republic

Sample (adjusted): 2000M01 2008M11
Included observations: 107 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.057683	0.005357	10.76792	0.0000
PDL01	0.088465	0.024071	3.675261	0.0004
PDL02	-0.003954	0.001220	-3.241821	0.0016
PDL03	-0.001211	0.000434	-2.791332	0.0063
R-squared	0.256027			

Lag Distribution of CZ_GAP	i	Coefficient	Std. Error	t-Statistic
* . |	0	-0.03852	0.04314	-0.89297
*. |	1	-0.01461	0.03361	-0.43486
* |	2	0.00687	0.02523	0.27227
.* |	3	0.02593	0.01831	1.41646
. * |	4	0.04257	0.01347	3.16024
. * |	5	0.05679	0.01170	4.85322
. * |	6	0.06858	0.01294	5.30164
. * |	7	0.07795	0.01559	4.99995
. * |	8	0.08490	0.01841	4.61145
. * |	9	0.08943	0.02084	4.29069
. * |	10	0.09153	0.02265	4.04017
. * |	11	0.09121	0.02375	3.84082
. * |	12	0.08847	0.02407	3.67526
. * |	13	0.08330	0.02360	3.52926
. * |	14	0.07571	0.02234	3.38938
. * |	15	0.06570	0.02029	3.23851
. * |	16	0.05327	0.01749	3.04567
. * |	17	0.03841	0.01405	2.73370
.* |	18	0.02113	0.01031	2.04992
* |	19	0.00143	0.00755	0.18953
* . |	20	-0.02069	0.00887	-2.33333
* . |	21	-0.04524	0.01431	-3.16052
* . |	22	-0.07221	0.02177	-3.31726
* . |	23	-0.10160	0.03047	-3.33499
* . |	24	-0.13342	0.04019	-3.31992

Table 5: Estonia

Sample (adjusted): 2000M01 2008M11
Included observations: 107 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.087384	0.005560	15.71777	0.0000
PDL01	0.071656	0.022896	3.129556	0.0023
PDL02	-0.007556	0.000778	-9.706043	0.0000
PDL03	-0.001064	0.000416	-2.559971	0.0119
R-squared	0.582446			

Lag Distribution of EE_GAP	i	Coefficient	Std. Error	t-Statistic
* |	0	0.00911	0.03886	0.23443
.* |	1	0.02603	0.02941	0.88490
. * |	2	0.04082	0.02090	1.95279
. * |	3	0.05348	0.01349	3.96471
. * |	4	0.06401	0.00779	8.21420
. * |	5	0.07241	0.00615	11.7753
. *|	6	0.07869	0.00905	8.69370
. *|	7	0.08284	0.01288	6.43119
. *|	8	0.08486	0.01633	5.19540
. *|	9	0.08475	0.01912	4.43193
. *|	10	0.08251	0.02116	3.89884
. *|	11	0.07815	0.02242	3.48486
. * |	12	0.07166	0.02290	3.12956
. * |	13	0.06304	0.02258	2.79203
. * |	14	0.05229	0.02148	2.43479
. * |	15	0.03941	0.01961	2.00948
.* |	16	0.02441	0.01704	1.43243
* |	17	0.00728	0.01388	0.52435
*. |	18	-0.01198	0.01047	-1.14430
* . |	19	-0.03337	0.00803	-4.15698
* . |	20	-0.05689	0.00914	-6.22324
* . |	21	-0.08253	0.01407	-5.86630
* . |	22	-0.11030	0.02104	-5.24301
* . |	23	-0.14021	0.02927	-4.78986
* . |	24	-0.17223	0.03852	-4.47119

Table 6: Hungary

Sample (adjusted): 2000M01 2008M10
Included observations: 106 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.063937	0.017653	3.621866	0.0005
PDL01	0.056664	0.018969	2.987158	0.0035
PDL02	-0.006112	0.001360	-4.493761	0.0000
PDL03	-0.001131	0.000378	-2.995171	0.0034
R-squared	0.244316			

Lag Distribution of HU_GAP	i	Coefficient	Std. Error	t-Statistic
* . |	0	-0.03288	0.04341	-0.75739
*. |	1	-0.01298	0.03505	-0.37026
* |	2	0.00467	0.02765	0.16877
.* |	3	0.02005	0.02138	0.93772
. * |	4	0.03317	0.01650	2.00941
. * |	5	0.04402	0.01345	3.27321
. * |	6	0.05261	0.01249	4.21237
. *|	7	0.05895	0.01322	4.45777
. *|	8	0.06301	0.01476	4.26951
. *|	9	0.06482	0.01640	3.95349
. *|	10	0.06436	0.01775	3.62590
. *|	11	0.06164	0.01864	3.30740
. * |	12	0.05666	0.01897	2.98716
. * |	13	0.04942	0.01871	2.64175
. * |	14	0.03991	0.01785	2.23551
. * |	15	0.02815	0.01645	1.71069
.* |	16	0.01412	0.01461	0.96596
* |	17	-0.00218	0.01259	-0.17293
* . |	18	-0.02073	0.01097	-1.88952
* . |	19	-0.04155	0.01083	-3.83821
* . |	20	-0.06463	0.01306	-4.95033
* . |	21	-0.08997	0.01747	-5.15076
* . |	22	-0.11758	0.02344	-5.01545
* . |	23	-0.14745	0.03059	-4.82041
* . |	24	-0.17958	0.03871	-4.63905

Table 7: Lithuania

Sample (adjusted): 2000M01 2008M11
Included observations: 107 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.081625	0.010081	8.096662	0.0000
PDL01	0.014805	0.067640	0.218884	0.8272
PDL02	-0.005055	0.002057	-2.456885	0.0157
PDL03	-7.87E-05	0.001364	-0.057707	0.9541
R-squared	0.099139			

Lag Distribution of LT_GAP	i	Coefficient	Std. Error	t-Statistic
. *|	0	0.06413	0.12317	0.52063
. *|	1	0.06088	0.09275	0.65645
. * |	2	0.05748	0.06525	0.88094
. * |	3	0.05392	0.04100	1.31530
. * |	4	0.05021	0.02140	2.34610
. * |	5	0.04633	0.01486	3.11849
. * |	6	0.04230	0.02540	1.66539
. * |	7	0.03811	0.03810	1.00019
. * |	8	0.03377	0.04906	0.68829
. * |	9	0.02926	0.05761	0.50791
. * |	10	0.02460	0.06359	0.38683
. * |	11	0.01978	0.06694	0.29549
. * |	12	0.01481	0.06764	0.21888
.* |	13	0.00967	0.06568	0.14726
* |	14	0.00438	0.06108	0.07172
*. |	15	-0.00107	0.05389	-0.01981
*. |	16	-0.00667	0.04424	-0.15084
* . |	17	-0.01244	0.03251	-0.38252
* . |	18	-0.01836	0.02039	-0.90031
* . |	19	-0.02444	0.01703	-1.43453
* . |	20	-0.03067	0.03133	-0.97892
* . |	21	-0.03707	0.05326	-0.69594
* . |	22	-0.04362	0.07903	-0.55190
* . |	23	-0.05032	0.10791	-0.46636
* . |	24	-0.05719	0.13969	-0.40941

Table 8: Latvia

Sample (adjusted): 2000M01 2008M10
Included observations: 106 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.008406	0.014269	0.589084	0.5571
PDL01	-0.126194	0.034927	-3.613058	0.0005
PDL02	-0.015408	0.001875	-8.215840	0.0000
PDL03	0.002143	0.000671	3.191882	0.0019
R-squared	0.476287			

Lag Distribution of LV_GAP	i	Coefficient	Std. Error	t-Statistic
. *|	0	0.36727	0.06327	5.80506
. * |	1	0.30258	0.04828	6.26710
. * |	2	0.24217	0.03484	6.95146
. * |	3	0.18605	0.02321	8.01675
. * |	4	0.13421	0.01430	9.38480
. * |	5	0.08666	0.01100	7.88015
.* |	6	0.04340	0.01443	3.00771
* |	7	0.00442	0.01993	0.22164
*. |	8	-0.03028	0.02511	-1.20570
* . |	9	-0.06068	0.02933	-2.06889
* . |	10	-0.08681	0.03241	-2.67834
* . |	11	-0.10864	0.03428	-3.16915
* . |	12	-0.12619	0.03493	-3.61306
* . |	13	-0.13946	0.03436	-4.05887
* . |	14	-0.14844	0.03262	-4.55068
* . |	15	-0.15313	0.02980	-5.13899
* . |	16	-0.15354	0.02609	-5.88442
* . |	17	-0.14967	0.02196	-6.81691
* . |	18	-0.14150	0.01848	-7.65616
* . |	19	-0.12906	0.01790	-7.20885
* . |	20	-0.11232	0.02215	-5.07173
* . |	21	-0.09130	0.03056	-2.98736
* . |	22	-0.06600	0.04177	-1.58003
*. |	23	-0.03641	0.05502	-0.66179
* |	24	-0.00253	0.06996	-0.03620

Table 9: Poland

Sample (adjusted): 2000M01 2008M11
Included observations: 107 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.073779	0.005889	12.52906	0.0000
PDL01	0.081836	0.013101	6.246566	0.0000
PDL02	-0.003217	0.000810	-3.973405	0.0001
PDL03	-0.001374	0.000255	-5.386705	0.0000
R-squared	0.434181			

Lag Distribution of PL_GAP	i	Coefficient	Std. Error	t-Statistic
* . |	0	-0.07740	0.02635	-2.93727
* . |	1	-0.04901	0.02065	-2.37312
*. |	2	-0.02338	0.01559	-1.49985
* |	3	-0.00049	0.01127	-0.04382
. * |	4	0.01964	0.00798	2.46170
. * |	5	0.03704	0.00629	5.88624
. * |	6	0.05168	0.00655	7.89088
. * |	7	0.06357	0.00796	7.98978
. * |	8	0.07272	0.00960	7.57635
. * |	9	0.07912	0.01105	7.15778
. * |	10	0.08277	0.01216	6.80651
. * |	11	0.08368	0.01285	6.51050
. * |	12	0.08184	0.01310	6.24657
. * |	13	0.07725	0.01290	5.99018
. * |	14	0.06991	0.01224	5.71153
. * |	15	0.05982	0.01115	5.36344
. * |	16	0.04699	0.00969	4.85068
. * |	17	0.03141	0.00796	3.94305
.* |	18	0.01308	0.00633	2.06474
* |	19	-0.00800	0.00568	-1.40793
* . |	20	-0.03183	0.00707	-4.50022
* . |	21	-0.05840	0.01024	-5.70342
* . |	22	-0.08772	0.01449	-6.05443
* . |	23	-0.11979	0.01949	-6.14554
* . |	24	-0.15460	0.02512	-6.15395

Table 10: Romania

Sample (adjusted): 2000M01 2008M11
Included observations: 107 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.037829	0.007127	5.307524	0.0000
PDL01	0.000562	0.004995	0.112485	0.9107
PDL02	-0.002225	0.000690	-3.226844	0.0017
PDL03	2.21E-05	0.000103	0.213952	0.8310
R-squared	0.153912			
Lag Distribution of RO_GAP		i	Coefficient	Std. Error	t-Statistic
. *|		0	0.03045	0.01582	1.92502
. * |		1	0.02772	0.01325	2.09155
. * |		2	0.02503	0.01093	2.29041
. * |		3	0.02238	0.00886	2.52563
. * |		4	0.01978	0.00709	2.79127
. * |		5	0.01722	0.00565	3.04841
. * |		6	0.01471	0.00462	3.18298
. * |		7	0.01224	0.00406	3.01318
. * |		8	0.00982	0.00395	2.48612
.* |		9	0.00744	0.00414	1.79798
.* |		10	0.00510	0.00445	1.14644
.* |		11	0.00281	0.00476	0.59017
* |		12	0.00056	0.00500	0.11249
*. |		13	-0.00164	0.00512	-0.32074
*. |		14	-0.00380	0.00511	-0.74337
* . |		15	-0.00592	0.00498	-1.18722
* . |		16	-0.00799	0.00475	-1.68227
* . |		17	-0.01001	0.00445	-2.24980
* . |		18	-0.01199	0.00418	-2.87289
* . |		19	-0.01393	0.00406	-3.43362
* . |		20	-0.01583	0.00427	-3.70835
* . |		21	-0.01768	0.00492	-3.58997
* . |		22	-0.01948	0.00603	-3.23020
* . |		23	-0.02124	0.00753	-2.82153
* . |		24	-0.02296	0.00935	-2.45443

Table 11: Slovenia

Sample (adjusted): 2000M01 2008M11
Included observations: 107 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.045796	0.009703	4.719696	0.0000
PDL01	0.081662	0.035396	2.307112	0.0230
PDL02	-0.003975	0.001552	-2.561125	0.0119
PDL03	-0.001455	0.000713	-2.039625	0.0439
R-squared	0.120534			

Lag Distribution of SI_GAP	i	Coefficient	Std. Error	t-Statistic
* . |	0	-0.08015	0.06559	-1.22202
* . |	1	-0.05066	0.04992	-1.01494
* . |	2	-0.02408	0.03590	-0.67076
* |	3	-0.00041	0.02386	-0.01733
.* |	4	0.02035	0.01482	1.37331
. * |	5	0.03819	0.01181	3.23547
. * |	6	0.05313	0.01551	3.42564
. *|	7	0.06516	0.02115	3.08173
. *|	8	0.07428	0.02637	2.81745
. *|	9	0.08049	0.03055	2.63520
. *|	10	0.08379	0.03349	2.50227
. *|	11	0.08418	0.03511	2.39743
. *|	12	0.08166	0.03540	2.30711
. *|	13	0.07623	0.03433	2.22081
. *|	14	0.06789	0.03192	2.12716
. * |	15	0.05664	0.02821	2.00801
. * |	16	0.04248	0.02331	1.82272
.* |	17	0.02541	0.01753	1.44961
* |	18	0.00544	0.01210	0.44927
*. |	19	-0.01745	0.01143	-1.52655
* . |	20	-0.04325	0.01853	-2.33475
* . |	21	-0.07196	0.02964	-2.42760
* . |	22	-0.10358	0.04295	-2.41184
* . |	23	-0.13811	0.05796	-2.38274
* . |	24	-0.17555	0.07454	-2.35513

Table 12: Slovakia

Sample (adjusted): 2000M01 2008M11
Included observations: 107 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.088496	0.007238	12.22646	0.0000
PDL01	-0.014479	0.011392	-1.271007	0.2066
PDL02	0.000867	0.000863	1.005340	0.3171
PDL03	0.000545	0.000237	2.296676	0.0237
R-squared	0.115291			

Lag Distribution of SK_GAP	i	Coefficient	Std. Error	t-Statistic
. * |	0	0.05358	0.02552	2.09913
. * |	1	0.04191	0.02030	2.06419
. * |	2	0.03134	0.01567	1.99937
. * |	3	0.02185	0.01173	1.86366
. * |	4	0.01346	0.00866	1.55429
.* |	5	0.00615	0.00683	0.90056
* |	6	-6.6E-05	0.00652	-0.01018
*. |	7	-0.00519	0.00733	-0.70877
*. |	8	-0.00923	0.00854	-1.08082
*. |	9	-0.01218	0.00970	-1.25487
*. |	10	-0.01403	0.01062	-1.32192
*. |	11	-0.01480	0.01119	-1.32263
*. |	12	-0.01448	0.01139	-1.27101
*. |	13	-0.01307	0.01121	-1.16554
*. |	14	-0.01056	0.01066	-0.99078
*. |	15	-0.00697	0.00979	-0.71206
*. |	16	-0.00229	0.00870	-0.26340
* |	17	0.00348	0.00761	0.45729
. * |	18	0.01034	0.00697	1.48343
. * |	19	0.01829	0.00743	2.46025
. * |	20	0.02733	0.00932	2.93400
. * |	21	0.03746	0.01238	3.02583
. * |	22	0.04868	0.01632	2.98311
. * |	23	0.06099	0.02095	2.91176
. * |	24	0.07439	0.02617	2.84264

Appendix C

The PDL-model

The lag-model for the CEE economies is specified as follows: Real growth in industrial production $\hat{g}$ is a function of the deviation of the natural from the real interest rate in CEE X_t.

$$\hat{g}_t = \alpha + \sum_{i=0}^{k} \beta_i X_{t-i} + \varepsilon_t \qquad (1)$$

with

$$\beta_i = a_o + \sum_{j=1}^{m} a_j i_j \qquad (2)$$

Assuming β_i to be a second degree polynomial *(j=2)* as in Carilli and Dempster (2008) brings about the following second order polynomial:

$$\beta_i = a_o + a_1 i + a_2 i^2$$

at lag length *i.* Thus,

$$\beta_0 = a_o$$

$$\beta_1 = a_o + a_1 + a_2$$

$$\beta_2 = a_o + a_1 * 2 + a_2 * 4$$

$$\vdots$$

$$\beta_k = a_o + a_1 * k + a_2 * k^2$$

Replacing β_0 to β_k in the growth equations brings about:

$$\hat{g}_t = \alpha + a_0 X_t + (a_0 + a_1 + a_2) * X_{t-1} + ... + (a_0 + a_1 * k + a_2 * k^2) * X_{t-k} + \varepsilon_t$$

or

$$\hat{g}_t = \alpha + a_0 (X_t + X_{t-1} + ... + X_{t-k}) + a_1 (X_t + 1X_{t-1} + ... + kX_{t-k}) + a_2 (X_t + 1X_{t-1} + ... + k^2 X_{t-k}) + \varepsilon_t$$

Then the parameters are substituted by the variables *Z*, which leads to the regression:

$$\hat{g}_t = \alpha + a_0 Z_{0t} + a_1 Z_{1t} + a_2 Z_{2t} + \varepsilon_t \qquad (3)$$

with

$$Z_{0t} = X_t + X_{t-1} + X_{t-2} + ... + X_{t-k}$$

$$Z_{1t} = X_t + 1X_{t-1} + 2X_{t-2} + ... + kX_{t-k}$$

$$Z_{2t} = X_t + 1X_{t-1} + 4X_{t-2} + ... + k^2 X_{t-k}$$

In 4.2 equation (3) is estimated.