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Master Thesis

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Master Thesis

Credit Growth in Central and Eastern Europe

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Academic year: 2011/2012

Declaration of Authorship

I hereby declare that I compiled the master thesis independently, using only the listed resources and literature.

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Prague, February 29, 2012 _____

Helena Němcová

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Abstract

This thesis focuses on the development of credit to the private sector in the Central and Eastern European (CEE) countries. Although the speed of credit growth in these countries has recently slowed down as the consequence of the global financial crisis, the overall increase in credit to the private sector over the past decades has been immense. As a result, the thesis examines whether this substantial increase in credit is linked to the convergence of the CEE countries towards the equilibrium or whether it represents an excessive credit growth that could threaten the macroeconomic and financial stability in these countries. We estimate the equilibrium credit levels for 11 transition countries by applying a dynamic panel data model. Since in-sample approach may bias the estimation results we perform the estimates out-of-sample using a panel of selected developed EU countries as a benchmark. The difference between the actual and estimated credit-to-GDP ratios serves as a measure of private credit excessiveness. The results indicate a slightly excessive or close to the equilibrium credit-to-GDP ratios in Bulgaria, Estonia, and Latvia prior to the financial crisis. With regard to the significant decline in GDP during the crisis this measure of credit excessiveness in these countries have further increased.

Abstrakt

Tato práce se zabývá vývojem úvěru soukromému sektoru v zemích střední a východní Evropy. Ačkoliv se jako následek globální finanční krize rychlost růstu úvěru v těchto zemích zpomalila, celkový nárůst úvěru soukromému sektoru během posledních desetiletí byl značný. Práce z tohoto důvodu zkoumá, do jaké míry byl tento velký nárůst úvěru spojen spíše s konvergencí zemí střední a východní Evropy k rovnovážnému stavu nebo zda se jednalo o již nadměrný úvěrový růst, který by mohl ohrozit makroekonomickou a finanční stabilitu v těchto zemích. Pomocí dynamického modelu panelových dat je odhadnuta rovnovážná úroveň úvěru pro 11 tranzitivních zemí. Jelikož odhad in-sample by mohl dané úrovně zadlužení zkreslit, je tento odhad proveden out-of-sample na vybraných rozvinutých zemích EU. Rozdíl mezi skutečnými a modelem odhadnutými podíly úvěrů na HDP slouží jako ukazatel nadměrného zadlužení soukromého sektoru. Výsledky ukazují, že před finanční krizí byl tento ukazatel zadlužení v Bulharsku, Estonsku a Lotyšsku mírně nadměrný nebo již blízko své rovnovážné úrovně. Vzhledem k výraznému poklesu HDP během krize se odhadnutý ukazatel nadměrného zadlužení u těchto zemí dále zvýšil.

JEL klas.:   C23, E44, G21

Klíčová slova: úvěr soukromému sektoru, nadměrný růst úvěru, tranzitivní země, dynamický model panelových dat

Master Thesis Proposal

Author: Bc. Helena Němcová

Supervisor: PhDr. Jakub Seidler

Proposed Topic: Credit growth in the Czech Republic: Determinants and future development forecasts

Topic characteristics:

The recent boom in the lending to the private sector in Central and Eastern European countries gave rise to a wide range of literature concerning the equilibrium credit growth. The main issue is, whether the steep credit growth is a sign of convergence to the equilibrium or if it is rather overshooting of the equilibrium that is not sustainable in the long run.

In my thesis I will focus on credit growth determinants that relate to both demand and supply side of the credit market. I will try to find the equilibrium credit growth for the Czech Republic to be able to decide, whether it is the overshooting case or not and finally I will try to predict the future credit growth rate.

Hypotheses:

Czech Republic does not belong to the credit growth overshooting countries.

In expansion the credit growth is more sensitive to demand side determinants, on the other hand, the supply side determinants are stronger in contraction.

Panel co-integration is an appropriate method for forecasting the credit growth rate.

Outline:

- Introduction
- Literature survey
- Determinants of credit growth
-         Model on credit demand and credit supply
-         Determinants of household credit
-         Determinants of corporate credit

- Equilibrium credit growth in the Czech Republic

- Forecasting the credit growth rate

- Results

- Conclusion

Methodology:

Econometric analysis of time series

VAR models

Co-integration analysis based on VAR models

Stochastic simulation econometric model

Core bibliography:

Albulescu, C. T. (2009): *Forecasting Credit Growth Rate in Romania: From Credit Boom to Credit Crunch?*, MPRA Paper No. 16740, 2009

Aydin, B. (2008): *Banking Structure and Credit Growth in Central and Eastern European Countries*, IMF Working Paper 215

Backé, P., Égert, B. and Walko, Z. (2007): *Credit Growth in Central and Eastern Europe Revisited*, Oesterreichische Nationalbank, Focus 2/07, pp.69-77

Coricelli, F., Mucci, F., Revoltella, D. (2006): *Household Credit in the New Europe: Lending Boom or Sustainable Growth?*, CEPR Discussion Paper No. 5520, 2006

Cottarelli, C., Dell'Ariccia, G. and Vladkova-Hollar I. (2005): *Early Birds, Late Risers, and Sleeping Beauties: Bank Credit Growth to the Private Sector in Central and Eastern Europe and the Balkans*, IMF Working Paper No. 03/213, 2005

Égert, B., Backé, P. and Zumer, T. (2006): *Credit Growth in Central and Eastern Europe. New (Over)shooting Stars?*, ECB Working Paper Series no.687

Hofmann, B. (2001): *The Deteminants of Private Sector Credit in Industrialised Countries: Do Property Prices matter?*, BIS Working Paper 108

Park, S. (1993): *The Determinants of Consumer Installment Credit*, "FED of St. Louis Review", No.11, pp.23-38

Prague, October 30, 2009   _____

                                                              Supervisor

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List of Acronyms

ADF	Augmented Dickey-Fuller Test
AIC	Akaike Information Criterion
ARDL	Autoregressive Distributed Lag Model
BCPS	Bank Credit to the Private Sector
BIC	Bayesian Information Criterion
CEE	Central and Eastern Europe
CPI	Consumer Price Index
DFE	Dynamic Fixed Effects Model
DOLS	Dynamic Ordinary Least Squares
ECM	Error Correction Model
EU	European Union
FE	Fixed Effects Model
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
HP	Hodrick-Prescott Filter
IFS	International Financial Statistics
IMF	International Monetary Fund
IPS	Im-Pesaran-Shin Test
MG	Mean Group Estimator
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PIIGS	Portugal, Italy, Ireland, Greece, and Spain
PMG	Pooled Mean Group Estimator
PPP	Purchasing Power Parity
PPS	Purchasing Power Standards
VAR	Vector Autoregression Model
VECM	Vector Error Correction Model
WDI	World Development Indicators

Introduction

The Central and Eastern European (CEE) countries have experienced a rapid growth of credit to the private sector. Even though the growth rate have slowed down in the aftermath of the global financial crisis, the increase in private credit over the past decades has been immense. The rapid credit dynamics in these countries might be attributed to comprehensive legal reforms and to macroeconomic stabilization brought by the transition process. Institutional changes in financial sector, entry of foreign banks into the market, and the overall financial deepening enhanced both supply and demand for credit. The question remains, whether the rapid credit growth is actually linked to the convergence of the CEE countries towards the equilibrium or whether it represents an excessive credit growth, which may lead to an economic overheating and thereby pose risks to macroeconomic and financial stability in these countries.

In this thesis we follow the econometric approach to the modelling of the excessive credit growth and estimate the equilibrium credit-to-GDP ratios for 11 CEE countries using the pooled mean group estimator proposed by Pesaran *et al.* (1999). This dynamic panel data estimator assumes a long-run equilibrium to be identical, while the short-run dynamics and the speed of adjustment towards the equilibrium can vary freely across the countries. This specification seems reasonable, because the short-run dynamics is largely determined by institutional features that can significantly differ across the countries. To provide a comparison and test the empirical relevance of the imposed coefficient restrictions we further perform the estimates using the dynamic fixed effects and the mean group estimator. Given that the CEE countries are likely to suffer from the initial credit undershooting the in-sample estimated slope coefficients will be biased upwards. Consequently, we estimate the equilibrium credit-to-GDP ratios out-of-sample using a panel of selected developed EU countries as a benchmark. The deviation of the actual credit-to-GDP ratio from the estimated long-run equilibrium represents a measure of credit excessiveness for the CEE economies. Our analysis cover the period from 2000 until the third quarter of 2011 and thus allows us to study the impact of the global financial crisis on the equilibrium credit-to-GDP ratios in the CEE countries. Moreover, it gives us an outlook about the latest credit dynamics, so that we can consider whether these countries tend to return to the pre-crisis credit development path.

The thesis is structured as follows. Chapter 1 reviews some stylized facts about credit growth and credit structure in the CEE countries, and shortly describes the current banking sector structure. Chapter 2 gives a theoretical background to credit growth by discussing credit supply and credit demand factors and different concepts of credit excessiveness, and overviews the relevant literature. Chapter 3 presents the econometric model and specifications, describes the data set and the estimation techniques, and discusses the estimation results. Finally, the last chapter concludes.

Chapter 1

Some Stylized Facts about Credit Growth

1.1 Credit Dynamics

The Central and Eastern European countries (CEE) have experienced a rapid credit growth to the private sector over the last decades. However, the speed of credit growth in this region has been far from homogeneous. The highest average annual real credit growth over the period 2001 – 2009 has been observed in Romania, where the credit growth has exceeded 55 percent, followed by Bulgaria, Latvia, and Lithuania with average annual growth rates over 30 percent. The real credit growth in Estonia and Slovenia was somewhat slower, but the average annual values were still above 20 percent. By contrast, relatively low average credit growth rates have been observed in the Czech Republic (8.8 percent) and in Slovakia (9.9 percent), where the average rate of credit growth has not outreached the 10 percent level.

The credit growth dynamics in the CEE economies is even more remarkable when compared to other European countries. As Table 1.1 suggests the average annual real credit growth in the EU 15 over the analyzed period has been 9.6 percent, which is far below the credit growth rates in the Baltic states (Estonia, Latvia, Lithuania) and also far below the credit growth rates in the transition countries in South Eastern Europe (Bulgaria, Croatia, Romania). The Visegrad countries (Czech Republic, Hungary, Poland, and Slovakia) and Slovenia are the only transition countries, in which credit to the private sector grew at a comparable rate to the EU 15.

Table 1.1: Bank Credit to Private Sector % Growth over the 2001 - 2009 Period

Credit growth	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average
Bulgaria	35.8	44.5	54.2	43.1	34.2	22.1	60.9	27.0	14.2	37.3
Croatia	23.8	33.2	15.0	14.2	15.4	23.0	15.5	8.7	3.0	16.9
Czech Republic	-11.7	-19.1	10.4	10.3	22.6	21.1	27.9	11.2	6.6	8.8
Estonia	20.2	30.5	29.9	31.2	31.1	41.8	29.7	3.0	4.9	24.7
Hungary	19.0	23.3	34.8	16.0	22.6	16.3	14.3	20.6	2.3	18.8
Latvia	50.4	37.3	35.9	42.3	62.7	58.6	29.7	6.7	8.6	36.9
Lithuania	8.8	29.0	56.7	35.8	61.2	39.1	40.2	12.6	-2.8	31.2
Poland	12.1	8.0	7.9	7.0	10.9	25.3	29.9	33.9	8.7	16.0
Romania	91.1	65.9	87.7	46.7	52.9	58.4	65.1	30.2	3.5	55.7
Slovakia	-17.3	19.1	-17.1	8.2	34.4	20.8	24.6	13.3	3.2	9.9
Slovenia	19.2	14.8	18.1	27.5	25.7	26.4	31.7	13.1	9.4	20.7
Baltic countries	26.5	32.3	40.8	36.4	51.7	46.5	33.2	7.4	3.6	30.9
Visegrad countries and Slovenia	4.3	9.2	10.8	13.8	23.2	22.0	25.7	18.4	6.1	14.8
South Eastern Europe	50.2	47.9	52.3	34.7	34.2	34.5	47.2	22.0	6.9	36.6
EU 15	11.2*	5.3	7.7	9.8	13.7	13.9	14.6	6.8	3.6**	9.6

*Figure computed for EU 15 without Sweden due to the data unavailability.
**Figure computed for EU 15 without Denmark and Sweden due to the data unavailability.

Source: IFS database and author's computations

The financial crisis started in the mid-2007 and intensified in the aftermath of the collapse of Lehman Brothers in September 2008. The overall economic

slowdown was accompanied by the decline in credit to the private sector. However, the credit market slump was not immediate. Owing to the perceived risk that the bank funding will be more difficult to obtain, private companies seem to have drawn available credit lines and thus kept the credit growth strong in the early phases of the financial crisis (ECB, 2011). From 2008 onwards the banking institutions started to lower their lending to the private sector. It was a reaction on the larger uncertainty, weakening capital positions, and especially on the increasing number of non-performing loans in their balance sheets. As the economic conditions worsened households reduced the consumption and private companies cut back the output, which consequently decreased the demand for credit.

The sharpest decline in credit to the private sector has been experienced in countries in Eastern Europe, which benefited from a substantial inflow of foreign funds and cross-boarder lending prior to the crisis (Cartas and McConagha, 2010). Moreover, in order to improve the financial positions of the foreign-owned banks, the parent bank institutions withdraw the liquidity from their subsidiaries located in this region. The figures in Table 1.1 confirm that the real credit growth rate between 2007 and 2008 dropped the most in the Baltic countries. The most profound drop has been observed in Estonia, in which the real credit to the private sector in 2008 has grown nearly ten times slower compared to the previous year.

The real credit growth rates have declined further both in 2009 and 2010 and in some countries, as for instance in the abovementioned Estonia or Lithuania, have the growth rates even decreased into negative values. The latest figures indicate that the growth rate of the real credit to the private sector in the CEE countries has not recovered yet. In the three Baltic countries and in Slovenia the real annual credit growth rates in the third quarter of 2011 have remained negative, while in the other five countries, for which the latest data are available, have the growth rates not exceeded 10 percent.

To avoid any misapprehension, it should be stressed that under credit to the private sector we understand credit to households and credit to private companies

provided by banking institutions, if not explicitly stated differently. Since the financial sectors in the CEE countries are largely dominated by banks rather than equity markets, the approximation of the private sector indebtedness by bank credit seems reasonable. On the other hand, this concept of private credit does not include loans provided by non-bank financial institutions that have recently gained on importance. Hence, we should keep in mind that by approximating by bank credit we slightly underestimate the true volume of private sector liabilities.
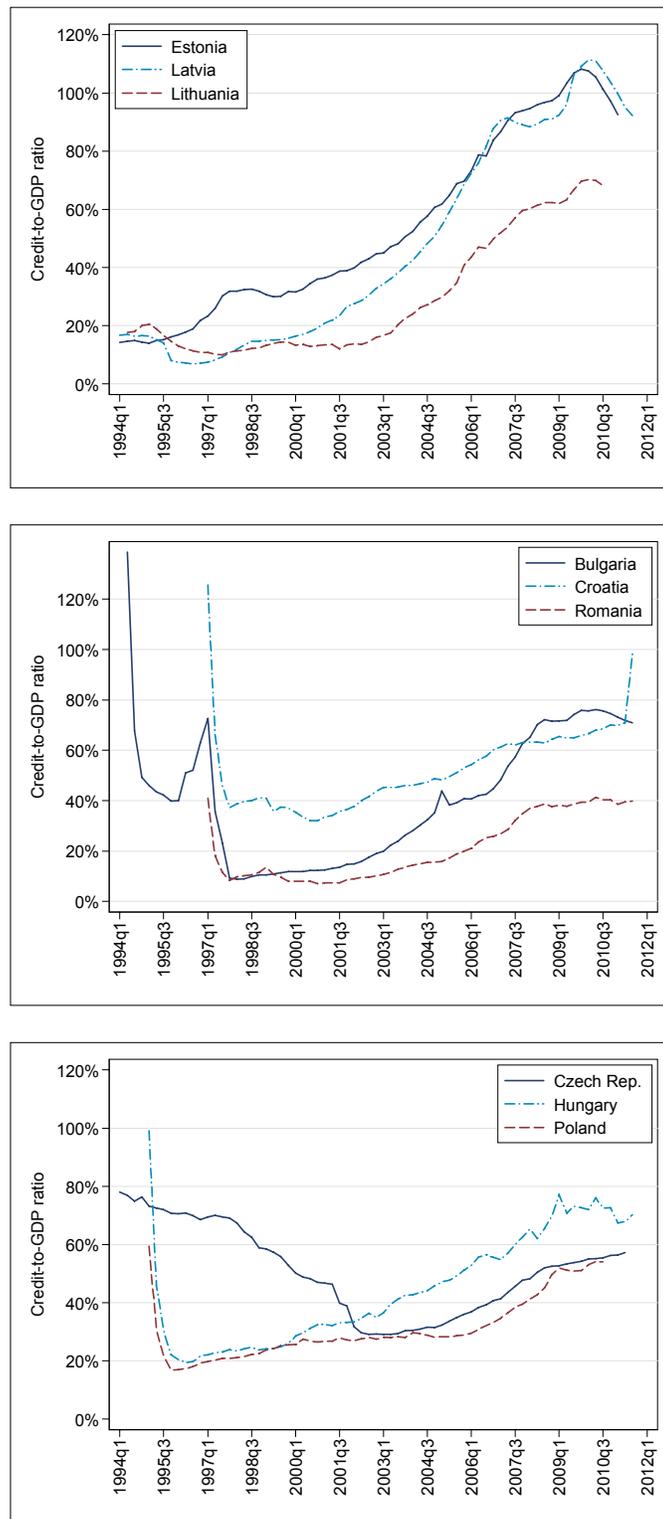
1.2 Credit-to-GDP Ratios

To consider the credit growth in relation to GDP as the credit-to-GDP ratio has its advantages. First of all, growth of credit-to-GDP ratio measures the credit growth in real terms. The credit-to-GDP ratio is also more appropriate when discussing the macroeconomic and financial stability, since we are more interested in how much the private sector owes in relation to the domestic product, rather than in absolute value of the private sector liabilities. Moreover, Arpa *et al.* (2005) points out to the possible distortion that can arise when credit growth is measured in absolute values.[1] In such a case, credit growth in country with lower initial credit-to-GDP level is generally higher than credit growth in country with higher initial credit-to-GDP if both countries have similar credit-to-GDP flows.

By depicting the credit-to-GDP ratios in the CEE countries over the last decades we can see some similar patterns in their dynamics. Figure 1.1 illustrates the development of the credit-to-GDP ratio from the beginning of 1994 until the third quarter of 2011 for the Baltic countries, the transition countries in South Eastern Europe, and for the Visegrad countries and Slovenia.

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[1] Credit growth measured using following ratio: $\left(\dfrac{C_t^P - C_{t-1}^P}{C_{t-1}^P} \right)$, where C_t^P denotes the private credit in time t.

Figure 1.1: Credit-to-GDP Ratios between 1994 – 2011 in Baltic Countries, in South Eastern Europe, and in Visegrad Countries and Slovenia
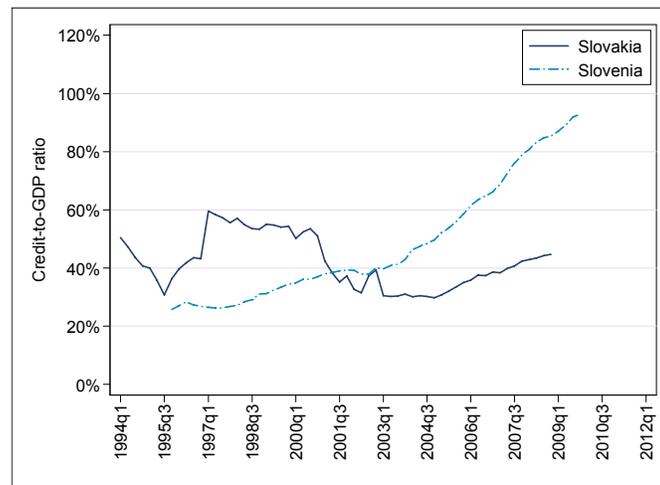
Source: IFS database and author's computations

The credit-to-GDP ratios in all three Baltic countries have developed much alike over the analyzed period. Starting with relatively low credit-to-GDP ratios that amounted to fewer than 20 percent the credit to the private sector expressed as a percentage of GDP has increased substantially over the past years in this region. In Estonia and Latvia the credit-to-GDP ratio peaked at the turn of 2009 and 2010 exceeding 100 percent. The subsequent decrease in the credit-to-GDP ratio in these countries was probably caused by the GDP revival, while the credit to the private sector remained weak in the aftermath of the global financial crisis. The credit-to-GDP ratio in Lithuania has increased slightly slower during the entire period when compared to the two abovementioned Baltic countries. However, the credit-to-GDP behavior in all the three countries in this region was particularly in the recent years nearly identical.

The transition countries in South Eastern Europe have experienced a significant initial drop in the credit-to-GDP ratios during the 1990s. The credit-to-GDP ratios in Bulgaria and Croatia fell from the levels exceeding 120 percent to the 10 and 40 percent level, respectively. For Romania the data prior to 1997 are unfortunately not available. Nevertheless, the earliest figures available suggest that the credit-to-GDP ratio in Romania developed in a very similar way.

Within the 1998 the credit-to-GDP ratios in the countries in South Eastern Europe have stabilized and started to increase gradually.

The dynamics of the credit-to-GDP ratios in Hungary and Poland can be characterized with an initial sharp decline and a subsequent gradual increase, just like in the economies in South Eastern Europe. The credit-to-GDP ratios in the Czech Republic and Slovakia decreased initially as well, however, the decline was not that profound and lasted several years. After the initial decrease the credit-to-GDP ratios in the Visegrad countries have grown rather moderately. On the contrary, the credit-to-GDP in Slovenia increased substantially reaching credit levels comparable to Estonia and Latvia.

As stated above, development of the credit-to-GDP ratios across the CEE countries may have some general similarities, which are related to the transition process of these countries. However, at the beginning of the transition process there were extensive differences in the credit-to-GDP ratios across the CEE countries. According to Backé *et al.* (2006) these differences in the initial credit-to-GDP ratios have originated from different approaches towards the credit financing of enterprises under central planning. As a result, most of the CEE economies have experienced a decrease in the credit-to-GDP ratio in the first decade of their transition. Figure 1.1 illustrates this initial decline in credit-to-GDP ratios for six out of the eleven analyzed CEE countries, namely for Bulgaria, Czech Republic, Croatia, Hungary, Poland, and Romania.

In some of these countries the decrease was extremely sharp and took only one or two years, while in other countries the credit-to-GDP ratio have been decreasing rather moderately over a couple of years. The initial decline in credit-to-GDP ratios can be largely explained by an extensive amount of bad loans inherited from the centralized system and a number of consolidation programs in the early stages of transition, by which the non-performing loans were removed from banks' balance sheets. Such consolidation programs have been implemented, for instance, in Bulgaria in 1991 – 1994, in the Czech Republic in years 1991 – 1993 and 1996

– 1997, and in Hungary in 1992 – 1994. Also Poland and the Baltic states went through some kind of restructuring of the banking sector.

Table 1.2: Non-performing Loans in the CEE countries as % of Total Loans[2]

Non-performing loans	1990 – 1993	1994	1995	1996	1997
Bulgaria	54	7	13	15	13
Croatia	-	12	13	11	10
Czech Republic	50 – 66	34	33	30	29
Estonia	40	4	3	2	1
Hungary	21 – 30	18	10	7	4
Latvia	-	10	19	20	10
Lithuania	-	27	17	32	28
Poland	30	29	21	13	10
Romania	-	19	38	48	57
Slovakia	-	30	41	32	33
Slovenia	-	22	13	14	12

Source: EBRD Transition Report 1998

Table 1.2 gives an overview about the size of non-performing loans in the bank portfolios at the beginning of the 1990s in the CEE countries. However, the data for most of the countries are not available for the first years of the transition process. Moreover, even available data are rather rough estimates than concrete figures. According to Table 1.2 the amount of non-performing loans in the Czech Republic in 1990 was somewhere between 50 and 66 percent. However, there are other studies, which estimate that non-performing loans were substantially lower. For instance, Tang *et al.* (2000) estimated the amount of non-performing loans to lie between 2.4 and 19 percent. As a result, the quality of data for CEE countries related to this period is limited. Also, the decline of credit-to-GDP ratio is caused by cleaning of the banks' portfolios and is not connected to any fundamental changes in these economies. This data limitation is taken into account later in our

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[2] The definition and measurement of non-performing loans differ across the countries and consequently the figures in Table 1.2 are not directly comparable. However, they are indicative of the magnitude of banking sector problems in individual countries.

study, where we discuss employed techniques for estimating credit excessiveness (see part 2.2.2).

Table 1.3 illustrates current characteristics of the banking sector across the CEE countries. There are evident some similarities, which are characterized by the relatively high share of foreign-owned banks, number of banks or capital adequacy ratios. Also the total banking assets to GDP ratio is still relatively low in the CEE countries (105 percent) compared to the eurozone average, where the value is over 550 percent as of end 2010 (see Figure A-1 in the Appendix).

Table 1.3: Banking Sector Structure in the CEE Countries

	Number of banks	Market share of state-owned banks (% of total assets)	Market share of foreign-owned banks (% of total assets)	Capital adequacy (% of risk weighted assets)
Czech Republic	41	3.3	86.9	15.5
Hungary	35	4.6	89.8	13.3
Poland	70	21.5	66.2	13.7
Slovakia	29	5.3	93.4	12.7
Slovenia	19	20.1	37.1	11.3
Bulgaria	30	3.2	80.7	17.5
Croatia	34	4.3	90.3	18.8
Romania	41	7.4	85.1	15.0

Source: Raiffeisen Bank Reports

Figure 1.2: Non-performing Loans and Return on Equity
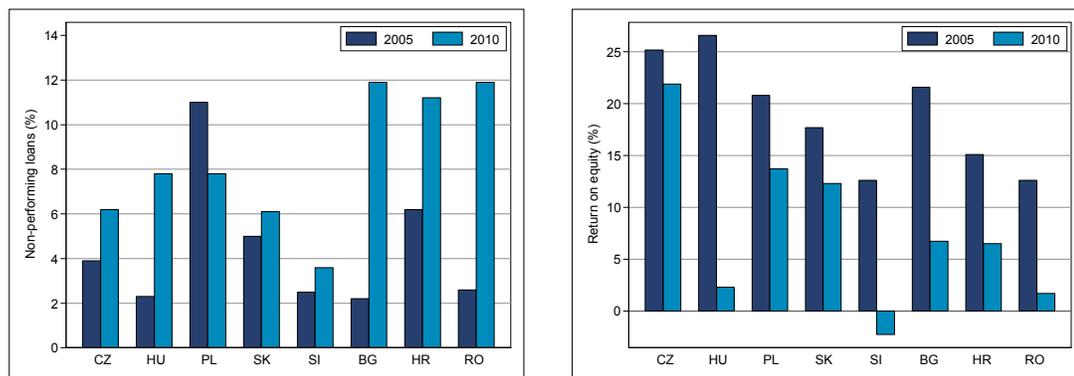
Source: Raiffeisen Bank Reports

However, some characteristics related to portfolio quality or profitability are still heterogeneous across the CEE banking sector, which is evident by non-performing loans ratios or the return on equity (see Figure 1.2).

Chapter 2

Theoretical Credit Growth Concepts

2.1 Determinants of Credit Growth

Credit growth is generally determined both by supply and demand side factors. During the 1990s the transition countries experienced significant changes in institutional environment of banking sector and in banking sector structure. Increased competition among banks, entry of foreign banks into the market and overall financial deepening enhanced the supply of credit. Falling interest rates, on the other hand, positively affected credit demand. As the changes in the banking sector have stabilized, the supply side factors have also become more stable and the role of the demand factors has gained greater importance (Gattin-Turkalj *et al.*, 2007). However, in some cases it can be rather difficult to clearly identify credit supply and credit demand factors, since some factors can simultaneously affect both the supply and the demand for credit.

Real GDP represents the economic activity and the overall development in the economy. When the economy grows and the expected income of households and private companies increases, the consumption and the investment demand increase as well. Higher consumption and investment demand together with the ability of households and private companies to bear more debts lead in turn to an increase in the demand for credit. Another incentive for private companies to increase credit financing in an economic upturn is the effort to hold the proportion of debt to equity more or less constant over time. It has been concluded that the increase in credit demand happens via income effect (Gattin-Turkalj *et al.*, 2007). Strong economic performance enhances also credit supply. Lending institutions are more willing to extend credit as they feel the ability of households and private companies to meet their liabilities. New loans can be secured with a higher valued collateral, which further stimulates credit supply, this time via wealth effect.

Short- and long-term interest rates represent the financing costs of credit. An increase in interest rates reduces the demand for credit, as loans become more expensive. The effect on credit supply is rather uncertain. On the one hand, an increase in interest rates can cause credit supply to shrink. Higher financing costs of credit may negatively affect the creditworthiness of households and companies and lending institutions may react to the newly perceived risk by a cut in credit supply. Hofmann (2001) has described the reduction of credit supply, which results from an interest rate increase based on a monetary tightening in the economy. If the monetary tightening is operated via open market sales by the central bank, the reserves and loanable funds of the lending institutions will be cut down, which may consequently reduce credit supply. On the other hand, an increase in interest rates may also have a positive impact on credit supply. As the interest rates increase, lending institutions obtain higher net interest incomes and may therefore raise the volume of loanable funds (Nieto, 2007).

Other factors that play a main role in determining credit growth relate to the liberalization and development of the financial sector. In particular, financial innovation that leads to the emergence of new credit instruments allows both credit

supply and demand to increase (Nieto, 2007). Households and private companies can choose from a wide variety of credit products that best suit their needs (floating-rate loans, variable-maturity loans), while lending institutions can better control and manage risks, and obtain more loanable funds at the same time (credit derivatives and securitization).

2.2 Excessive Credit Growth

2.2.1 Excessive Credit and Banking Crisis

The excessive credit growth or, in other words, a credit boom may represent a serious threat for the economy. It may pose risks to the financial stability of the country in form of a banking distress or even a banking crisis. Simultaneously, it may undermine the macroeconomic stability.

The link to the banking distress reflects the fact that the banks' screening of borrowers worsen when funding is easy to obtain and competition among banking institutions is strong (Schadler *et al.,* 2004). Indeed, the empirical literature shows that banking crises are typically preceded by lending booms. However, only a few lending booms end in a banking crisis (Gourinchas *et al.*, 1999; Tornell and Westermann, 2002). Consequently, the excessive credit growth generally appears to be a necessary but not a sufficient condition for a banking crisis. Gourinchas *et al.* (1999) estimated the probability of a banking crises following a lending boom at 10 – 21 percent, while Tornell and Westermann (2002) estimated the same probability much lower, at 6 – 9 percent. However, the situation is slightly different in emerging economies that are more vulnerable (Kaminsky and Reinhart, 1999). Moreover, credit booms tend to amplify internal financial imbalances by fuelling excessive demand, inflationary pressures and speculative asset price bubbles.

2.2.2 Measurement of Credit Excessiveness

According to the literature concerning the lending booms the growth rate of credit is considered as excessive if it either threatens the financial stability or it leads to an unsustainable macroeconomic development. The financial stability is undermined through the increased share of non-performing loans in the bank balance sheets and the related deterioration of the overall quality of the bank portfolios. The unsustainable macroeconomic development is then typically fuelled by overoptimistic market expectations and the related economic overheating creates inflation pressures as well as strains on the asset prices. The abovementioned definition of an excessive credit growth is, however, rather theoretical. As stressed by Boissay *et al.* (2005, p.5) *"...none of these two effects can be easily measured or forecasted. It is thus unsurprising that the empirical literature on the measurement of excessiveness has been very limited."*

▪ **Speed Limits**

The simplest approach to the measurement of the credit excessiveness is to specify a threshold level, above which the rate of credit growth would be considered as excessive. The background idea for the setting-up of a general speed limit on the assets growth in the banking sector originates from the regulatory effort to affect the structure of bank loan portfolios, so far as the bank soundness is concerned, and from the common observation that the rapid growth in bank loan portfolios is often witnessed within individual bank failures or in some types of systemic crisis. Setting-up a speed limit on the growth rate of the loan portfolios would allow the regulators to control the banking institutions *ex ante*, in contrast to the current practice when the banks that recorded a rapid loan portfolio growth are *ex post* target for a special examination, although the damage may have already be done in that moment (Honohan, 1997). However, the problematical issue regarding the appropriate amplitude of the speed limit remains unanswered. Another drawback of the speed limits is that they do not take into account other macroeconomic variables when deciding upon the excessive credit growth.

▪ **Statistical Approach**

Since the speed and volatility of credit growth varies across countries and in time, the definition ef excessive credit growth should be to some extent country specific and path dependent. But at the same time, the definition should be general enough to allow for cross-country comparison. The statistical approach attempts to identify the long-run trend of the credit development using the Hodrick-Prescott (HP) filter. The estimated trend represents the equilibrium financial deepening and the credit growth that exceeds its long-run trend above a given threshold is labelled as excessive. The threshold can be specified both in terms of an absolute and relative deviation from the long-run trend, as suggested by Gourinchas *et al.* (2001). For instance, the IMF (2004) specified the threshold as 1.75 times the standard deviation around the estimated trend. Assuming that the observations of the analyzed credit growth are normally distributed, this threshold level ensures that with a probability of 95 percent the credit growth will be situated inside of the confidence interval.

Gourinchas *et al.* (2001) proposed to apply the HP filter using the backward looking rolling. Within this method the credit growth rate in each point in time is being compared with the long-run trend that is estimated over the preceding period. As a result, in each past period we use only the data that were available in that period to the policy makers and to the other market participants. Barajas *et al.* (2007) stressed the advantages of this recursive method in comparison to the trend estimates over the entire sample period as, for instance, employed in Mendoza and Terrones (2004). First, the trend estimates over the entire period would tend to overestimate excessive credit growth that ended up in a crisis, since the subsequent crisis would be a part of the previous trend estimates. The second drawback is that this method makes use of information not available at the time of the excessive credit growth and hence makes the estimates difficult to apply operationally.

Although the HP filter is the most often used univariate time series method for the long-run trend estimates it has a few shortcomings. First of all, the estimated trend is significantly dependent on the length of the chosen time series, and its

calculation is very sensitive to the smoothing parameter lambda. The HP filter further generates highly unreliable estimates of the long-run trend at the end of the data, which is in general called the end-point bias (Frait *et al.*, 2011). Also the application of the HP filter for the credit growth in the transition countries can be problematical, since the time series for the transition countries do not usually cover sufficiently long time periods that would allow the estimation of a plausible trend.

▪ **Econometric Approach**

Even though the statistical approach is useful in that it compares the historical and the recent credit developments, it does not take into account other economic fundamentals. The last definition of the excessive credit is based on an econometric regression. This approach separates the level of credit that would be justified by the underlying economic fundamentals and compares it with the actual credit development. The deviation of the actual credit level from its estimated value serves as a measure of credit excessiveness. The econometric approach turned out to be convenient and consequently is often used in the research papers dealing with the excessive credit growth.

Figure 2.1 illustrates the idea behind the econometric approach and simultaneously overviews the concept of initial credit undershooting as introduced by Backé *et al.* (2006). The equilibrium level of credit to the private sector expressed as a percentage of GDP is the credit-to-GDP ratio, which would be justified by the economic fundamentals. If a change in the credit-to-GDP ratio cannot be explained by a change in the underlying economic fundamentals the deviation from the equilibrium occurs. The deviations of the credit-to-GDP ratio from its equilibrium are called credit under- and overshooting. The economic fundamentals are the determinants of the private credit as discussed in the previous section.

Figure 2.1: Development of Credit-to-GDP Ratio
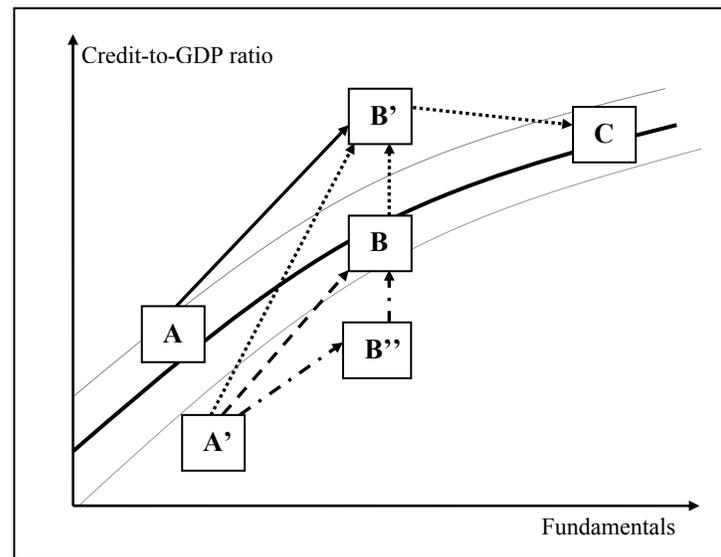
Source: Inspired by Backé et al. (2006)

According to Figure 2.1 the development of credit-to-GDP ratio from point A to point B and further to point C follow the equilibrium path justified by the fundamentals. However, if the credit-to-GDP ratio increases to point B' instead the deviation from the equilibrium occurs and the resulting credit to the private sector would be considered as excessive. This excessive credit development can be decomposed into two separate parts. The first part, the progress from point A to point B is the equilibrium development, since this credit dynamics can be again explained by its economic fundamentals. The subsequent increase of the credit-to-GDP ratio from the equilibrium point B towards B' represents the excessive part or, in other words, the credit overshooting.

If the economy starts with a lower credit-to-GDP ratio than the underlying fundamentals suggest, we speak about the initial credit undershooting. The case of the initial credit undershooting is depicted in Figure 2.1 by the point A'. If the credit-to-GDP ratio develops from the initial point A' to point B that follows the credit equilibrium path the increase in the credit-to-GDP ratio can be again decomposed into two separate parts. The first part, the progress from point A to point B'' is the equilibrium credit growth, while the subsequent increase in

credit-to-GDP ratio to point B represents the equilibrium adjustment from the initial credit undershooting. However, if the credit-to-GDP ratio would increase further above towards point B' the credit-to-GDP ratio would be already considered as excessive.

The concept of the initial credit undershooting is particularly important regarding the CEE countries. The CEE countries that went through the transition process started after the transformation of the central planning into the market economy with relatively low levels of credit to the private sector. The initial credit-to-GDP ratios for the transition countries were much lower than the equilibrium credit levels justified by the underlying economic fundamentals. Thus, we can conclude that these economies suffered under initial credit undershooting. According to the abovementioned example concerning the initial credit undershooting, the rapid growth of credit to the private sector observed in the transition countries over the past decades does not necessarily need to represent an excessive credit growth. It can merely represent an adjustment from the initial credit undershooting towards the equilibrium level.

Given the initial credit undershooting in the CEE countries and the adjustment towards the equilibrium that occurs gradually (*i.e.* persistent initial undershooting during the adjustment process) the empirical estimates of the equilibrium credit-to-GDP ratios that employ panels consisting exclusively from the transition countries would be biased. If we regress the credit-to-GDP ratios moving from point A' to point B (instead of the equilibrium increase from point A to point B) on a set of economic fundamentals, the estimated slope coefficients would be biased upwards and on the contrary, the estimated constant term would be biased downwards (Backé *et al.*, 2006). The solution of this so called transition bias is to derive the equilibrium credit-to-GDP ratios for the CEE countries out-of-sample. The equilibrium coefficients are estimated on a panel of benchmark countries that do not suffer from the initial credit undershooting but follow the equilibrium path.

Kiss *et al.* (2006) introduced three measures of the credit excessiveness based on the econometric approach. Figure 2.2 illustrates these concepts. According to

the Figure 2.2 the credit level is considered as excessive if the actual credit level lies above the fundamentally justified equilibrium and hence the first concept of the credit excessiveness is identical to the abovementioned one.

Figure 2.2: Credit Excessiveness
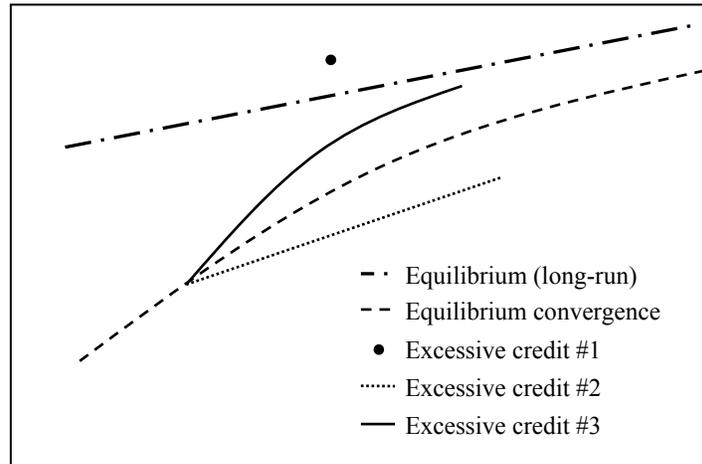
Source: Inspired by Kiss et al. (2006)

The second concept suggests that if the credit level is below its justified equilibrium but at the same time the growth rate is faster than what would be observed along the long-run credit equilibrium path, the credit should be also considered as excessive. The third concept then indicates an excessive credit growth if the credit growth rate is even faster than what would be justified by the convergence process. If the actual credit level is below its equilibrium, the third concept of credit excessiveness automatically implies the second one (Kiss *et al.*, 2006).

2.3 Literature Survey

Most of the existing credit growth literature focuses on the analysis of demand for credit on an aggregated level. The main reason for using credit aggregates is the unavailability of credit data on a more disaggregated level across the countries with appropriate time length. Hence, there are only a few studies that analyze

credit to households and credit to private corporations separately or for different currency breakdowns (see *e.g.* Fase *et al.*, 1992; De Bandt and Jacquinot, 1992; and Kiss *et al.*, 2006 for an overview).

The models of credit demand generally include some simple set of explanatory variables such as real GDP or real GDP per capita, different types of nominal or real interest rate and inflation. Some authors add also variables concerning financial liberalization and financial deepening, which represent the credit supply side in the models.[3]

Calza *et al*. (2001) studied the determinants of loans to the private sector in the euro area countries. They identified a cointegrating relationship linking real loans, GDP and interest rates. This relationship implied that in the long-run real loans are positively related to real GDP and negatively to real weighted short-term and long-term interest rates. Hofmann (2001) presented a similar model as Calza *et al*. (2001) but expanded the number of explanatory variables by adding property prices. Using the cointegrating VAR methodology on a set of industrialized countries he found a positive long-run relationship between real loans and real residential and commercial property prices.

Cottarelli *et al*. (2003) calculated the equilibrium credit levels for 15 CEE countries. Compared to the previous studies they included as dependent variable in the model credit-to-GDP ratio, instead of absolute credit level. The usual set of explanatory variables was further enriched by public debt as a percentage of GDP, financial liberalization index, bank entry requirements, quality of accounting standards, and origin of the legal system. Public debt captures the potential crowding-out effect, which credit to the public sector may have on credit to the

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[3] The credit level modelled as a function of real GDP, interest rate and inflation may represent a credit demand relationship but may also capture credit supply effects (see section 2.1). Consequently, the estimation results of such a demand relationship should be interpreted with caution, since they rely on the strong assumption that supply effects did not play a significant role. The solution to this co called supply-versus-demand puzzle would be a simultaneous modelling of credit demand and credit supply (Gattin-Turkalj *et al*., 2007). However, as stressed for instance by Calza *et al*. (2001) and Hofmann (2001) to model explicitly the credit supply function would require sufficiently long and harmonized data on important credit supply factors (interest rate margins, measures of competiton in the banking sector, bank's profitability measures, *etc*.), which are unfortunately not readily available.

private sector. Financial liberalization index and bank entry requirements model the credit supply. Quality of accounting standards controls for the quality of information on which the lending decisions are based, and further facilitates supply of credit as it reduces the risk premium. German legal origin is then believed to support the creation of well-developed and well-functioning banks and enters the regression model as a dummy variable. From the comparison of the actual and theoretical values of credit-to-GDP ratios in the analyzed CEE countries the authors concluded that the credit-to-GDP ratios are still substantially below their equilibrium levels. However, since the data series used in the analysis cover the period only until 2002, they do not include the recent strong credit dynamics observed in most of the CEE countries.

Boissay *et al*. (2005) expressed the credit growth as a function of both macroeconomic fundamentals and the gap between the actual credit-to-GDP ratio and its equilibrium level. The model derived short-run credit elasticities with respect to the explanatory variables as well as the estimates of the expected credit growth rates for a sample of 11 CEE countries. The comparison of the expected credit growth rates and the actually observed credit dynamics provided again a measure of credit excessiveness. In addition to the standard determinants of credit growth such as real GDP and real interest rate Boissay *et al*. (2005) included also financial liberalization into the model. The authors stressed the problematical issues regarding the measurement and modelling of the impact of financial liberalization on the credit market. Consequently, the effects of financial liberalization were approximated by a deterministic non-linear time trend. The estimation results suggested an excessive credit growth in the three Baltic countries and in Bulgaria and to a lesser extent also in Hungary and Croatia. The credit growth in Romania and Slovenia seemed to be non-excessive.

Also Backé *et al*. (2006) estimated equilibrium credit levels for a panel of 11 CEE countries. To avoid the upward estimation bias that the initial credit undershooting in the transition countries could cause, the authors performed the estimates out-of-sample using small open OECD economies as a benchmark. The

existence of public and private registries was included as a new explanatory variable. The regression coefficients were derived using three different estimation techniques. Besides the fixed effects and the panel dynamic OLS Backé *et al.* (2006) employed also the mean group (MG) estimator. The results indicated that Croatia was the only country, which might have reached the equilibrium credit-to-GDP ratio by the end of 2004. Credit-to-GDP ratios in the other five analyzed countries, namely in Bulgaria, Estonia, Hungary, Latvia, and Slovenia were very close to their equilibrium levels.

The study by Kiss *et al.* (2006) shares several features with that of Backé *et al.* (2006). Considering the possible transition bias, the authors applied the pooled mean group (PMG) estimator proposed by Pesaran *et al.* (1999) on a panel of 11 euro area countries and generated out-of-sample estimates of the equilibrium credit-to-GDP ratios. The estimates were performed for the aggregated credit to the private sector, as well as for the credit to households and credit to non-financial private corporations separately. Nevertheless, the time series for the sector breakdown cover quite a short time period making the sector estimation results not very reliable. The results on the aggregated level showed that only Latvia and Estonia might have recently come close to their equilibrium, while the other CEE countries still had the credit-to-GDP ratios well below the estimated equilibrium levels.

To the latest studies on credit growth belongs the research paper by Zdzienicka (2009). The author estimated the equilibrium credit-to-GDP ratios for a panel of 11 CEE countries covering the period until 2007. The estimation results indicated an excessive credit growth in the case of the eight studied countries (Bulgaria, Croatia, Estonia, Latvia, Lithuania, Hungary, Romania, and Slovenia) by the end of the period. Moreover, the excessive credit growth in most of the countries under consideration could be observed already since 2004. Table 2.1 presents summary of available studies and overviews employed techniques and variables.

Table 2.1: Literature Overview

Authors	Target group	Methodology	Approach	Variables used
Calza *et al.* (2001)	11 euro area countries	VECM	in-sample	real loans to the private sector, real GDP, short- and long-term real interest rate
Hofmann (2001)	16 industrialized countries	Cointegrating VAR	in-sample	real loans to the private sector, real GDP, real short-term interest rate, weighted average of real residential and real commercial prices
Cottarelli *et al.* (2003)	15 CEE countries	HP filter Random effects	in-sample out-of-sample	BCPS ratio*, GDP per capita, inflation, public debt/GDP, liberalization index, bank entry requirements, accounting standards, German legal origin
Boissay *et al.* (2005)	11 CEE countries	ECM	out-of-sample	domestic private sector credit/GDP, real GDP, real interest rate, time trend
Backé *et al.* (2006)	11 CEE countries	Fixed effects DOLS MG	out-of-sample	BCPS ratio*, GDP per capita, governmental debt/GDP, short- and long-term nominal interest rates, inflation, house prices, spread between lending and deposit rates, public and private credit registries
Kiss *et al.* (2006)	8 CEE countries	ECM PMG	out-of-sample	domestic private sector credit/GDP, GDP per capita, real interest rate, inflation
Zdzienicka (2009)	11 CEE countries	Fixed effects PMG GMM	out-of-sample	BCPS ratio*, GDP per capita, real interest rate, inflation, spread between lending and deposit rates, governmental debt/GDP

*The variable BCPS ratio denotes bank credit to the private sector as a percentage of GDP.

As follows from the results of the abovementioned studies, there is still a lot of uncertainty regarding the equilibrium level of credit growth in the CEE countries. The literature still does not give a clear answer whether the observed credit dynamics in these countries represents a convergence process towards the equilibrium or whether the equilibrium was already reached and the observed credit dynamics should be considered as excessive. It can be illustrated on the case of Lithuania. According to both Kiss *et al*. (2006) and Backé *et al*. (2006) the credit growth in Lithuania was not excessive and the credit-to-GDP ratio was not even close to its equilibrium by the end of 2004. By contrast, Boissay *et al*. (2005)

as well as Zdzienicka (2009) estimated that the credit-to-GDP ratio in Lithuania and in the other two Baltic countries was already considerably above its equilibrium level by the end of that year.

We contribute to the existing literature by expanding the studied period until the third quarter of 2011 using the advanced pooled mean group estimator introduced by Pesaran *et al*. (1999) This allows us to examine the impact of the global financial crisis on the equilibrium credit to the private sector in the CEE countries. This analysis gives us also an outlook about the latest credit dynamics, so that we can consider whether the transition countries tend to return to the pre-crisis credit development path.[4] Further, we carefully construct the panel of the benchmark countries for the out-of-sample estimates that follow the equilibrium path and consequently do not suffer from the initial credit over- or undershooting.

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[4] However, not for all countries of our interest is latest data available.

Chapter 3

Empirical Model and Specifications

3.1 Explanatory Variables

The econometric approach described in previous chapter suggests that the equilibrium level of credit in the economy can be expressed as a function of some economic fundamentals. We follow this approach and model the equilibrium level of credit to the private sector using a simple set of explanatory variables. The selection of the explanatory variables for our regression analysis is strongly influenced by the availability of corresponding data. For most countries, and in particular for the CEE countries, longer time series are available only for basic economic indicators. Consequently, we estimate the equilibrium credit level using following explanatory variables:

    1. **Real GDP per capita** represents the economic activity and development in the economy. An increase in real GDP per capita is expected to increase credit to

the private sector, as the expected income and consequently the consumption and the investment demand raise the demand for credit. According to the consumption smoothing theory, an increase in real GDP per capita can also have a negative effect on credit to the private sector. Households may prefer a stable path of consumption over time, which means a lower demand for credit when the income temporarily increases and *vice versa*. Nevertheless, the empirical evidence suggests that the correlation between real GDP per capita and credit to the private sector is strictly positive (Boissay *et al*., 2005). Consequently, we expect a positive sign of the real GDP per capita coefficient.

2. **Claims on the government** as a percentage of GDP should capture the possible crowding-out effect. Higher government borrowings tend to increase market interest rates and thereby crowd-out households and private companies from the credit market. An increase in claims on the government reduces credit to the private sector, and the corresponding coefficient is therefore expected to be negative.

3. **Consumption** as a percentage of GDP is positively correlated to credit to the private sector. The positive impact that the credit has on consumption is quite straightforward, since consumer credit represents a considerable part of the aggregated credit to the private sector. The reverse causality was already mentioned in connection with the real GDP per capita variable. An increase in consumption demand enhances the demand for credit and hence we expect a positive sign of the consumption coefficient.[5]

4. **Lending rate** is negatively related to credit to the private sector. Higher lending rate increases the financing costs of credit and decreases the credit demand. The sign of the lending rate coefficient is expected to be negative.

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[5] Real GDP per capita and consumption variable are potentially highly positively correlated. If both variables fulfill the assumptions of the estimator and turn out to be the determinants of the equilibrium credit level in our regression analysis, we need to check for multicollinearity. Multicollinearity does not reduce the predictive power or reliability of the model as whole. However, the presence of multicollinearity in the model can cause wide confidence intervals and unrealistic p-values for other explanatory variables and thus make the variables seem less important than they really are.

5. **Inflation** measured in terms of consumer price index (CPI) is expected to have a negative impact on credit to the private sector. High inflation translates into high uncertainty and hinders the effective functioning of financial markets. Thus, the expected sign of the inflation coefficient is negative.

Our specification includes real GDP per capita, claims on the government, consumption, lending rate and CPI-based inflation:

$$c^P = f\left(\overset{+}{gdp}, \ \overset{-}{gov}, \ \overset{+}{con}, \ \overset{-}{lr}, \ \overset{-}{\pi} \right) \tag{1}$$

where the dependent variable c^P denotes credit to the private sector expressed as a percentage of GDP or, in other words, credit-to-GDP ratio.

3.2 Data

▪ **Data Sources and Definitions**

We take quarterly data from the International Financial Statistics (IFS) of the International Monetary Fund (IMF). The data on the quarterly basis are prefered to the annual data, because they allow us to include more observations for each cross-sectional unit into the model, which should consequently enhance the reliability of the estimation results. The exact IFS codes for all employed variables are reported in the Appendix.

Inflation is computed on a year-on-year basis. Khan *et al*. (2001) proposed a non-linear threshold specification for modelling the effect of inflation. The idea behind the inflation threshold is that if the inflation rate is above a threshold level then inflation significantly negatively affects financial activity. However, if the inflation rate is below the threshold, a small increase has either no effect or even a small positive effect on the level of financial activity. We apply the threshold specification in the model and include a variable ($1/\pi_{it}-1/\pi_{threshold}$) that measures how far below or above the threshold the level of inflation is at time *t* for a country *i*. A second variable we add is a dummy variable for inflation above the threshold level (π_{high}). The inflation variable can be written as follows:

$$\pi = \pi_{high}\left(1/\pi_{it} - 1/\pi_{threshold}\right) \qquad\qquad (2)$$

$$\pi_{high} = \begin{cases} 1 \ \ if \ \pi_{it} > \pi_{threshold} \\ 0 \ \ if \ \pi_{it} \leq \pi_{threshold} \end{cases} \qquad i = 1,...,N; \ \ t = 1,...,T$$

We set the non-linear inflation threshold at 4 percent as in Cotarelli *et al.* (2003).[6]

Lending rate is based on bank lending rate to households and to private corporations. The bank lending rate cathegory for some countries is subdivided into lending rate to households, private corporations, new businesses, and for house purchase with different maturities. In that case, we computed the average lending rate from the lending rate subcathegories.

Claims on the government are the sum of credit to the central and local governments, and of credit to nonfinancial public enterprises provided by banking sector. Backé *et al.* (2006) argued that credit to the government provided by banking institutions captures better the potential crowding-out effect than public debt, as employed for instance in Cotarelli *et al.* (2003). Public entities may well get the financial sources also on the foreign credit markets and securities markets, which does not affect the domestic credit market interest rates. In addition, public debt is also subject to valuation and stock-flow adjustments.

The IFS provides quarterly nominal GDP in national currencies. We converted the nominal GDP figures into real terms using the respective GDP deflators. The real GDP data were further converted into U.S. dollar using the average nominal exchange rates during the relevant time period and divided by the population size. Since the population size is typically measured only once a year, the population data were linearly interpolated from annual to quarterly frequencies. The real GDP per capita is included into the regression in form of a natural logarithm. The financial sector in developed countries is significantly larger than in emerging economies, which can be illustrated by a much higher proportion of financial assets to GDP. This suggests that the financial market grows rather exponentially

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[6] According to Khan *et al.* (2001), the optimal inflation threshold level lies in the range of 3-6 percent.

as the economy develops. Hence, to include the real GDP per capita variable in form of a natural logarithm may reasonably link this observed non-linear relationship. Moreover, due to the logarithmic transformation we get the coefficients of all explanatory variables roughly in the same scale.

The conversion of GDP data in national currencies into U.S. dollar brings along the exchange rate effects. Accordingly, some authors prefer to use the GDP per capita in terms of purchasing power parity (PPP). The GDP per capita in PPP is more suitable for a cross-border comparison, because it corrects for differences in price levels. Quarterly GDP data in terms of PPP are usually not available and have to be interpolated from annual frequencies. For instance, Backé *et al.* (2006) draw GDP per capita expressed in purchasing power standards (PPS) against euro and the U.S. dollar from the AMECO database of the European Commission and the World Development Indicators (WDI) of the World Bank. The authors further linearly interpolate the GDP data from annual to quarterly frequencies and include the interpolated GDP per capita together with other explanatory variables both in levels and in first differences into the regression relationship.[7] We do not consider this procedure as correct. Differencing linearly interpolated data from the annual to quarterly frequencies brings the sequence of four exactly same figures in a data set. The constant segments bias the data and consequently the estimation results. As a result, we conclude that although we are aware of the exchange rate effects, we consider the potential distortion of the data to be negligible in comparison to the interpolation data bias, and hence prefer the use of the real GDP per capita.

Quarterly private final consumption expenditures are included into the regression as a percentage of GDP. The credit-to-GDP ratio as dependent variable is based on the bank credit to the private sector. Private credit provided by banking institutions slightly underestimates the total private indebtedness, since it does not include the cross-boarder loans and loans provided by non-bank financial

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[7] Backé *et al.* (2006) have also linearly interpolated from annual to quarterly frequencies another explanatory variable - financial liberalization index.

intermediaries (for instance, leasing). However, the difference between the two concepts in the banking-based financial systems of the CEE countries is negligible.

It would be more appropriate not to use the aggregated credit to the private sector but rather the structure of the credit with respect to households and non-financial private companies. As the credit development in these sectors may differ, the equilibrium credit level may vary as well. However, because of limited data availability we focus only on total private sector later in this study. Structural characteristics of the bank credit to the private sector in the CEE countries are presented in the Appendix in Table A-2.

▪ **Data Panels**

We use two different data panels. One data set serves as an in-sample, for which our model is estimated. The second data set is then used as so called out-of-sample, for which the estimated model is applied.

Out-of-sample data panel consists of the countries of our interest, for which we want to investigate the equilibrium credit-to-GDP ratio, *i.e.* three Baltic states (Estonia, Latvia, and Lithuania), the three transition economies in South Eastern Europe (Bulgaria, Croatia, and Romania), the Visegrad countries (Czech Republic, Hungary, Poland, and Slovakia) and Slovenia. Since these countries clearly suffer from the initial credit undershooting the estimates of the coefficients would be biased if the model would be directly estimated for these countries. At the same time, the estimates would not reflect the equilibrium but rather the present relationship between credit to the private sector and the economic fundamentals (Frait *et al*., 2011).

Consequently, we construct a second data panel in-sample that includes countries, which we believe follow the credit equilibrium path. The in-sample countries should share common characteristics with the CEE countries (for instance, size of the economy, international openess, *etc.*). Otherwise it could happen that some omitted variables would expand the unexplained cross-country variance and the out-of-sample application of the estimated relationship would produce highly insignificant results (Kiss *et al*., 2006). However, the selection of

the benchmark countries is quite limited by the data availability, since longer time series for our dependent and explanatory variables are not reported for some countries. That is especially true for some emerging economies in Asia and the Americas.

We construct the in-sample panel from the developed EU countries. Countries hidden under the acronym PIIGS[8] were excluded from the panel, as they are considered economically weaker following the financial crisis and in addition, their level of public and private indebtedness might be already excessive. We further omitt Luxembourg due to the size of its financial sector. The resulting in-sample panel consists of the following countries: Austria, Belgium, Denmark, Finland, France, Germany, Netherlands, Sweden, and the United Kingdom.

▪ **Time Spans**

The data series for the out-of-sample panel start in 2000 and cover the period until the third quarter of 2011. The data series prior to 2000 are not reliable enough, since the transition countries introduced a number of transformation and consolidation measures among others aimed at the removal of non-performing loans from the banks' balance sheets. Not for all CEE countries of our interest is the latest data available. This applies especially to the CEE countries that have recently adopted the euro currency.

The data series for the in-sample panel begin in 1980 and cover the period until 2007. The subsequent financial crisis represented a large structural shock to the economies. Consequently, we do not include later data into our analysis, since the employed model could be significantly affected by the crisis development. The exact data time spans for both the in-sample and out-of-sample countries are reported in the Appendix.

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[8] Portugal, Italy, Ireland, Greece, and Spain.

3.3 Estimation Techniques

3.3.1 PMG Estimator

The data panels in a cross-country analysis usually contain a relatively large number of observations T and a number of cross-sectional units N of the same order of magnitude. There are two approaches commonly used for such data panels. The first approach is to estimate separate equations for each cross-sectional unit and calculate the coefficient means. This approach called the mean group (MG) estimator produces consistent estimates of the average of the coefficients but does not take into account the fact that certain coefficients may be the same across the units (Pesaran and Smith, 1995). The second approach is the traditional fixed and random effects estimator. These estimators pool the data and constraint the slope coefficients and error variances to be identical across the units, while the intercepts are allowed to differ. Pesaran *et al.* (1999) proposed an intermediate approach referred to as the pooled mean group (PMG) estimator, which constraints the long-run coefficients to be the same, but allows the short-run coefficients and the error variances to differ freely across the units.[9]

The PMG estimator derives the long-run panel coefficients from the autoregressive distributed lag (ARDL) models of individual cross-sectional units. We assume that the long-run relationship is given by:

$$y_{it} = \theta_{i0} + \sum_{j=1}^{q} \theta_{ij} X_{it} + \varepsilon_{it} \tag{3}$$

where the number of cross-sectional units $i = 1,2,...,N$, the number of time periods $t = 1,2,...,T$, X_{it} is the vector of explanatory variables for a unit i, θ_{ij} are the long-run coefficient vectors, y_{it} is the dependent variable, and θ_{i0} represents the constant term for a unit i. If the variables are integrated of order one [$I(1)$] and

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[9] The generalized method of moments (GMM) estimator proposed by Arellano (1989) or Arellano and Bover (1995) is an often used dynamic panel data estimator. However, this estimator is designed rather for panels containing large number of cross-sectional units N and a relatively small number of observations T for each unit. For a larger number of observations the GMM estimator can produce inconsistent and potentially very misleading estimates of the average values of the coefficients as argued by Pesaran *et al.* (1999).

cointegrated, then the error term ε_{it} is integrated of order zero [$I(0)$] for all i. The ARDL (p,q,q,…,q) dynamic panel specification of equation (3) can be written as follows:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \delta_{ij} X_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (4)$$

where μ_i represents the fixed effects, λ_{ij} are the coefficients of the lagged dependent variable, and δ_{ij} are the short-run coefficient vectors. Equation (4) can be expressed in an error-correction form using the following reparametrization:

$$\Delta y_{it} = \phi_i \left(y_{i,t-1} - \theta_{i0} - \sum_{j=1}^{q} \theta_{ij} X_{it} \right) + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}^* \Delta X_{i,t-j} + \varepsilon_{it} \qquad (5)$$

where $\phi_i = -\left(1 - \sum_{j=1}^{p} \lambda_{ij}\right)$, $\theta_{i0} = \dfrac{\mu_i}{1 - \sum_{j=1}^{p} \lambda_{ij}}$, $\theta_{ij} = \dfrac{\sum_{j=0}^{q} \delta_{ij}}{1 - \sum_{j=1}^{p} \lambda_{ij}}$,

$\lambda_{ij}^* = -\sum_{m=j+1}^{p} \lambda_{im}$, $j = 1,2,...,p-1$, and $\delta_{ij}^* = -\sum_{m=j+1}^{q} \delta_{im}$, $j = 1,2,...,q-1$.

The expression in the brackets in equation (5) represents the actual deviation of the dependent variable from its long-run relationship (equilibrium). Parameter ϕ_i is called the error-correction term or the speed of adjustment. A negative value of the error-correction term suggests that the dependent variable converges to its long-run equilibrium. Coefficients λ_{ij}, δ_{ij} represent the short-run dynamics or, in other words, they capture the covergence process towards the equilibrium level. However, often only the long-run coefficients θ_{ij} are of interest (Blackburne and Frank, 2007).

3.3.2 Estimation Outline

The main objective of the empirical analysis is to determine the equilibrium credit-to-GDP ratios for the panel consisting of the 11 CEE countries. We model the equilibrium credit-to-GDP ratio as a function of explanatory variables within an error-correction framework. The error-correction model postulates a long-run equilibrium relationship between the dependent and the explanatory variables and

a short-run dynamics, which is responsible for the convergence towards the equilibrium. We estimate the error-correction model using the PMG estimator, which constraints the long-run coefficients to be the same across the countries in the panel, while the short-run coefficients are allowed to vary. This specification means that the relationship between the equilibrium credit-to-GDP ratio and the explanatory variables is assumed to be identical, while the short-run dynamics around the equilibrium as well as the speed of adjustment can differ. The short-run dynamics or cyclical movements are often determined by institutional features that can vary considerably across the countries. Hence, imposing no restrictions on the short-run coefficients seems appropriate (Kiss *et al*., 2006). We perform the estimates out-of-sample using a panel of developed EU countries as a benchmark. We use the estimated coefficients to calculate the theoretical equilibrium credit-to-GDP ratios for the 11 CEE countries. The deviation of the actual and theoretical credit-to-GDP values gives us a measure of credit excessiveness.

The steps to perform the estimates of the equilibrium credit-to-GDP ratios are the following:

1. Test the stationarity of the variables both in levels and in first differences.

2. Identify a long-run relationship between the variables using the cointegration methodology.

3. Specify the short-term dynamics using the ARDL (p,q,q,...,q) model.

4. Formulate the error-correction equation, which includes both the long-run relationship and the short-term dynamics. Estimate the regression coefficients using the PMG estimator. Test the quality of the estimates.

5. Use the estimated coefficients and calculate the theoretical equilibrium credit-to-GDP ratios for the out-of-sample countries. Compare the actual credit-to-GDP ratios with their theoretical equilibrium values and decide, whether the credit development in these countries should be considered as excessive.

3.4 Testing the Variables

3.4.1 Stationarity

We tested the stationarity of the variables using the Augmented Dickey-Fuller (ADF) test. The appropriate number of lagged values was chosen using the common rule of thumb, which suggests at least four lagged values for quarterly data. According to the test results the null hypothesis of a unit root cannot be rejected at the 1 percent significance level for the real GDP per capita, consumption, and lending rate variable. The existence of a unit root for the claims on the government variable cannot be rejected at the 5 percent significance level. The inflation variable was generated by a stationary process at the 5 percent level of significance for most of the countries in the panel.

However, it is a well known argument that the ADF test lacks power to distinguish the unit root null hypothesis from the stationary alternative when the root is close to one. Another disadvantage of the ADF test pointed out by Shiller and Perron (1985) is its low power with short time spans. Since, our longest time series contains 112 quarterly observations, *i.e.* they span only over 28 years, the short time span of the data can be another source of a potential failure of the ADF test.

Table 3.1: Unit Root Tests

P-values	c^P	gdp	gov	con	lr	π
Individual ADF tests						
Austria	0.9058	0.9862	0.0721	0.7929	0.5988	0.0262
Belgium	0.6639	0.2452	0.7178	0.9869	0.4523	0.0007
Denmark	0.9955	0.9863	0.3822	0.6407	0.4556	0.0309
Finland	0.6410	0.8271	0.6012	0.3117	0.8197	0.0346
France	0.6989	0.1330	0.5706	0.9941	0.6360	0.0000
Germany	0.1737	0.9760	0.4396	0.9858	0.0162	0.0071
Netherlands	1.0000	0.9604	0.9115	0.9855	0.6039	0.0015
Sweden	0.9960	0.3114	0.1453	0.1518	0.2965	0.3159
United Kingdom	0.9318	0.8053	0.7432	0.2697	0.4915	0.0112
Panel IPS test						
Developed EU countries	1.0000	0.9239	0.1727	0.8379	0.1372	0.0000

Notes: ADF tests H_0: variable contains a unit root   IPS tests H_0: all panels contain unit roots
H_1: variable is stationary H_1: some panels are stationary

Hence, we further employed a panel unit root test proposed by Im, Pesaran, and Shin (1997).[10] The Im-Pesaran-Shin (IPS) test combines the evidence of several independent unit root tests and exploits the cross sectional information, which may increase the power of the unit root test. We used the Bayesian Information Criterion (BIC) to determine the appropriate number of lagged values. At the 5 percent significance level we cannot reject the null hypothesis that all countries contain a unit root. This applies to all examined variables, except for the inflation.

We further performed the panel IPS test on the variables in first differences. The test results suggest that the real GDP per capita, claims on the government, consumption, and lending rate variables are not stationary in levels but are stationary in first differences both at the 1 percent and the 5 percent significance level. Thus, these variables are integrated of order one [$I(1)$]. By contrast, the inflation variable was generated by a stationary process, *i.e.* the inflation variable is integrated of order zero [$I(0)$]. The unit root test results in form of the corresponding p-values for the variables in levels are shown in Table 3.1. The test results for the variables in first differences are listed in the Appendix.

3.4.2 Cointegration

Generally, a linear combination of two series integrated of order one is also a $I(1)$ series. If the linear combination of two or more $I(1)$ series turns out to be integrated of order zero [$I(0)$], the series are cointegrated or in a long-run equilibrium. In the previous section we have tested the stationarity of our variables both in levels and in first differences and have concluded that except for the

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[10] There is a number of different panel unit root tests such as Harris-Tzavalis (1999) test, Breitung (2000) test, Levin-Lin-Chu (2002) or Breitung and Das (2005). All these tests investigate the presence of a unit root under the assumption that all panels have the same value of the autoregression coefficient. The Im-Pesaran-Shin (IPS) test relaxes this assumption and instead allows the autoregression coefficient to differ in each panel. Another limitation of the aforementioned panel unit root tests is that they require strongly balanced data. Since our panel data are strongly unbalanced we prefer the IPS test, which can be applied also for unbalanced data as shown by Madalla and Wu (1999).

inflation variable our series can be considerd as $I(1)$. We search for a long-run relationship among the $I(1)$ variables using the panel cointegration techniques.

Basically, there are two groups of panel cointegration tests. The first group of tests takes cointegration as the null hypothesis. This group includes for instance the panel cointegration tests proposed by McCoskey and Kao (1998) or by Westerlund (2005). The second group of panel cointegration tests is mostly based on the methodology of Engle and Granger (1987) and the null hypothesis corresponds to no cointegration.

Westerlund (2007) suggests four new panel tests of the null hypothesis of no cointegration that are based on structural rather than residual dynamics. The author argues that these tests are potentially more powerful than residual-based tests, as they do not restrict the long-run cointegrating vector for the variables in their levels to be equal to the short-run adjustment process for the variables in their differences.

Table 3.2: Westerlund Panel Cointegration Tests

	Statistics	P-value	
Gt	-3.812	0.056	H_0: no cointegration
Ga	-18.442	0.105	H_1: cointegration of at least one cross-sectional unit
Pt	-8.970	0.002	H_0: no cointegration
Pa	-8.367	0.048	H_1: cointegration for the panel as whole

Notes: The test results are for the long-run relationship between the *gdp*, *gov*, *lr*, and c^p variables.

By applying the four panel cointegration tests proposed by Westerlund (2007) we identified a long-run relationship between the real GDP per capita, claims on the government, lending rate, and the dependent variable represented by the credit-to-GDP ratio. Table 3.2 illustrates the cointegration test results. The G_t statistics allows rejecting the null hypothesis of no cointegration at the 10 percent level of significance. The G_a statistics supports these findings, since at the 15 percent significance level we reject the null hypothesis and accept the alternative of cointegration of at least one cross-sectional unit in the panel. According to the P_a and P_t statistics that are based on pooling the information

among the cross-sectional units, we reject the null hypothesis and accept the alternative of cointegration for the panel as whole at the 5 percent significance level.

3.5 Results

By performing the panel cointegration tests we identified following long-run relationship between the dependent and the explanatory variables:

$$c_{it}^P = \theta_{i0} + \theta_{i1}gdp_{it} + \theta_{i2}gov_{it} + \theta_{i3}lr_{it} + \varepsilon_{it} \tag{6}$$

where the number of the countries $i = 1,2,...,N$, the number of time periods $t = 1,2,...,T$, c^P_{it} represents the credit-to-GDP ratio, θ_{i0} represents the constant term, gdp_{it} is the natural logarithm of real GDP per capita, gov_{it} are the claims on the government expressed as a percentage of GDP, and lr_{it} denotes the lending rate. Since all of the variables are $I(1)$ and cointegrated, the error term ε_{it} is $I(0)$ for all i.

To specify the short-run dynamics we use the autoregressive distributed lag, ARDL (p,q,q,...,q), model. The optimal number of lagged values for the ARDL specification was chosen using the Bayesian Information Criterion (BIC). The BIC for the regression is minimized if there is one lag included for each explanatory and the dependent variable, *i.e.* the model is ARDL (1,1,1,1).[11] The ARDL model specification can be written as follows:

$$c_{it}^P = \lambda_{i1}c_{i,t-1}^P + \delta_{10i}gdp_{it} + \delta_{11i}gdp_{i,t-1} + \delta_{20i}gov_{it} + \delta_{21i}gov_{i,t-1} + \delta_{30i}lr_{it} + \delta_{31i}lr_{i,t-1} + \mu_i + \varepsilon_{it} \tag{7}$$

where μ_i represents the fixed effects, λ_{i1} is the coefficient of the lagged dependent variable, and δ_{ji} are the short-run coefficients. By rewriting the equation (7) into the error-correction form we get the following expression:

$$\Delta c_{it}^P = \phi_i\left(c_{i,t-1}^P - \theta_{i0} - \theta_{i1}gdp_{it} - \theta_{i2}gov_{it} - \theta_{i3}lr_{it}\right) + \delta_{11i}\Delta gdp_{it} + \delta_{21i}\Delta gov_{it} + \delta_{31i}\Delta lr_{it} + \varepsilon_{it} \tag{8}$$

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[11] The same results were obtained when using the Akaike Information Criterion (AIC) instead.

where $\phi_i = -(1 - \lambda_{i1})$, $\theta_{i0} = \dfrac{\mu_i}{1 - \lambda_{i1}}$, $\theta_{i1} = \dfrac{\delta_{10i} + \delta_{11i}}{1 - \lambda_{i1}}$, $\theta_{i2} = \dfrac{\delta_{20i} + \delta_{21i}}{1 - \lambda_{i1}}$, $\theta_{i3} = \dfrac{\delta_{30i} + \delta_{31i}}{1 - \lambda_{i1}}$.

▪ PMG Estimator

We estimate the coefficients of the error-correction model using the PMG estimator.[12] The obtained estimation results are reported in Table 3.3. According to the estimates the real GDP per capita enters the long-run relationship with the expected positive sign and is statistically significant at the 5 percent significance level. The claims on the government turn out to be statistically significant at the 1 percent significance level. An increase in the government borrowings has the expected negative impact on credit to the private sector. Hence, this finding supports the crowding-out hypothesis. A strong negative relationship has also been revealed between credit to the private sector and the financing costs, which are represented by the lending rate.

Table 3.3: PMG Estimator – Estimation Results

PMG	Coefficients	Standard Errors	95% Conf. Interval	
long-run				
gdp	0.1202**	0.0548	0.0127	0.2276
gov	-0.6401***	0.2015	-1.0351	-0.2451
lr	-0.0327**	0.0167	-0.0653	-0.0000
short-run				
ec	-0.0591**	0.0236	-0.1054	-0.0128
d.gdp	0.6100**	0.2902	0.0413	1.1789
d.gov	1.3660***	0.4262	0.5307	2.2013
d.lr	0.0086**	0.0036	0.0009	0.0164
constant	0.0011	0.0061	-0.0107	0.0130

Notes: *, **, *** denote 1%, 5%, 10% significance level respectively.

Even though we are particularly interested in the long-run relationship, we also briefly comment on the estimated short-run coefficients. Since the PMG estimator does not constraint the short-run dynamics to be the same across the groups, the

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[12] The PMG estimator is in principle a maximum likehood estimator. The Newton-Raphson algorithm without a common time trend was set as the maximization technique. A different stepping algorithm was used for the non-concave regions of the likelihood.

short-run coefficients are country-specific. The figures reported in Table 3.3 are consequently the averaged values of the short-run coefficients of the individual countries. All of the explanatory variables turned out to be significant in the short-run and on average affect positively credit to the private sector. As a result, at least in the short-run the government borrowings do not crowd-out private entities from the credit market.

▪ **Speed of Adjustment**

The error-correction term or the speed of adjustment is also country specific.[13] For all countries included in the panel appeared the speed of adjustment negative and statistically significant. The only exception is Sweden, where the coefficient has albeit a negative sign is, however, not significant. A negative sign of the speed of adjustment indicates that the actual deviation of credit to the private sector from its long-run equilibrium is being eliminated through the short-run dynamics. Simultaneously, the absolute value of the coefficient suggests how fast this convergence towards the equilibrium occurs.

Table 3.4: Speed of Adjustment

Country	Error-correction term
Austria	-0.1843***
Belgium	-0.0463**
Denmark	-0.0444***
Finland	-0.0459**
France	-0.0282*
Germany	-0.0486*
Netherlands	-0.0255***
Sweden	-0.0296
United Kingdom	-0.0788***

Notes: *, **, *** denote 1%, 5%, 10% significance level respectively.

According to Table 3.4 most of the countries included in the panel share a very similar speed of adjustment. The only exception is Austria with the speed of adjustment approximately 0.18 in the absolute value, which implies that credit to

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[13] The error-correction term is denoted in the text either as ϕ or *ec*.

the private sector in this country converges to its long-run equilibrium more than twice as fast as in the other countries in the panel.

The speed of adjustment obtained from the error-correction model serves at the same time as a cointegration test. A negative and statistically significant value of the speed of adjustment is taken as a proof for cointegration between the variables. We tested the presence of cointegration in one of the previous sections using the four panel cointegration tests proposed by Westerlund (2007). The speed of adjustment estimated by the PMG procedure confirms the primary findings.

▪ **Dynamic FE and MG Estimator**

To provide a comparison we further estimate the coefficients of the error-correction form using the mean group (MG) estimator and the dynamic fixed effects (FE) estimator. However, the estimated coefficients can vary substantially since each of the estimation techniques imposes different restrictions regarding the homogeneity of the short- and long-run coefficients. The dynamic FE estimator, just like the PMG estimator, constraints the long-run coefficients to be identical across the groups. In addition, the dynamic FE procedure constraints also the short-run coefficients including the speed of adjustment to be equal. Only the individual intercepts may differ freely. Table 3.5 presents the estimation results obtained by the dynamic FE estimator. According to the results the real GDP per capita and the claims on the government variables are both statistically significant and enter the long-run relationship with the expected signs. The lending rate coefficient has a negative sign as expected but the variable is not significant at any level considered. The negative and statistically significant speed of adjustment suggests again that the short-run dynamics ensures the convergence of the credit to the private sector towards its long-run equilibrium level.   .

Table 3.5: Dynamic FE Estimator – Estimation Results

Dynamic FE	Coefficients	Standard Errors	95% Conf. Interval	
long-run				
gdp	0.7117***	0.1415	0.4345	0.9890
gov	-1.2791**	0.6203	-2.4950	-0.0633
lr	-0.0155	0.0167	-0.0482	0.0172
short-run				
ec	-0.0376***	0.0071	-0.0515	-0.0237
d.*gdp*	-0.1272***	0.0461	-0.2175	-0.0369
d.*gov*	1.6552***	0.0788	1.5001	1.8096
d.*lr*	0.0099***	0.0024	0.0052	0.0146
constant	-0.1951***	0.0589	-0.3106	-0.0796

Notes: *, **, *** denote 1%, 5%, 10% significance level respectively.

The MG estimator is the least restrictive, as it allows for the heterogeneity of both short- and long-run coefficients. However, regarding the lack of restrictions the PMG procedure may potentially yield inefficient estimates. The averaged estimated coefficient for the real GDP per capita and the averaged speed of adjustment are both significant with the proper signs. The other explanatory variables turned out insignificant in the long-run. The averaged coefficients derived using the MG estimator are reported in the Appendix.

Table 3.6: Estimated Coefficients – Comparison

Estimator	gdp	gov	lr	ec
PMG	0.1202**	-0.6401***	-0.0327**	-0.0591**
Dynamic FE	0.7117***	-1.2791**	-0.0155	-0.0376***
MG	2.1508*	4.4994	-0.0026	-0.0903***

Notes: *, **, *** denote 1%, 5%, 10% significance level respectively.

Table 3.6 illustrates the estimated long-run coefficients and the estimated speed of adjustment obtained using the three abovementioned estimation techniques. It is apparent that the PMG and the dynamic FE procedures provide very similar results. All of the coefficients have the expected signs and are statistically significant, with the exception of the lending rate variable for the dynamic FE estimator that is insignificant at all levels considered. According to the dynamic FE estimates, an increase in real GDP per capita would, however,

have a much higher impact on credit to the private sector in the long-run than predicted by the PMG estimator. Also an increase in the government borrowings in the dynamic FE model would negatively affect the private credit nearly twice as much as suggested by the PMG procedure.

▪ **Hausman Specification Test**

As already mentioned above the PMG estimator restricts the long-run coefficients to be identical across the groups. This pooling across the groups yields efficient and consistent estimates when the applied restrictions are true. However, often the hypothesis of the long-run slope homogeneity is rejected empirically. If the true model contains heterogeneous long-run coefficients then the PMG estimates are inconsistent. The MG estimates are consistent in either case (Blackburne and Frank, 2007). The Hausman specification test compares the two estimators and evaluates their significance. Under the null hypothesis the PMG estimator is efficient and consistent. The alternative states that the MG estimator is consistent, while the PMG estimator is not. The p-value of approximately 0.17 allows us to accept the null hypothesis at the 15 percent significance level and thus the restrictions imposed on the homogeneity of the long-run coefficients are justified. Table 3.7 summarizes the tested hypothesis and results in form of the corresponding p-values.

Table 3.7: Hausman Specification Test

Hypotheses		P-values
H_0: b_0 and b_1 are consistent, b_1 is efficient	b_0: MG b_1: PMG	Prob>chi2 = 0.1734
H_1: b_0 is consistent, b_1 is not consistent	b_0: MG b_1: DFE	Prob>chi2 = 0.3690

By applying the Hausman specification test we can also test the dynamic FE estimates. As discussed by Baltagi et al. (2000) the FE models are often subject to a simultaneous equation bias that stems from the endogeneity between the lagged dependent variable and the error term. The Hausman specification test measures the extent of this endogeneity. The null hypothesis assumes an efficient and

consistent dynamic FE estimator, while the alternative states that this estimator is inconsistent. A high p-value leads to the acceptance of the null hypothesis. Hence, the simultaneous equation bias is minimal.

▪ **Equilibrium Credit-to-GDP Ratios**

The long-run coefficients estimated by the PMG procedure were applied to derive the equilibrium credit-to-GDP ratios for the 11 CEE countries. Since the estimated short-run coefficients are country-specific, there is no constant term available for the CEE countries. Backé *et al.* (2006) proposed to employ the median constant term estimated for the in-sample panel simultaneously with its smallest and largest value. We decided to use a similar approach, however, instead of using the smallest and the largest value of the constant term we consider the standard deviation from the short-run constant term average. As a result, we obtain an approximately 20 percent wide range for the equilibrium credit-to-GDP ratio. The equilibrium credit-to-GDP ratios together with the actual credit dynamics are depicted in Figure 1-A in the Appendix.

If the actual credit-to-GDP ratio lies above the estimated equilibrium level the credit development is considered as excessive. Figures 3.1, 3.2, and 3.3 illustrate the actual credit deviation from the long-run equilibrium for the Baltic countries, for the transition countries in South Eastern Europe, and for the Visegrad countries and Slovenia, respectively. On the first sight, it is obvious that the analyzed CEE countries do not generally suffer under excessive credit to the private sector. The negative values of the deviation indicate that the credit-to-GDP ratios observed in the transition countries during the 2000 – 2011 period were mostly lower than their justified equilibrium credit levels.

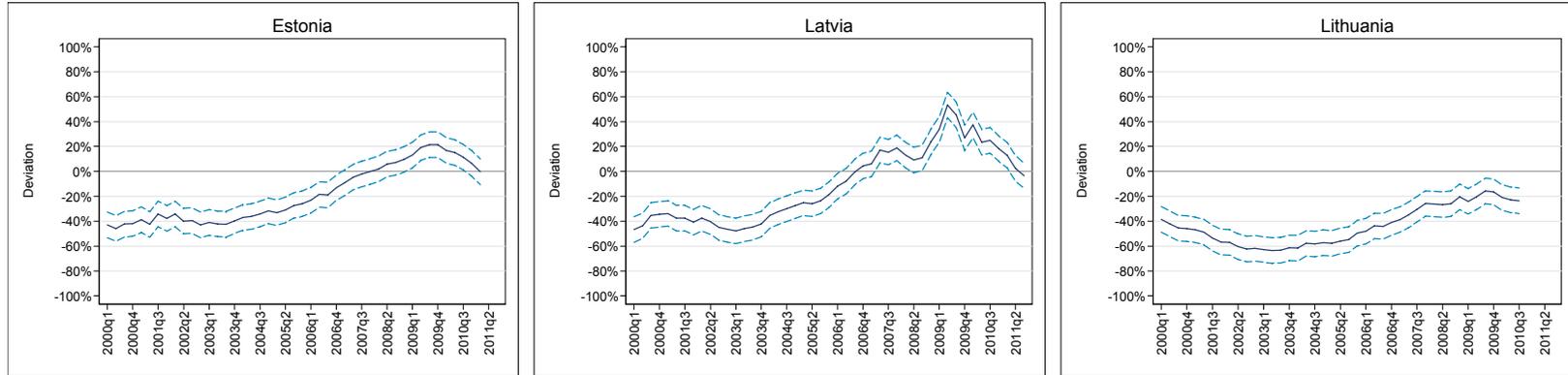**Figure 3.1: Deviation from Long-Run Equilibrium Credit-to-GDP in Baltic Countries**

Figure 3.2: Deviation from Long-Run Equilibrium Credit-to-GDP in South Eastern Europe
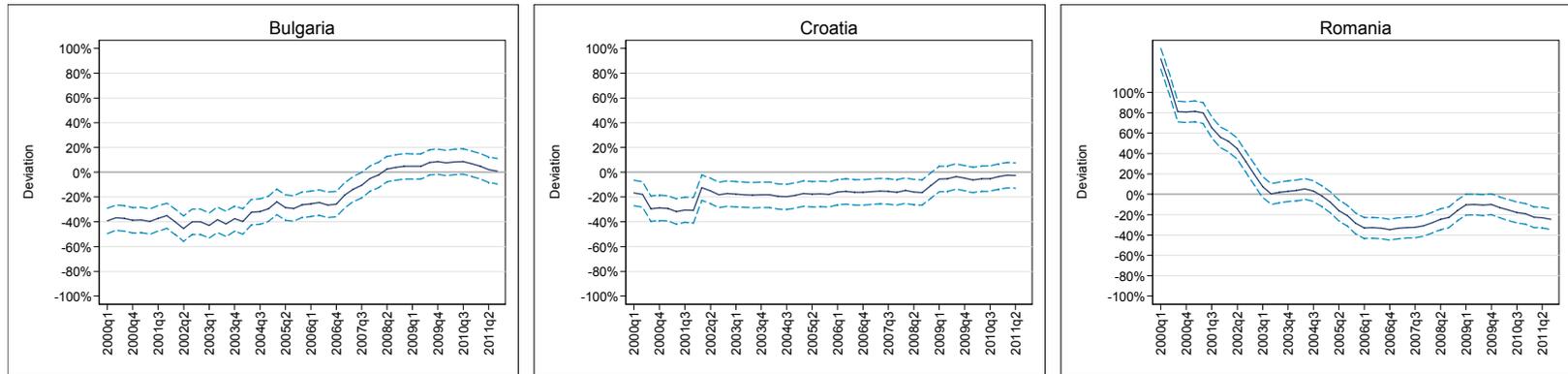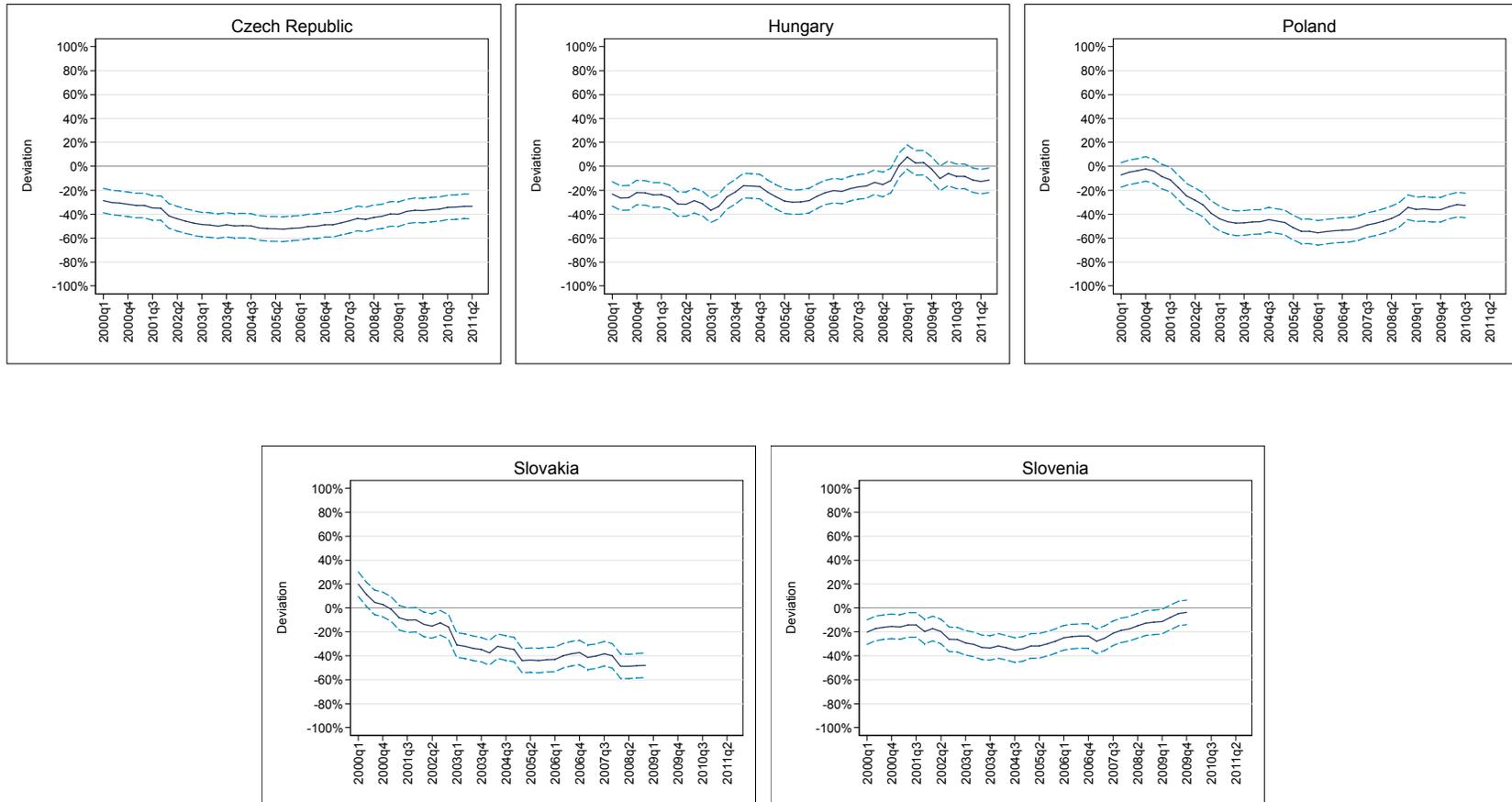
Figure 3.3: Deviation from Long-Run Equilibrium Credit-to-GDP in Visegrad Countries and Slovenia

Some CEE countries experienced excessive credit-to-GDP ratios at the beginning of the studied period. This is the case of Slovakia and Romania. However, in case of Romania the estimated results from the beginning of the analyzed period are not very reliable. Extremely high lending rates that accompanied the transition process forced the estimated equilibrium credit-to-GDP ratio in this country into negative values and consequently made the relatively slow credit dynamics look excessive.

According to the deviations from the long-run equilibrium the analyzed CEE countries can be divided into three groups. The first group of countries consists of the Czech Republic, Poland, and Slovakia. These countries have been substantially below their equilibrium levels throughout the entire period and their credit-to-GDP ratios seem to converge rather moderately towards them.

The second group includes countries that have not only converged but also eventually nearly or completely reached the equilibrium. At the same time, the credit to the private sector for these countries cannot be considered as excessive at any point within the studied period. These countries are Croatia, Hungary, Lithuania, Romania, and Slovenia. Particularly interesting is the development of the credit-to-GDP ratio in Croatia. Starting from 2002 onwards, Croatia practically followed the credit equilibrium path when considering the lower bound of the long-run equilibrium range. The overall economic slowdown in the aftermath of the financial crisis pushed the private credit even closer towards the equilibrium, so that the lately recorded credit-to-GDP ratios in Croatia are situated directly in the mid-point of the equilibrium range. To include Slovenia into this group is slightly inconsistent. Even though Slovenia meets all of the abovementioned criteria, given the previous credit dynamics in this country and the fact that the data cover the period only until the fourth quarter of 2009, it is likely that the latest credit development was already excessive.

Bulgaria, Estonia, and Latvia constitute the last group of countries. The credit-to-GDP ratios in these countries were slightly excessive or very close to their long-run equilibrium levels in the period preceding the financial crisis. As the

crisis spread across the countries, the worsened economic conditions accompanied by the decline in GDP affected both the actual credit-to-GDP dynamics and the long-run equilibrium. The significant decrease in the GDP lowered the estimated long-run equilibrium. The credit growth rate dropped substantially as well, however, as the decrease in GDP was more profound the actual credit-to-GDP ratio has remained stable or has even slightly increased during the crisis. As a result, the credit-to-GDP ratios in these countries grew further above the equilibrium and hence, also the measure of credit excessiveness increased further. The latest figures indicate that the credit-to-GDP ratios in these transition countries might tend to return to their pre-crisis levels. However, for us to draw any conclusions we do not have sufficiently long data series.

Conclusion

In this thesis, we have analyzed the equilibrium credit to the private sector for 11 CEE countries. The reason behind the analysis was the rapid credit dynamics observed in these countries over the past decades and the related question whether the rapid credit growth was actually linked to the convergence of the CEE countries towards their long-run equilibrium or whether it represented an excessive credit growth, which may potentially threaten the macroeconomic and financial stability in these countries.

We modelled the equilibrium credit-to-GDP ratio for the 11 CEE countries within an error-correction framework by applying the advanced pooled mean group (PMG) estimator. This dynamic panel data procedure constraints the long-run coefficients to be the same across countries, while the convergence towards the equilibrium represented by the short-run dynamics can be

heterogeneous. We found that the equilibrium credit to the private sector can be expressed as a function of real GDP per capita, lending rate, and the claims on the government. The real GDP per capita affects the private credit positively in the long-run, whereas an increase in financing costs represented by a higher lending rate tends to lower the private credit level. The government borrowings have also a negative impact on private credit in the long-run, confirming the crowding-out hypothesis. We tested the applied restrictions regarding the homogeneity of the long-run coefficients using the Hausman specification test and concluded that the PMG procedure yields efficient and consistent estimates. The long-run coefficients were estimated on a panel of selected developed EU countries and the equilibrium credit-to-GDP ratios for the CEE countries were derived out-of-sample in order to avoid the potential transition bias. The deviation of the actual credit-to-GDP ratio from the estimated long-run equilibrium served as a measure of credit excessiveness.

The results indicated that the analyzed CEE countries did not generally suffer under excessive credit to the private sector during the 2000 - 2011 period. The only countries that came very close or slightly above the equilibrium in the period preceding the global financial crisis were Bulgaria, Estonia, and Latvia. Moreover, the further increase in the credit excessiveness measure throughout the crisis can be rather attributed to the worsened economic conditions and to the singnificant decline in GDP in these countries than to a further increase in private credit.

The prospective research may analyze not only the credit level represented by the credit-to-GDP ratio as is the current practice but simultaneously concentrate on the equilibrium growth rate of private credit. Even though the credit-to-GDP ratio does not exceed the justified long-run equilibrium its steep rate of growth might undermine the stability by cumulating potential risks that might become apparent only later.

References

Arellano, M. (1989): *A Note on the Anderson-Hsiao Estimator for Panel Data*, Economics Letters, Vol.31, pp.337-341.

Arellano, M., and Bover, O. (1995): *Another Look at the Instrumental Variable Estimation of Error-Components Models*, Journal of Econometrics, Vol.68, pp.29-52.

Arpa, A., Reininger, T., and Walko, Z. (2005): *Can Banking Intermediation in the Central and Eastern European Countries Ever Catch up with the Euro Area?*, Focus on European Economic Integration 2/05, Oesterreichische Nationalbank.

Backé, P., Égert, B., and Zumer, T. (2006): *Credit Growth in Central and Eastern Europe: New (Over)shooting Stars?*, ECB Working Paper No.687, October 2006.

Baltagi, B. H., Griffin, J. M., and Xiong, W. (2000): *To Pool or not to Pool: Homogeneous versus Heterogeneous Estimators Applied to Cigarette Demand*, Review of Economics and Statistics 82, pp.117-126.

Barajas, A., Dell'Ariccia, G., and Levchenko, A. (2007): *Credit Booms: the Good, the Bad, the Ugly, Unpublished Manuscript*, International Monetary Fund, Washington, DC.

Blackburne, E. F., and Frank, M. W. (2007): *Estimation of Nonstationary Heterogeneous Panels*, The Stata Journal, 2007, Number 2, pp.197-208.

Boissay, F., Calvo-Gonzales, O., and Kozluk, T. (2005): *Is Lending in Central and Eastern Europe Developing too Fast?*, Paper presented at the conference "Finance and Consumption

Workshop: Consumption and Credit in Countries with Developing Credit Markets", Florence, 16-17 June 2006.

Breitung, J. (2000): *The Local Power of Some Unit Root Tests for Panel Data*, in Baltagi (ed.) Advances in Econometrics, Vol.15, Nonstationary Panels, Panel Cointegration, and Dynamic Panels, Amsterdam: JAI Press, pp.161-178.

Breitung, J., and Das, S. (2005): *Panel Unit Root Tests under Cross-sectional Dependence,* Statistica Neerlandica, Vol.59, Issue 4, November 2005, pp.414-433.

Calza, A., Gartner, C., and Sousa, J. (2001): *Modelling the Demand for Loans to the Private Sector in the Euro Area*, ECB Working Paper No.55, April 2001.

Cartas, J. M., McConagha, M. (2010): *Credit to the Private Sector Remains Weak*, Finance & Development, Vol.47, Nr. 2, June 2010.

Cottarelli, C., Dell'Ariccia, G., and Vladkova-Hollar, I. (2003): *Early Birds, Late Risers, and Sleeping Beauties: Bank Credit Growth to the Private Sector in Central and Eastern Europe and the Balkans*, IMF Working Paper WP/03/213, November 2003.

De Bandt, O., and Jacquinot, P. (1992): *The Financing of Corporate Firms in France: An Econometric Model*, Economic Modelling 9, pp.153-269.

EBRD (1998): *Transition Report 1998*.

ECB (2011)*: Recent Developments in Loans to the Private Sector*, ECB Monthly Bulletin, January 2011, pp.57-72.

Engle, R., and Granger, C. (1987): *Cointegration and Error Correction: Representation, Estimation and Testing*, Econometrica, Vol.55, pp.251-276.

Fase, M. M. G., Kramera, P., and Boeschotena, W. C. (1992): *MORKMON II: De Nederlandsche Bank's Quarterly Model of the Netherlands Economy*, Economic Modelling 9, pp.146-204.

Frait, J., Geršl, A., and Seidler, J. (2011): *Credit Growth and Financial Stability in the Czech Republic,* Policy Research Working Paper Series 5771, World Bank, August 2011.

Gattin-Turkalj, K., Ljubaj, I., Martinis, A., and Mrkalj, M. (2007): *Estimating Credit Demand in Croatia*, Croatian National Bank Working Paper, 2007, pp.1-32.

Gourinchas, P.O, Valdes, R., and Landrechte, O. (1999): *Lending Booms: Some Stylized Facts*, Economia, pp.47-49, Italy.

Gourinchas, P.O, Valdes, R., and Landrechte, O. (2001): *Lending Booms: Latin America and the World*, NBER Working Paper No.8249, April 2001.

Harris, R. D. F., and Tzavalis, E. (1999): *Inference for Unit Roots in Dynamic Panels where the Time Dimension is Fixed*, Journal of Econometrics, Vol.91, pp.201-226.

Hofmann, B. (2001): *The Determinants of Private Sector Credit in Industrialised Countries: Do Property Prices Matter?*, BIS Working Paper No.108, December 2001.

Honohan, P. (1997): *Banking System Failures in Developing and Transition Countries: Diagnostics and Prediction*, BIS Working Paper No.39, January 1997.

Im, K. S., Pesaran, M. H., and Shin, Y. (1997): *Testing for Unit Roots in Heterogeneous Panels*, Mimeo, Department of Applied Economics, University of Cambridge.

IMF (2004): *World Economic Outlook*, April 2004.

Kaminsky, G. L., and Reinhart, M. (1999): *The Twin Crises: The Causes of Banking and Balance-of-Payments Problems*, American Economic Review, Vol.89, No.3, pp.473-500.

Khan, M., Senhadji, A., and Smith, B. (2001): *Inflation and Financial Depth*, IMF Working Paper 01/44, Washington, International Monetary Fund.

Kiss, G., Nagy, M., and Vonnák, B. (2006): *Credit Growth in Central and Eastern Europe: Convergence or Boom?*, MNB Working paper 2006/10, November 2006.

Levin, A., Lin, C. F., and Chu, C. (2002): *Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties*, Journal of Econometrics, Vol.108, pp.1-24.

Madalla, G.S., and Wu, S. (1999): *Cross-country Growth Regressions: Problems of Heterogeneity, Stability and Interpretation*, Applied Economics, Vol.32, Issue 5, 2000, pp.635-642.

McCoskey, S., and Kao, C. (1998): *A Residual-Based Test of the Null of Cointegration in Panel Data,* Econometric Reviews, Vol.17, pp.57-84.

Mendoza, E., and Terrones, M. (2004): *Are Credit Booms in Emerging Markets a Concern?*, World Economic Outlook, pp.148-166.

Nieto, F. (2007): *The Determinants of Household Credit in Spain*, Banco de España Working Papers 0716, Banco de España.

Pesaran, M. H., Shin, Y., and Smith, R. (1999): *Pooled Mean Group Estimation of Dynamic Heterogeneous Panels*, Journal of the American Statistical Association, Vol.94, No.446 (June 1999), pp.621-634.

Pesaran, M. H., and Smith, R. P. (1995): *Estimating Long-Run Relationships from Dynamic Heterogeneous Panels*, Journal of Econometrics, Vol.68, pp.79-113.

Raiffeisen Bank Research (2010): *CEE Banking Sector Report*, September 2010.

Raiffeisen Bank Research (2011): *CEE Banking Sector Report*, October 2011.

Schadler, S., Murgasova, Z., and Van Elkan, R. (2004): *Credit Booms, Demand Booms, and Euro Adoption*, IMF, Paper fof Conference on Challenges for Central Banks in an Enlarged EMU, Austrian National Bank, Vienna, February 20-21, 2004.

Shiller, R. J., and Perron, P. (1985): *Testing the Random Walk Hypothesis: Power versus Frequency of Observation*, Economics Letters, Elsevier, Vol.18(4), pp.381-386.

Tang, H., Zoli, E., and Klytchnikova, I. (2000): *Banking Crises in Transition Countries: Fiscal Costs and Related Issues*, World Bank Policy Research Working Paper No.2484, November 2000.

Tornell, A., and Westermann, F. (2002): Boom-bust Cycles in Middle Income Countries: Facts and Explanation, IMF Staff Papers, Vol.49, Special Issue.

Westerlund, J. (2005): *A Panel CUSUM Test of the Null of Cointegration*, Oxford Bulletin of Economics and Statistics, Vol.62, pp.231-262.

Westerlund, J. (2007): *Testing for Error Correction in Panel Data*, Oxford Bulletin of Economics and Statistics, Vol.69, pp.709-748.

Zdzienicka, A. (2009): *Vulnerabilities in Central and Eastern Europe: Credit Growth*, GATE Working Paper 09-12, Mai 2009, University of Lyon.

Appendix

Figure A-1: Total Bank Assets in % of GDP
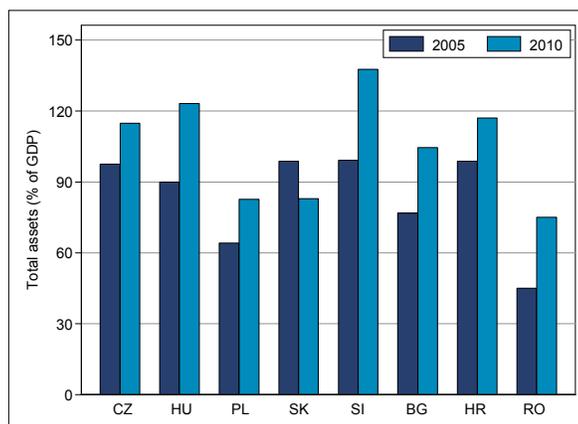
Source: Raiffeisen Bank Reports

Table A-1: International Financial Statistics Codes

Claims on Private Sector	22 D
Claims on Central Government	22 A
Claims on State and Local Government	22 B
Claims on Nonfinancial Public Enterprises	22 C
Private Final Consumption Expenditures	82 A
Consumer Prices, index numbers 2005=100	64
Exchange Rate, period average, per U.S. dollar	RF
Lending Rate	60 P
Households, up to 1 year	60 PH
New Business, floating, up to 1 year	60 PN
House Purchase, over 5 years	
House Purchase, New Business, 5-10 years	60 PC
Corporations, up to 1 year	
New Business, over €1 mil., up to 1 year	
Gross Domestic Product, nominal, seasonally adjusted	99 B
Population	99 Z

Table A-2: Bank Loans Structure

	Loans to households	Loans to private companies	Mortgage loans	Loans in foreign currency	Total loans/total deposits
Czech Republic	44.2	55.8	27.8	13.76	78.0
Hungary	51.6	48.4	41.2	61.6	140.3
Poland	68.1	31.9	38.3	34.2	112.6
Slovakia	44.2	55.8	31.6	1.5	84.4
Slovenia	23.0	77.0	-	6.94	146.1
Bulgaria	34.5	65.5	17.2	61.3	114.8
Croatia	45.6	54.4	22.1	72.9	103.0
Romania	48.6	51.4	13.8	63.3	109.7

Source: Raiffeisen Bank Reports and author's computations

Table A-3: Time Span of the Data

Transition countries (out-of-sample panel)	
Bulgaria	2000q1 – 2011q3
Croatia	2000q1 – 2011q2
Czech Republic	2000q1 – 2011q2

Estonia	2000q1 – 2011q1
Hungary	2000q1 – 2011q3
Latvia	2000q1 – 2011q3
Lithuania	2000q1 – 2010q3
Poland	2000q1 – 2010q3
Romania	2000q1 – 2011q3
Slovakia	2000q1 – 2008q4
Slovenia	2000q1 – 2009q4
Developed EU countries (in-sample panel)	
Austria	1995q2 – 2007q4
Belgium	1980q1 – 2007q4
Denmark	1991q1 – 2007q4
Finland	1980q1 – 2007q4
France	1984q2 – 2007q4
Germany	1991q1 – 2007q4
Netherlands	1980q1 – 2007q4
Sweden	2001q4 – 2007q4
United Kingdom	1980q1 – 2007q4

Table A-4: Unit Root IPS Test – Variables in Levels

	Statistics	P-value	Lags average
c^P	8.4118	1.0000	1.53
gdp	1.4316	0.9239	3.80
gov	-0.9435	0.1727	1.00
con	0.9859	0.8379	2.33
lr	-1.0932	0.1379	1.20
π	-7.0159	0.0000	4.00

Notes: The number of lags of the series was chosen such that the BIC for the regression is minimized.

Table A-5: Unit Root IPS Test – Variables in 1st Differences

	Statistics	P-value	Lags average
d.c^P	-22.7372	0.0000	1.00
d.gdp	-0.4321	0.0000	2.33
d.gov	-28.3054	0.0000	0.73
d.con	-13.5619	0.0000	1.40
d.lr	-19.8748	0.0000	0.27
d.π	-18.0773	0.0000	2.80

Notes: The number of lags of the series was chosen such that the BIC for the regression is minimized.

Table A-6: MG Estimator – Estimation Results

MG	Coefficients	Standard Errors	95% Conf. Interval	
long-run				
gdp	2.1508*	1.2330	-0.2659	4.5674
gov	4.4994	6.7331	-8.6972	17.6961
lr	-0.0026	0.0549	-0.1101	0.1049
short-run				
ec	-0.0903***	0.0229	-0.1352	-0.4544
d.*gdp*	-0.1078**	0.0418	-0.1897	-0.0260
d.*gov*	1.3054***	0.4164	0.4893	2.1216
d.*lr*	0.0077**	0.0030	0.0019	0.0136
constant	-0.2097	0.2885	-0.7751	0.3556

Notes: *, **, *** denote 1%, 5%, 10% significance level respectively.

Figure A-2: Equilibrium Credit-to-GDP Ratios in Baltic Countries, in South Eastern Europe, and in Visegrad Countries and Slovenia