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## **EXCESSIVE CREDIT GROWTH OR THE CATCHING UP PROCESS: THE CASE OF CENTRAL, EASTERN, AND SOUTHEASTERN EUROPEAN COUNTRIES\*\*\***

**ABSTRACT:** *Most CESEE countries had an impressive credit growth prior to the outbreak of the financial crisis in 2008. Nevertheless, that experience has taught us that the strong expansion of private sector credit must not be ignored. In an attempt to investigate whether the rapid credit growth was a result of the catching-up process or was a risky process with well-known consequences, we performed empirical analysis by applying statistical (HP filter) and econometric (pooled OLS, fixed effect OLS, and PMG) approaches. The empirical results of both out-of-sample and in-sample approaches suggest that in the pre-crisis*

*period excessive credit growth in terms of higher actual than estimated credit growth was recorded for the majority of the countries observed. Compared to the out-of-sample approach, in-sample estimates, which turned out to be more reliable, indicate that the pre-crisis growth was less pronounced and that over the post-crisis period actual credit growth fluctuated around the estimated growth, pointing to the fact that the former was in line with movements in its fitted values.*

**KEY WORDS:** *Capital inflows, credit growth, financial deepening, HP filter*

**JEL CLASSIFICATION:** E44, E51, G21

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## **1. INTRODUCTION**

In the past decade, most Central, Eastern, and Southeastern European (CESEE) countries<sup>1</sup> saw an unprecedented credit boom. Capital inflows are regarded as by far the most important factor contributing to the credit boom, of which ‘other investment’ was the most important (the main components of ‘other investment’ are loans, trade credits, and deposits). In addition, bank credits have been of particular importance for the CESEE-12 countries, as their financial systems are bank-centric and banks have played a vital role in intermediating capital inflows to these emerging countries. This can be seen in the fact that bank assets constitute about 85% of financial sector assets, whereas the development of capital markets and other non-bank financial institutions is still relatively limited.

Factors other than capital inflows also affected the rapid credit expansion in the region, indicating a tendency of the CESEE-12 countries to become closer to Western Europe in terms of income level. These factors include overall banking reform, macroeconomic stabilization, and privatization of the financial sector, all of which marked a turning point. At the beginning of the transition from a centrally planned to a market-based economy, both income level and credit growth in the region were at a low level. This was one of the reasons why the region intended to accelerate credit growth, as it would give the region a chance to achieve a higher degree of the income convergence.

This working paper aims to provide the answers to two questions: which of the CESEE-12 countries saw excessive credit growth, and was this excessive credit growth a result of the convergence process or was it unsustainable due to the high risks posed to the financial sector? In the economic literature there are two distinctive approaches to identifying credit booms, which we use in this paper. The first is a statistical approach, where we apply the methodology proposed by Mendoza & Terrones (2008), Selim & Yiqun (2011), and Gourinchas et al. (1999, 2001). The second is an econometric approach, where we use both out-of-sample and in-sample approaches in order to identify structural relationships

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<sup>1</sup> The group of CESEE countries considered in this paper consists of: Estonia, Latvia, Lithuania, the Czech Republic, Slovakia, Poland, Croatia, Bulgaria, Hungary, Romania, Slovenia, and Serbia.

between credit and economic fundamentals. Several studies have used econometric tools in an attempt to provide a theoretical and an empirical approach to this topic (Cotarelli et al. 2005, Kiss et al. 2006, Geršl & Seidler 2010, Coudert & Pouvelle 2010, Boissay et al. 2005, Egert et al. 2006, Jovanović et al. 2014).

The major challenge in this econometric and statistical analysis is to determine whether the strong credit growth prior to the onset of the global financial crisis was excessive, or if it was a part of a catching-up process, bearing country-specific economic features in mind. The issue of estimating equilibrium credit growth in the CESEE-12 countries becomes even bigger and more complicated if we take into account the problem of availability of banking sector data in these countries.

The statistical analysis results show that the majority of the observed developing economies saw excessive credit growth (credit-to-GDP ratio indicator), while based on the real credit growth indicator this is only the case for Serbia and Croatia. Moreover, the robustness check of the statistical approach refers to the existence of excessive credit growth in all the transition countries under investigation. On the other hand, the empirical results of both the out-of-sample and the in-sample approach (econometric analysis) suggest that in the pre-crisis period excessive credit growth was recorded for the majority of the countries observed. As opposed to the out-of-sample approach, in-sample estimates, which turned out to be more reliable, indicate that the pre-crisis growth was less pronounced and that over the post-crisis period actual credit growth fluctuated around the estimated growth, pointing to the fact that the former was in line with movements in its fitted values.

The rest of the paper is structured as follows. In Section 2 we briefly present some of the stylized facts on the banking sector in the CESEE-12 countries, which are considered to be largely responsible for the rapid credit growth in the region. In Sections 3 and 4 we carry out an empirical analysis based on the statistical and econometric approaches in order to assess whether the credit growth was excessive or not. In Section 5 we present concluding remarks.

## **2. BANKING SECTOR AND CREDIT GROWTH IN CESEE ECONOMIES: STYLIZED FACTS**

Before estimating observed credit growth, we present some stylized facts on the banking sector of the CESEE-12 countries. The main purpose of this is explain why the private credit-to-GDP ratio differed across our countries of interest, i.e., to find the factors that supported the credit growth.

The main feature of the CESEE-12 countries is that they all underwent a transition from a socialist to a market economic structure. These countries' banking sectors were relatively underdeveloped in comparison with real economies, due mainly to the fact that they were subservient to state enterprises. Also, no attention was paid to implementing a reasonable risk management policy when making decisions on granting credits.

In the 1990s, in order to counter the macroeconomic and financial instability and to remove crowding-out effects, these countries were forced to change the old way of doing business and to focus on deregulating the banking industry. Thus, the structure of the financial system experienced tremendous changes, an indirect channel for funding firms became dominant, and capital markets generally remained underdeveloped. Thus banks have had a major role in the region's financial systems. Moreover, most of these banks are foreign-owned (Figure 2), and the presence of foreign banks made it possible to increase the availability of funds to the private sector in these countries. More competitive banking sectors contributed to decreasing interest margins, which reduced the cost of borrowing and increasing credit supply because of access to cheaper funds from parent banks.

On the other hand, the demand for credit also grew as a result of improving macroeconomic conditions (inflation stabilization, relatively predictable exchange rates, interest rate movements in borrowing countries), optimistic income expectations, and an initial low level of household indebtedness.

The aforementioned internal factors made the region a favourable destination for investment, but there were also external factors which further boosted capital inflows to the CESEE-12 economies, of which the most important were low interest rates in advanced economies (lending countries) and an over-

optimistic perception of the region in terms of further development. The quest for much higher yields and an attempt to take advantage of new investment opportunities had an effect on the decision to invest in the region.

In the economic literature these factors are also known as ‘push’ and ‘pull factors’ (see Agénor 1998, Fernandez-Arias 1996, Sirtaine & Skamnelos 2007, Dell’Ariccia G. et al. 2012). Which factors play role in explaining the surge in capital inflows and how sustainable they are, has significant policy implications.

**Table 1:** Real GDP growth (percent)

	Average						
	2001-2006	2007	2008	2009	2010	2011	2012
Advanced economies	2.334	2.801	0.069	-3.47	3.012	1.634	1.249
European Union	2.310	3.44	0.547	-4.201	2.046	1.605	-0.24
Bulgaria	5.654	6.448	6.191	-5.476	0.393	1.841	0.775
Croatia	4.541	5.06	2.084	-6.947	-2.272	-0.047	-1.976
Czech Republic	4.588	5.735	3.099	-4.507	2.492	1.887	-1.249
Estonia	8.086	7.492	-4.151	-14.072	3.33	8.282	3.224
Hungary	4.140	0.125	0.743	-6.695	1.244	1.652	-1.659
Latvia	8.718	9.6	-3.275	-17.729	-0.942	5.477	5.578
Lithuania	7.797	9.796	2.912	-14.847	1.521	5.866	3.617
Poland	3.617	6.785	5.127	1.628	3.875	4.321	2.045
Romania	6.085	6.317	7.349	-6.576	-1.149	2.158	0.327
Serbia	5.067	5.4	3.8	-3.5	1	1.6	-1.757
Slovak Republic	5.483	10.494	5.751	-4.936	4.382	3.226	2.027
Slovenia	3.992	6.96	3.383	-7.841	1.24	0.6	-2.337

**Note:** Grey fields present predicted value of real GDP growth.

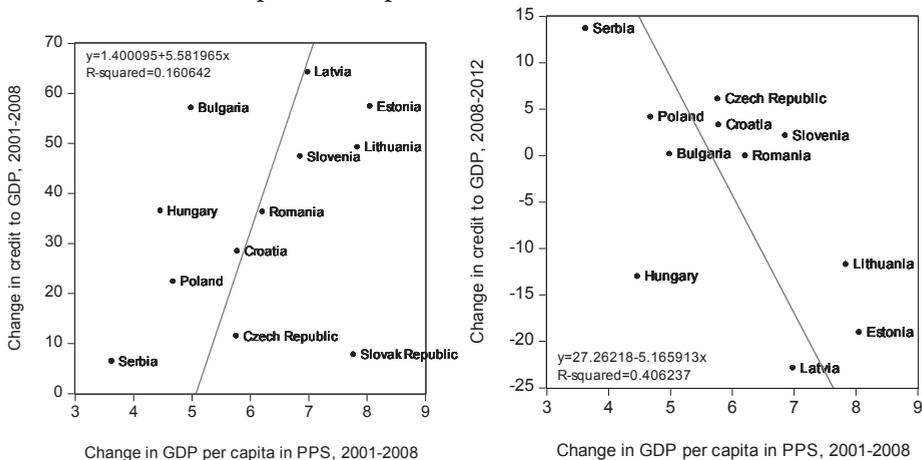
**Source:** IMF, WEO Database, April 2013.

A common feature of the CESEE-12 countries is that they all had robust economic growth promoted by strong capital inflows (Table 1). This economic growth reflected a catching-up process towards Western European income

levels. The Baltic countries that attained the highest economic growth, with average growth rates of 8.72% in Latvia, 8.09% in Estonia, and 7.8% in Lithuania over the period 2001-2006. A second group of countries achieved a slightly lower average real GDP growth rate of 6.1% in Romania, 5.6% in Bulgaria, 5.5% in the Slovak Republic, and 5.1% in Serbia. The lowest average growth rates in the region were in the Czech Republic (4.6%), Croatia (4.5%), Hungary (4.1%), and Slovenia (3.9%).

Despite having the lowest growth rate, the last group of countries had almost twice as much real GDP growth than both the advanced economies and the European Union. All of these countries enjoyed further economic growth in the runup to the global financial crisis of 2008, with the exception of Estonia and Hungary, which had a lower average income with respect to the previous year. The Slovak Republic was a special case doubling its growth rate. Following the outbreak of the crisis and deteriorating economic conditions for doing business, the whole region except for Poland recorded negative economic growth. In the post-crisis period, the region has succeeded in halting the downward trend of economic growth and has prevented its economies from collapsing.

**Figure 1:** Change in credit-to-GDP and change in GDP per capita in PPS, pre-crisis and post-crisis period in the CESEE-12 countries



**Note:** The Slovak Republic is not taken into consideration in the right-hand graph because of a time series break.

**Source:** Authors' calculation based on data from WB (WDI), AMECO.

Next we focus on the regression of financial development on economic growth, whereby the role of banks in the economy is measured by the amount of credit to the private sector. There is another indicator (the level of monetization - the ratio of broad money to GDP) which is also a proxy for financial deepening (credit grows more quickly than GDP as an economy improves), but which is not considered in this paper.<sup>2</sup>

What is interesting is that credit growth in the CESEE-12 countries is not always accompanied to the same extent by economic growth. Indeed, in the pre-crisis period, Baltic countries had the highest credit growth fostered by an increase in GDP per capita, as opposed to the Slovak and Czech Republics, which had a considerably lower level of bank intermediation in the face of their high economic growth (Figure 1, left-side plot). This clearly suggests that financial depth - i.e., an increase in bank credit to the private sector - can only be partly explained by GDP growth, which will be supported later on in the econometric analysis by including additional variables of interest. As for the post-crisis period, the plot on the right-hand side of Figure 1 shows a downward trend of the regression line, suggesting that countries with the strongest GDP growth in the pre-crisis period had the weakest credit growth in the post-crisis period (Baltic countries). Furthermore, there are two interesting cases, one of which is Serbia, the only country with increased credit growth. The second one is Hungary, which had credit growth like that of the Baltic countries but with a lower GDP growth.

All in all, capital inflows played a substantial role in financing the credit boom in the CESEE-12 countries. Moreover, rapid credit growth can increase macroeconomic vulnerability and as a result lead to a financial crisis. Hernandez & Landerretche (2002) conclude that there is a higher probability that capital inflows will be followed by a lending boom in developing countries than in advanced economies. In addition, whether strong credit expansion will deteriorate macrofinancial fragility mainly depends on the strength of the financial sector, which is basically determined both by the shallowness of financial markets and by the quality of the regulatory and supervisory

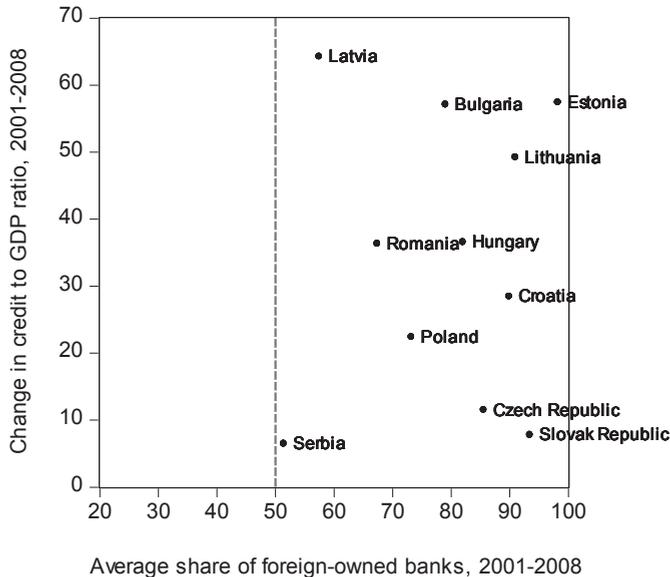
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<sup>2</sup> More about the causality between financial deepening and economic growth can be found in studies done by the IMF (2004), Kiss et al. (2008).

framework. In this regard, countries with developed financial sectors are less prone to a credit crunch after experiencing a lending boom.

All CESEE-12 countries improved their institutional frameworks, but their bank-centric financial systems, with banks which to a large extent are foreign-owned, have made them vulnerable to financial risks. The dominant presence of foreign banks in the region's financial systems also indicates a high level of financial euroization. On the liability side, subsidiaries of powerful Western European banks in the region have depended considerably on funds given by their parent banks. On the asset side, foreign banks in the region were able to make foreign currency loans at interest rates lower than domestic borrowing costs. Borrowers in the region took interest rate differentials between domestic and foreign currencies into account when deciding whether to borrow in domestic or foreign currency (Rosenberg C.B. & Tirpák M. 2008). This might account for the high share of foreign loans in total loans (Figure 3). The high share of foreign-currency-denominated loans exposed banks to both direct and indirect credit risks. Direct credit risk is reflected in mismatching in banks' balance sheets, as long-term loans (real estate) tend to be financed mostly through short-term deposits (rollover risk). Indirect credit risk means that loans are made to local residents, whose income is mainly denominated in domestic currency. In the case of domestic currency depreciation, the cost of servicing debt expressed in domestic currency is increased, and as a result exchange rate risk will turn into credit risk. The macroeconomic aspect of credit expansion emphasises a growing concern about the inadequate structure of loans (loan and currency mismatches).

**Figure 2:** Contribution of foreign-owned banks to credit growth in the CESEE-12 countries



**Note:** Foreign-owned banks are defined as those with foreign ownership exceeding 50%, end-of-year.

**Source:** EBRD Banking Survey, WB Global Financial Development (Hungary) for 2006-2008, WB Global Financial Indicators.

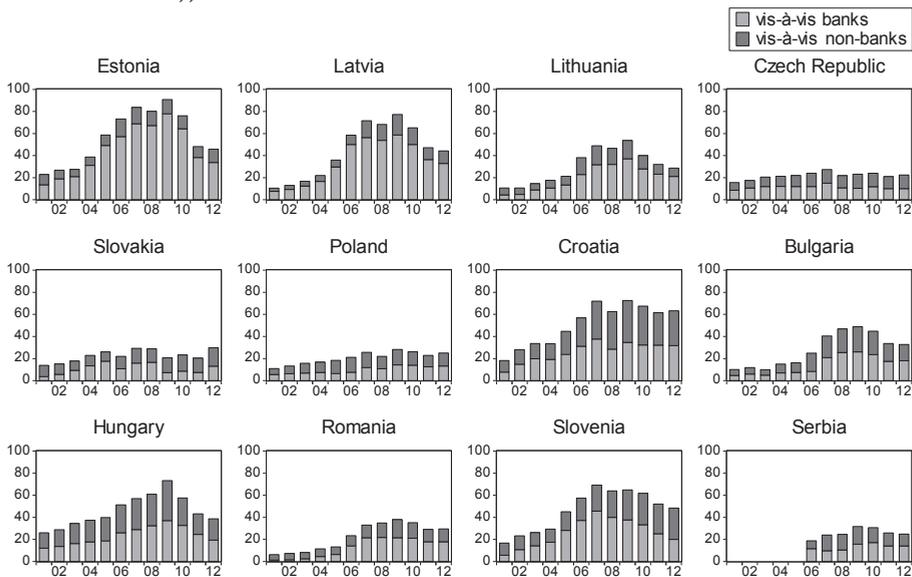
It is also worth specifying that foreign funding, irrespective of the high presence of foreign ownership, is not always at a high level. It is still unclear to what extent credit growth in the CESEE-12 countries is due to foreign banks. To clarify the question, we suggest looking at Figure 2. What is noticeable is that foreign banks made up more than 50% of the banking sector of the observed countries, but their contribution to credit growth differs. The main difference between countries with a high share of foreign banks, such as Estonia and Latvia on the one hand and the Czech and Slovak Republics on the other hand, the contribution of foreign banks to their credit growth. They also differ in the manner of credit expansion funding. Estonia and Latvia relied significantly on cross-border funding<sup>3</sup>, as opposed to the Czech and Slovak

<sup>3</sup>External positions vis-à-vis banks is used as a measure of parent companies' cross-border funding to subsidiaries in host countries.

Republics (Figure 3), which funded their credit growth through local deposits and capital markets. Thus, countries with low domestic savings will try to compensate for the lack of funds with capital transfers from their parent banks, which in turn is likely to have an effect on the higher presence of foreign banks in their financial systems. Increased lending in foreign currency also affects lending in the domestic currency as banks that generally rely on domestic deposits do their best to survive by keeping their market share.

Another important factor that might explain why the CESEE-12 countries differ from other regions in terms of cross-border funding is the central banking model, which foreign banks have embraced as a way of doing business in the region.<sup>4</sup>

**Figure 3:** External positions of BIS reporting banks in the CESEE-12 countries, 2001-2012 (X-axis: years; Y-axis: foreign funding by countries (% of GDP))



**Note:** Data for Serbia is only available from 2006 to 2012.

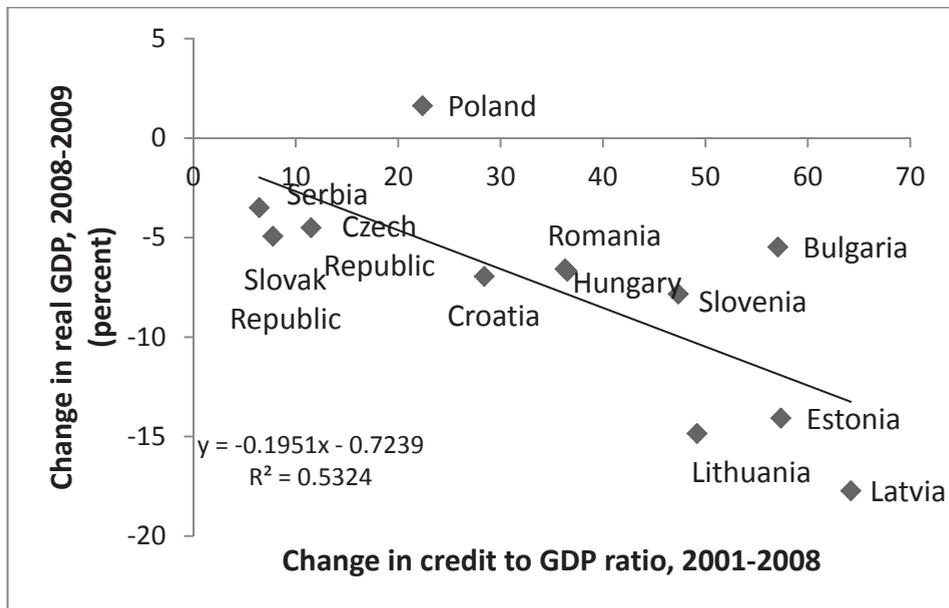
**Source:** Authors' calculation based on data from BIS, IMF WEO Database, April 2013.

<sup>4</sup> The centralized banking model means that funding and liquidity decisions are centralized, as opposed to the decentralized model where there is a degree of funding independence for subsidiaries (Impavido et al. 2013).

Following the outbreak of the financial crisis in 2008, parent banks in the region faced liquidity and capital pressures. Consequently, subsidiaries in the region also faced liquidity pressure, as they could not rely on funds given by their parent banks.

Financial instability became even higher after the rating agency (Moody's) issued a report warning that it might downgrade Western European banks that were mainly exposed to CESEE countries (Cocoza et al. 2011).

**Figure 4:** Economic growth in the function of credit growth in the CESEE-12 countries



**Source:** Authors' calculation based on data from WB (WDI), IMF WEO Database, April 2013.

The countries in our sample that saw the most pronounced credit boom (Baltic countries and Bulgaria) were those with the highest cost-of-income adjustment (Figure 4).

Although there was concern that credit growth was becoming unsustainable, the rapid income convergence process along with unpopular restrictive policies meant that the rapid credit growth was neglected. Moreover, in some countries

the risk of rapid credit growth was ignored because the authorities believed that the stability of their banking systems would be preserved from external shocks because of improvements in their regulatory frameworks.

The pros and cons of a number of appropriate instruments for curbing rapid credit growth and their macroeconomic and financial implications are broadly discussed in the empirical literature (Hilbers et al. 2005, Backe et al. 2007, Cottarelli et al. 2003, Sorsa et al. 2007, Sirtaine & Skamnelos 2007, Bakker & Gulde 2010). Authorities can decelerate the speed of credit growth using macroeconomic, prudential, supervisory, and/or administrative measures.

In terms of monetary policy tools, the authorities can resort to monetary tightening (increasing interest rates or raising required reserves) in response to overheating. However, the effectiveness of the open market depends to a large extent, on capital mobility and the exchange rate regime.<sup>5</sup> If there is space for monetary authorities to manoeuvre, central banks can raise interest rates. But in countries with a high degree of currency-denominated financial assets and liabilities, i.e., a high level of financial euroization, and/or a fixed exchange rate regime, this measure has limited power to contain rapid credit growth. A higher interest rate is likely to fuel lending in foreign currency or increase capital inflows, and thus requires sterilization to prevent their demand impact on the economy. For these reasons countries are reluctant to undertake only monetary policy measures. Keeping the limitations of the monetary measures in mind, macroprudential policy plays a supporting role in sustaining financial stability.

Providing countries with new fiscal tools can also put further pressure on both bank and nonbank financial institutions, and decelerate the speed of credit growth. These measures are primarily reflected in levies imposed on financial activities and a countercyclical tax on debt (Dell’Ariccia et al. 2012). The revenues of the new fiscal tools can serve as a public buffer.

As for prudential and supervisory measures, authorities can raise capital and liquidity requirements, impose credit growth limits on financial institutions,

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<sup>5</sup> For example, a combination of increased flexibility of exchange rate and decreasing interest rate differentials contributed to reducing the level of FX-denominated loans granted by banks in Poland in 2001 (Hilbers et al. 2005).

tighten loan eligibility criteria, or raise the frequency of stress testing. But these measures cannot differ much across countries due to a need for harmonization of regulations within the region.

The message is clear: ‘Until we know how to build safer roads, let’s make slower cars’ (Gourinchas et al. 2001, p. 3).

### **3. THE STATISTICAL APPROACH TO IDENTIFYING CREDIT BOOMS**

Despite the fact that credit growth can encourage economic growth, rapid credit growth in some cases precedes the occurrence of a banking crisis. The IMF (2004) revealed that about 75% and 85% of the credit booms in emerging market economies were associated with a banking crisis and a currency crisis, respectively. A financial accelerator amplifies the initial effects of any shock (financial or real) on economic activity, and is a critically important mechanism that can lead to a credit boom. The three main channels through which shocks affect the business cycle are: 1) bank credit, 2) the balance sheet, and 3) a liquidity. The first two transmission channels between the financial and real sectors are known as financial accelerator channels (Bernanke & Getler 1989); the third one has become increasingly important since the financial crisis (Basel 2011).

The first channel refers to the influence of any shock on net worth (firm profits and household income), which will then also have an effect on the borrower’s cost of financing, and consequently on expenditure and thereby aggregate demand. The second channel indicates adverse shocks to the balance sheet of financial institutions, which might be a result of changes in monetary policy (interest rate) and/or regulatory policy (capital requirements). To what extent this channel will amplify the adverse effects of any shock on financial institutions’ balance sheets depends on the borrowers’ dependence on bank credit. In emerging market economies, financial accelerator effects tend to spur business cycle fluctuations.<sup>6</sup> Finally, the third channel emphasises the importance of banks’ liquidity, which is necessary to extend credit and consequently accelerate economic activity.

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<sup>6</sup> It is also important to point out that the financial accelerator mechanism plays a critical role in the duration of economic recessions (Sa 2006 )

Bearing that in mind, empirical literature attempts to apply some indicators which will opportunely give policymakers warnings of potential problems in the banking sector. One method for identifying excessive credit growth is the Hodrick-Prescott (HP) filter. Following Hodrick & Prescott (1981), the time series is the sum of a growth component (trend) and a cyclical component:

$$y_{it} = g_{it} + c_{it} \quad (1)$$

$$c_{it} = y_{it} - g_{it} \quad (2)$$

where  $y_{it}$  stands for the time series,  $g_{it}$  is the growth component, and  $c_{it}$  is the cyclical component:  $t$  is a date and  $i$  is a country.

The cyclical component is the deviation of the actual value from the trend. Empirical literature (Mendoza & Terrones 2008, Selim & Yiqun 2011, Gourinchas et al. 1999, 2001, Geršl & Seidler 2010, Coudert & Pouvelle 2010, Hansen N-J. & Sulla O. 2013) uses two indicators for the actual value of credit growth, such as credit-to-GDP ratio and real credit growth. Credit-to-GDP ratio is defined as the end-of-period stock of credit divided by nominal GDP, while real credit growth is defined as the end-of-period stock of credit divided by the CPI. The long-term trend is estimated by applying an HP filter with the smoothing parameter ( $\lambda$ ), whose value is 100 for annual data.

The country is said to be experiencing a credit boom if the cyclical component is above a certain threshold ( $\tau$ ), which is obtained for each country individually by multiplying the standard deviation of the cyclical component ( $\sigma$ ) and factor ( $\phi$ ). Factor  $\phi$  amounts to 1.75 (IMF 2004)

$$c_{it} > \tau_{it} \quad (3)$$

$$\tau_{it} = \phi \sigma_i \quad (4)$$

The figures in Appendix 4 depict two indicators for identifying whether the level of credit is excessive and as such exposes the financial sector to instability. As mentioned above, a credit boom is identified only if the real credit and credit-to-GDP ratio indicators exceed previously determined thresholds. These conditions are both justified in Serbia, but there is a difference between these

two indicators. According to the real credit growth indicator, a credit boom was recorded in 1999, but the credit-to-GDP indicator identified a credit boom in 2000. A credit bust occurs when credit contraction exceeds the lower threshold. In the case of Serbia, two indicators show that the credit contraction was only close to a credit bust in 2002.

The credit/GDP ratio shows credit booms in several CESEE countries (see Appendix 4, left-hand column): Estonia (2009), Poland (2008), Bulgaria (2008), Hungary (2008), and Romania (2008). In contrast to this indicator, the real credit growth indicator (see Appendix 4, right-hand column) shows that a credit boom only occurred in Croatia (2002). On the other hand, using the credit-GDP ratio, a credit bust did exist in Estonia (2012) and Latvia (2012), the Czech Republic (2002), Poland (2005), Hungary (2012), and Croatia (2000). Based on the real credit growth indicator, Estonia (2008) and the Czech Republic (2002) were the only countries in the region to experience a credit bust.

Finally, a reasonable explanation is needed to show why there is a slight difference between the two indicators when identifying credit booms. First of all, we should not neglect the fact that at the beginning of the transition process credit stock in the region was low. But the real credit growth indicator does not take the initial level of credit into account, which might overestimate credit growth. For instance, assuming that the growth rate is negative in one period, quite a low positive growth rate in another period will be identified as a credit boom. Since credit growth rate might take us in the wrong direction because of a potential overestimation or underestimation of credit booms, using credit-to-GDP ratio is suggested as an appropriate indicator (Coudert & Pouvelle 2010). However, the credit-to-GDP ratio has its own drawbacks.<sup>7</sup> Take, for example, the case in which both credit stock and nominal GDP are falling, but the denominator is being reduced faster than the nominator, causing the ratio to increase. What is more, credit and output can not have the same trend, which is significant if countries are undergoing financial deepening or credit and GDP are moving at different rates (Elekdag & Wu 2011). Furthermore, there are other relevant denominators that should be taken into account because of their

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<sup>7</sup> A problem with credit to GDP ratio is that the results are sensitive to individual observation; robustness may be absent as a result of short time series (Cotarelli et al. 2005).

influence on credit growth, such as financial assets or total assets of the private sector (Geršl & Seidler 2010).

Kelly et al. (2013) concluded that the trend estimated by the HP filter is sensitive to a selection of smoothing parameter values. In order to check this argument, we performed the same statistical analysis, but on a quarterly basis, using a typical 1600 lambda value. The results of this analysis indicate that all the sample countries experienced a credit boom as observed by one or other of the two described indicators, with Bulgaria, Hungary, and the Slovak Republic seeing the most striking credit booms. Furthermore, while real credit growth on an annual basis showed no credit boom - with the exception of Croatia - the same indicator on a quarterly basis detected a credit boom in the majority of countries observed. (Results available upon request.)

All in all, despite the above analysis using the HP-filter, which can give useful warning signals, there are still misleading conclusions. Therefore the statistical approach to identifying credit booms should be complemented by an econometric approach.

#### **4. THE ECONOMETRIC APPROACH TO IDENTIFYING CREDIT BOOMS**

In an attempt to account for the equilibrium level of the credit-to-GDP ratio as a function of fundamentals, a number of authors have carried out econometric analysis using different variables in their in-sample and/or out-of-sample estimations. For example, Cottarelli et al. (2005) were the first to perform regression of the credit-to-GDP ratio on a set of explanatory variables (public debt, GDP per capita, inflation, entry restriction, accounting standards, etc.). They used the random effects estimator (static model) rather than the fixed effects estimator (also static model) to apply the estimated parameters of 24 non-transition countries (obtained in out-of-sample estimation) for 15 transition economies (CEE). Egert et al. (2006) did out-of-sample panel estimations composed of developed OECD countries and Asian and Latin-American emerging markets for the analysis of the long-run level of the credit-to-GDP ratio of the CEE transition economies. They used fixed-effect OLS (FE\_OLS), panel dynamic OLS (DOLS), and the mean group estimator (MGE) with explanatory variables (GDP per capita, short and long term interest rates,

inflation, house prices, etc.) to estimate the equilibrium level of the credit-to-GDP ratio.

As opposed to Cottarelli et al. (2005), Kiss et al. (2006) focused on the dynamic panel model (PMG-Pooled Mean Group Estimator) including GDP per capita in PPP (purchasing power parity), inflation, and real interest rate of euro-area countries in order to do an out-of-sample estimation for 8 transition countries (3 Baltic and 5 CEE countries). Boissay et al. (2005) took advantage of 11 developed benchmark countries to apply their estimated parameters for 8 transition economies, whereby a set of explanatory variables consists of real interest rate, a quadratic trend, and a dummy variable. Coudert & Pouvell (2010) preferred to use the whole sample, which consists of 21 developed and 31 emerging countries, unlike the aforementioned authors. In addition, the Fully Modified OLS (FMOLS) was used for estimating the equilibrium level of the credit-to-GDP ratio, and ECM for estimating changes in the credit-to-GDP ratio, the explanatory variables being GDP per capita in PPP, an exchange rate regime, net capital inflows, stock market capitalization-to-GDP ratio, etc.

It is interesting that Cottarelli et al. (2005) and Egert et al. (2006) did not use ECM in their studies, and hence did not estimate the credit growth rates. Kiss et al. (2006), Boissay et al. (2005), and Coudert & Pouvell (2010) did perform ECM and thus modelled the credit growth rates.

In stark contrast to the existing literature, Jovanović et al. (2014) use an in-sample approach, paying exclusive attention to SEE countries to get the fitted values. More to the point, they differentiate between a fundamental and an equilibrium level of credit, which they consider essential from the policy intervention standpoint.

These papers point to the possibility of applying either an in-sample or an out-of-sample approach. As both approaches have their own advantages and disadvantages we are reluctant to base our conclusions exclusively on one or the other, as these authors have done. Instead, we shall use both in-sample and out-of-sample approaches, to check which of them gives the more reasonable results.

In our study, out-of-sample panel estimation means that we first estimate the equilibrium level of the credit-to-GDP ratio based on 14 countries<sup>8</sup>, and then apply their estimated parameters to the data of 12 CESEE countries to obtain the irequilibrium levels with the assumption that the parameters across countries are homogeneous in the long run. In other words, out-of-sample estimation gives us the opportunity to look at whether the dependent variable (the volume of private sector credit to GDP) in the CESEE-12 countries is a function of independent variables (fundamentals). In the in-sample analysis we estimate fitted values for a set of developing countries<sup>9</sup> by using their original data.

#### 4.1. Estimation of the Equilibrium Credit-to-GDP Ratio

We estimate the equilibrium level of the credit-to-GDP ratio (denoted as *credit\_to\_gdp* in the equation) as a function of economic variables, and then compare this equilibrium level with the observed levels of credit to assess whether the credit level in the region is excessive or not. If the observed level of credit does not reach its equilibrium level, rapid credit growth is justified due to the catching-up process. On the other hand, if the observed level is above its equilibrium level, strong credit growth cannot be explained by changes in the economic variables.

In our study we consider the set of variables most frequently used in the working papers previously quoted, as follows:

1. GDP per capita in PPP (purchasing power parity), taken in the log (*loggdpcc\_ppp*). This variable explains the level of economic development. The higher the economic growth, the higher the degree of financial deepening. Consequently, the expected sign of this variable is positive. Here we make the assumption that the direction of causality goes from economic growth to credit growth.
2. Inflation (*infla*). When inflation goes up, the cost of borrowing for households and firms diminishes, and consequently encourages greater

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<sup>8</sup> Our out-of-sample countries are: Austria, Belgium, Denmark, Finland, France, Switzerland, Norway, Sweden, The United Kingdom, Spain, Italy, Canada, Australia, New Zealand.

<sup>9</sup> Our in-sample countries are: Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Serbia, the Slovak Republic, Slovenia.

demand for loans. This favours a positive relationship between inflation and credit to the private sector. But higher inflation can also lead to increasing uncertainty in financial markets, and thus the private sector is not inclined to borrow. In this case, the expected sign of inflation is negative, and ambiguous.

3. Public debt as a percentage of GDP (*public\_debt*). The expected sign of this variable is negative, as a higher level of credit to the public sector means a lower level of disposable funds that could be steered to the private sector. In this case, we are talking about a crowding-out effect.
4. Stock market capitalization-to-GDP ratio (*stock\_m\_c*). The more-developed equity market provides the private sector with better access to an alternative financing channel. The higher the demand of the private sector for a direct channel to finance their investment needs, the lower their demand for external sources of financing (demand for credit). Therefore the expected sign of the variable is negative. But, if this source of funds is regarded as a complementary financing source, then the sign of this variable is positive. For this reason, the sign of the stock market capitalization-to-GDP ratio is ambiguous.

The basic panel equation has the following form:

$$y_{it} = \alpha + X'_{it}\beta + \varepsilon_{it} \quad i=1, \dots, 14 \quad t=1, \dots, 21 \quad (5)$$

Here  $y_{it}$  denotes the credit-to-GDP ratio for a country  $i$  and time period  $t$ ,  $\alpha$  denotes a constant term,  $X'_{it}$  stands for the  $i$ th observation on  $K$  explanatory variables,  $\beta$  is  $K \times 1$  parameters, and  $\varepsilon_{it}$  is the error term, which is independent and identically distributed  $\varepsilon_{it} \sim IID(0, \sigma^2)$ .

It should be noted that we are only going to apply standard econometric models, pooled OLS, and fixed effects for the developed countries.

To determine whether there is indeed a long-run equilibrium relationship between the credit-to-GDP ratio and the set of explanatory variables, we need to do the cointegration analysis. The first part of this analysis is to determine the variables' order of integration. Even though the variables are integrated at order one in the notation  $I(1)$ , we should not omit them from further estimation because there might exist a linear combination that is stationary in the notation

$I(0)$  - or, in other words, they have common trends. These variables are called cointegrated variables because they are integrated in a similar way, i.e., they do not drive each other apart. But if the variables have a unit root and are not cointegrated, the regression is considered to be a spurious regression, which means that the model is misspecified with high t-values and high  $R^2$ s, along with low values of the DW-statistic.

For the purpose of determining the presence of a unit root in the variables of interest, we apply the panel unit root tests of Levin Lin Chu (LLC), Breitung (B), Im Peseran Shin (IPS), Augmented Dickey-Fuller (Fischer Chi square), and Phillips-Perron (Fischer Chi square). All these tests have the null hypothesis of the presence of a unit root, as opposed to the alternative hypothesis that the series is stationary. While the first two tests have a common unit root, the others are less restrictive and allow for the individual unit root process.

The table in Appendix 2 refers to the panel unit root tests that fail to reject the null hypothesis of non-stationarity in levels for *credit\_to\_gdp*, *public\_debt*, and *stock\_mark\_c*. Hence, *public\_debt* and *stock\_m\_c* can be kept as our variables that help to explain *credit\_to\_gdp* in the long run. However, if we differentiated the variables they all would be stationary<sup>10</sup>, and in this way we would only obtain a short-run relationship between variables.

To determine which of the non-stationary variables can affect the credit-to-GDP ratio in the long run, i.e., which of them is cointegrated with the credit-to-GDP ratio, we are going to run the panel cointegration tests suggested by Pedroni (2004).

The tests performed and presented in the table in Appendix 3 indicate the cointegration of *public\_debt*, and *stock\_m\_c* with *credit\_to\_gdp*. Therefore, our next step is to estimate the long-run equilibrium relationship between cointegrated variables with the pooled OLS.

Following the estimation of the equation (5) with the pooled OLS, *public\_debt* and *stock\_m\_c* are significant at 1% and also have the expected sign.

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<sup>10</sup> These results are not presented in the paper but are available from the authors upon request.

The pooled OLS, however, has a serious drawback, as it assumes common intercept and slope coefficients for all cross section units (countries), and thus neglects individual effect or heterogeneity. For this reason the individual effects ( $u_i$ ) are included in the error term, making the pooled OLS biased and inconsistent because of the violation of the exogeneity assumption. In addition, it is reasonable to assume that each country has its own initial credit-to-GDP growth, as they entered the transition process at different times. Bearing in mind that each country has its own individual characteristics that make it unique, i.e., they differ from each other, and due to the fact that they may or may not have an effect on the explanatory variables, and consequently on the dependent variable, we decided to include fixed effects in our econometric model. By including the unobserved time-constant characteristics in the econometric framework, we are able to observe the changes in the dependent variable exclusively as a result of changes in the independent variables.

The fixed effect model allows for the intercept to differ across countries (country specific intercepts), but assumes common slope coefficients and variance. The one-way fixed effect model is represented as follows:

$$credit\_to\_gdp_{it} = \alpha + \mu_i + \beta_1 public\_debt_{it} + \beta_2 stock\_m\_c_{it} + \varepsilon_{it} \quad (6)$$

After estimating the long-run relationship between cointegrated variables with FE OLS, the results of the estimation are presented in Table 2. Variables *stock\_m\_c* and *constant* are highly significant compared to *public\_debt*, which has the theoretically expected sign but is irrelevant. The F-test (fixed effect) examines the null hypothesis that the all individual effects ( $u_i$ ) are zero,  $H_0: u_1=u_2=\dots=u_{14}=0$ . As the F-test (fixed effect) is significant, the null hypothesis is rejected and the fixed effect model is better than the pooled OLS.

**Table 2:** Panel regression results of *credit\_to\_gdp*

Explanatory variables	Pooled OLS		Pooled OLS with Fixed Effect	
	Coefficient t	Std. Error	Coefficient	Std. Error
Public_debt	-0.3560***	0.0769	-1.2644***	0.1828
Stock_m_c	0.3074***	0.0345	0.0987	0.0679
Intercept	94.9171***	6.6602	162.6684***	12.8938
Country Number of observations	14 216		14 216	
R squared	0.2407		0.1150	
F-test (model)	66.51***		29.19***	
F-test (fixed effect)			13.31***	

**Notes:** \*,\*\*,\*\*\* indicate significance at 10%, 5%, 1% respectively. The Pooled OLS model is estimated with robust standard errors. Estimations have been done in STATA 10.

Nevertheless, the estimation results of these static models can be regarded as misleading due to the potential reverse causality between credit stock and its regressors. In other words, we are dealing with the issue of endogeneity bias, which impairs our statistical inferences. One of the ways to resolve the problem of endogeneity is to apply a dynamic model. Our preferred dynamic estimation model is the pooled mean group (PMG) estimator developed by Pesaran et al. (1999). The PMG estimator is a maximum likelihood estimator, which allows intercepts, the short-run coefficients, the speed of adjustment to the long-run equilibrium, and error variances to differ across countries, but determines that the long-run coefficients are identical. According to Samargandi et al. (2013), there are several requirements for the validity, consistency, and efficiency of this model. First, the error correction term should be negative and significant so as to confirm the existence of the long-run relationship among the variables of interest. Second, the PMG estimator can be incorporated into the error correction framework by means of the autoregressive distributed lag ARDL

(p,q) model, which enables us to correct for both the problem of residual autocorrelation and endogeneity. Third, the large size of N and T gives us an opportunity to utilize the dynamic structure of our model and thus avoid the bias in the average estimators and resolve the problem of heterogeneity.

Following Jovanović et al. (2014), non-stationary variables are included in both the long-run and short-run equations, while stationary variables are included in the long run.

The ARDL model transformed in error-correction form is:

$$\Delta y_{it} = \phi_i (y_{i,t-1} - \theta'_i X_{it}) + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta y_{i,t-1} + \sum_{j=0}^{q-1} \delta_{ij}^* \Delta X_{i,t-j} + \mu_i + \varepsilon_{it} \quad (7)$$

The parameter  $\phi_i$  is the error-correcting speed-of-adjustment term, while  $\phi_i (y_{i,t-1} - \theta'_i X_{it})$  describes the common long-run relationship between credit growth and its fundamentals, and  $\sum_{j=1}^{p-1} \lambda_{ij}^* \Delta y_{i,t-1} + \sum_{j=0}^{q-1} \delta_{ij}^* \Delta X_{i,t-j} + \mu_i$  depicts short-run adjustment terms, which are assumed to be heterogeneous across countries. Country-specific unobserved heterogeneity and error terms are represented by  $\mu_i$  and  $\varepsilon_{it}$  respectively.

In an attempt to determine the optimal ARDL lag structure, we apply the Akaike information criteria. For the lag selection we are constrained to a maximum of 1 lag for annual data and 4 lags for quarterly data. For annual data the AIC selected the ARDL model (1,1,1), while for quarterly data the AIC selected the ARDL model (4,1,1) as the best of the 16 models evaluated.

**Table 3:** Heterogeneous panel cointegration estimations of  $\Delta credit\_to\_gdp$

Type of estimation	Pooled Mean Group		Pooled Mean Group	
	<i>Out-of-sample</i>		<i>In sample</i>	
Variable	Coefficient	Std. Error	Coefficient	Std. Error
<i>Long Run Coefficients</i>				
public_debt	-2.8759***	0.1196	0.1329*	0.0794
stock_m_c	0.2865***	0.0873	1.1969***	0.1594
<i>Short Run Coefficients</i>				
Error correction coefficient	-0.1359***	0.0568	-0.1718*	0.1034
$\Delta \text{Loggdppc\_ppp}$	-8.6209	47.3383	-63.6205***	21.9719
$\Delta \text{public\_debt}$	0.1666	0.2599	-0.1203	0.4079
$\Delta \text{stock\_m\_c}$	0.0926	0.0644	-0.4403	0.4595
$\Delta \text{Infla}$	-0.1027	0.4248	-0.2386***	0.0775
$\Delta \text{credit\_to\_gdp}(-1)$			0.0875	0.1051
$\Delta \text{credit\_to\_gdp}(-2)$			0.0369	0.0969
$\Delta \text{credit\_to\_gdp}(-3)$			0.0336	0.0957
Intercept	34.4746***	13.0051	3.3252***	1.2631
Country	14		12	
Number of observations	202		432	
Specification	ARDL(1,1,1)		ARDL(4,1,1)	

**Notes:** \*,\*\*,\*\*\* indicate significance at 10%, 5%, 1% respectively. The short-run coefficients and error correction term are simple averages of the estimated cross-section parameters. The Pooled Mean Group model has been estimated by using xtpmg routine in STATA 10.

In out-of-sample estimation the PMG model suggests that in the long run both variables have the theoretically expected sign and significance at 1%. For instance, a 1% increase in *public\_debt*, ceteris paribus, has a negative effect on the long-run credit growth of 2.88 percentage points. Furthermore, the PMG suggests that although *stock\_m\_c* and *infla* have the expected sign they do not

significantly contribute to credit growth in the short run. The error correction term is negative and statistically significant at 1% referring to the existence of a long-run cointegration relationship. This also applies to PMG in the in-sample estimation approach, but at 10%. As regards the in-sample approach, both variables are statistically significant in the long run, while in the short run this is true for *loggdppc\_ppp* and *infla*.

What is important to highlight with regard to the speed of adjustment is that the countries in our sample need, on average, roughly two years to halve the deviation of actual credit growth from their estimated equilibrium credit growth in the absence of shocks and lagged effects.<sup>11</sup>

#### **4.2. Out-of-Sample and in-Sample Estimation of Credit Growth for CESEE-12 Countries**

As mentioned above, the estimated coefficients obtained for developed economies will be used to derive the fitted values of the credit-to-GDP ratio for the CESEE-12 countries, again assuming parameter homogeneity in the long run between developed and transition economies. Since we do not include the CESEE-12 countries in the panel along with developed economies, we are not able to get their own country-specific constant terms. According to Maeso-Fernandez et al. (2004), including transition economies in the regression with developed countries does not solve the problem at all. Given the lack of available data for the acceding countries, their potential inclusion will cause great loss of degrees of freedom. We should therefore calculate the intercept for CESEE-12 countries in an indirect way. But the problem that arises is which of the constant terms of our sample countries should be used. Egert et al. (2006) consider that the most reliable way to solve the issue is to use the largest, the smallest, or the median constant term. In our case only the median constant term is used and it amounts to 19.3144.

By comparing the fitted values of the credit-to-GDP ratio for the CESEE-12 countries with their observed values, we can determine the deviation between them. So long as the observed value is below the fitted value, greater credit growth can be justified by the catching-up process.

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<sup>11</sup> The half-life in years is calculated by the following formula:  $t^{1/2} = \frac{\ln(0.5)}{\ln(1+ect)}$

What is striking in Figure 6 is that actual credit growth in nearly all the observed countries was above its predicted value in the 2000–09 pre-crisis period. More to the point, after the outbreak of the financial crisis the deviation of the actual from the estimated credit growth was gradually reduced. This is noticeable in the case of Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Poland, Romania, and Serbia. Nevertheless, we should be cautious about results related to pre-crisis credit growth as they largely depend on the estimation coefficients of developed countries that are applied to developing-country parameter estimates. By the same token, a strong credit crunch was distinctive only to developed countries, whereas the adverse effects of the financial upheaval on developing economies were limited, owing to the absence of toxic assets. Since the credit crunch caused a structural break bias for the developed countries, which was then inexorably transmitted to the estimates for the transition economies, we resort to the in-sample approach.

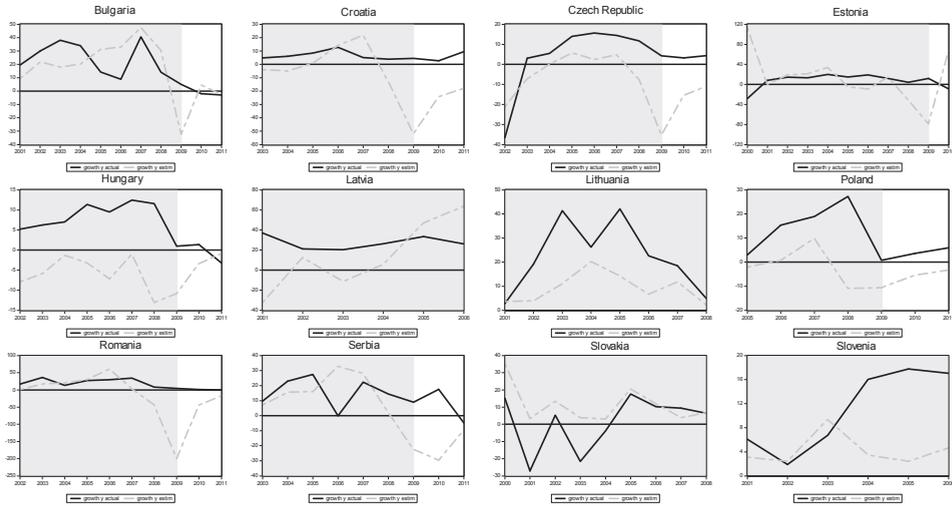
Being constrained by the data availability for developing countries and with the aim of performing a PMG model for them, we made use of quarterly data rather than using data on an annual basis.<sup>12</sup>

The results of the in-sample approach show that in most of the countries in the pre-crisis period there was excessive credit growth in terms of higher actual credit growth than estimated. Compared to the out-of-sample approach, in the post-crisis period actual credit growth fluctuated around the estimated credit growth, pointing to the fact that the former was in line with the movements in its fitted values. Nevertheless, Jovanović et al. (2014) highlight that fitted values calculated in such a manner do not imply a need for policy action, since they could fluctuate considerably in a short period of time as a result of changes in fundamentals. Thus, whether or not policymakers should act to curb excessive credit growth, apart from the fundamental level Jovanović et al. (2014) recommend using an equilibrium level, i.e., a level that could occur if economy was in medium-term equilibrium.

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<sup>12</sup> For this purpose, quarterly data are used from IMF IFS for nominal credit (IFS line 22d) and CPI (IFS line 64), IMF WEO for gdp per capita in ppp and public debt, and WB GFD for stock market capitalization. In addition, variables like gdp per capita in ppp, public debt, and stock market capitalization are linearly interpolated using Cubic Spline, while credit-to-GDP ratio is seasonally adjusted in Demetra+.

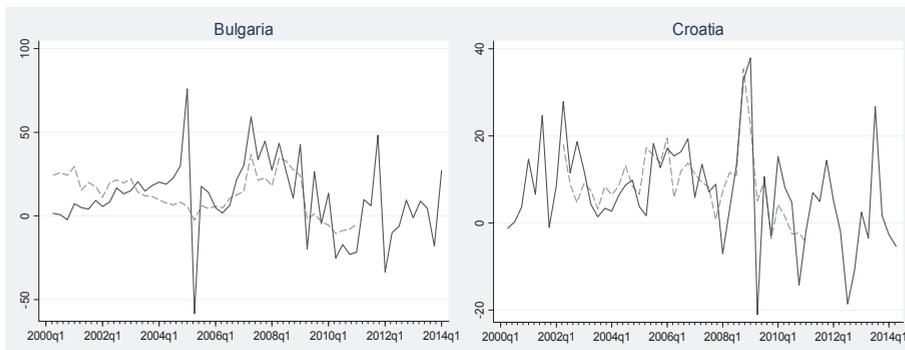
**Figure 5:** Out-of-sample approach to identifying a credit boom



**Note:** the solid line represents actual credit growth, the dashed line indicates estimated credit growth, the shaded area refers to the pre-crisis period

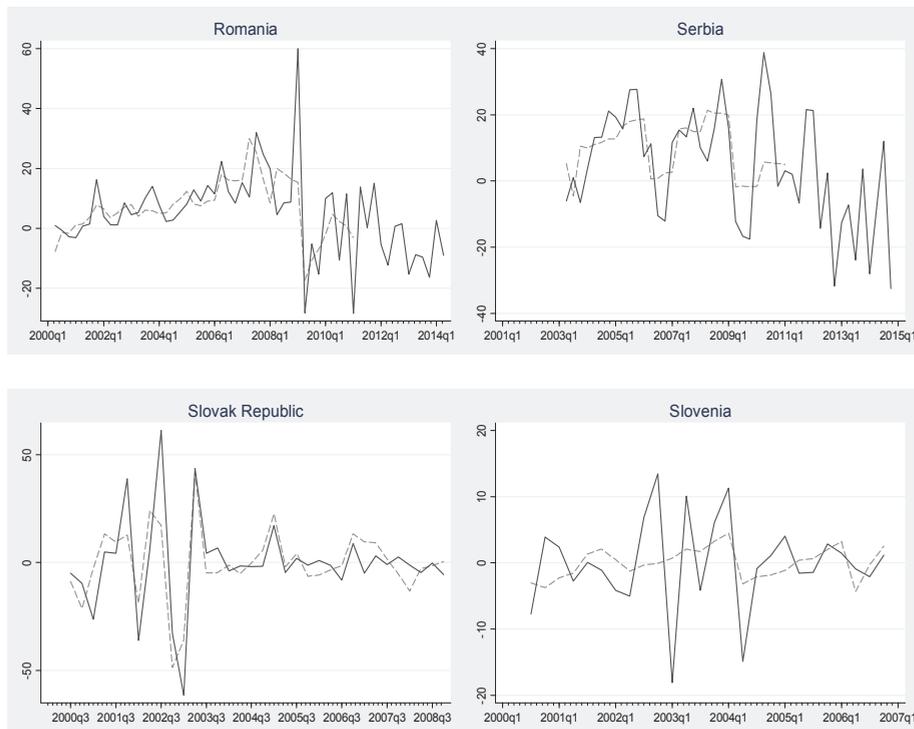
**Source:** Authors' calculations

**Figure 6:** In-sample approach to identifying a credit boom





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**Note:** Solid line represents actual credit growth, while dashed line indicates estimated credit growth.

**Source:** Authors' calculations

## 5. CONCLUSION

The region of CESEE-12 countries observed in our study was characterized by an impressive credit growth leading up to the financial crisis. The strong credit expansion can be attributed to a variety of factors, including overall banking reforms, macroeconomic stabilization, and privatization of the financial sector, which made the region more attractive for capital inflows. Although this generated a space for accelerating the speed of the region's income-convergence process with the advanced European economies, there were growing concerns among policymakers across the region's emerging market economies about the potential implications of therapid credit growth for the real economy. In the past a variety of countries with similar levels of development underwent credit booms accompanied by severe banking and balance-of-payment crises.

In this paper we attempt to check whether the concerns were justified. First and foremost, we apply two different approaches (statistical and econometric) to identify credit booms. Based on the credit-to-GDP indicator, the statistical approach identified a credit boom in Estonia (2009), Poland (2008), Bulgaria (2008), Hungary (2008), Romania (2008), and Serbia (2000), while the real credit growth indicator only indicated a credit boom in Serbia (1999) and Croatia (2002). The robustness check indicates that all the sample countries experienced a credit boom observed by one of the two indicators, with Bulgaria, Hungary, and the Slovak Republic seeing the most striking credit booms according to the credit-to-GDP indicator, and the real credit growth indicator detecting a credit boom in the majority of countries observed.

The econometric approach determines the equilibrium credit level as a function of economic fundamentals. We make inferences as to whether some countries experienced a credit boom from the estimation results obtained by the PMG estimator in out-of-sample and in-sample approaches. This dynamic estimator overcomes the issues with static estimators. The majority of the CESEE-12 countries experienced a credit boom prior to the global financial crisis, so the in-sample estimates are considered more reliable than the out-of-sample estimates.

Based on the findings of these two approaches, it seems that authorities in some countries in the region were correct when they claimed that the rapid credit growth was unsustainable, as the countries with the strongest credit growth were those with the highest loss of output.

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**Appendix 1: Variables and data sources**

<b>Variable</b>	<b>Label</b>	<b>Definition</b>	<b>Data Source</b>
<b>Statistical approach</b>			
Domestic credit to private sector, in % of GDP	<i>credit_to_gdp_ratio</i>	Domestic credit to private sector by financial corporations, in % of GDP	WB WDI
Claims on private sector, in national currency	<i>nominal_credit</i>	End-of-period stock of credit to private sector, in national currency	IMF IFS (line 22d)
Consumer Prices Index	<i>CPI</i>	Inflation, end of period consumer prices, percentage change (2010=100)	IMF IFS (line 64)
Nominal Gross Domestic Product, in national currency	<i>Nominal_gdp</i>	Nominal Gross Domestic Product, in national currency	IMF IFS (line 99b)
<b>Empirical approach</b>			
Domestic credit to private sector, in % of GDP	<i>credit_to_gdp_ratio</i>	Domestic credit to private sector by financial corporations, in % of GDP	WB WDI
GDP per capita in PPP, in natural logarithms	<i>loggppc_ppp</i>	Gross domestic product based on purchasing-power-parity per capita GDP, current international dollar	IMF WEO
Inflation	<i>infla</i>	Inflation, end of period consumer prices, percentage change (2010=100)	IMF IFS (line 64)
Public debt as a percentage of GDP	<i>public_debt</i>	General government gross debt, in % of GDP	IMF WEO
Stock market capitalization-to-GDP ratio	<i>stock_m_c</i>	Total value of all listed shares in a stock market as a percentage of GDP.	WB GFD

**Appendix 2: Panel unit root tests**

Variables	Constant							
	LLC		IPS		ADF		PP	
	H0=common unit root process		H0=individual unit root process					
	stat	p-value	stat	p-value	stat	p-value	stat	p-value
Credit_to_gdp	-4.40	0.00	0.32	0.63	29.56	0.38	13.24	0.99
Loggdppc_ppp	-8.56	0.00	-2.89	0.00	52.87	0.00	52.23	0.00
Public_debt	-2.38	0.01	-1.22	0.11	46.69	0.01	15.83	0.97
Stock_mark_c	-4.93	0.00	-3.63	0.00	57.72	0.00	32.24	0.26
Infla	-8.21	0.00	-8.54	0.00	121.64	0.00	141.54	0.00

**Note:** The optimal lags are automatically selected by Schwarz information criterion. Panel unit root tests were performed in Eviews 8.0.

**Appendix 3: Panel cointegration tests**

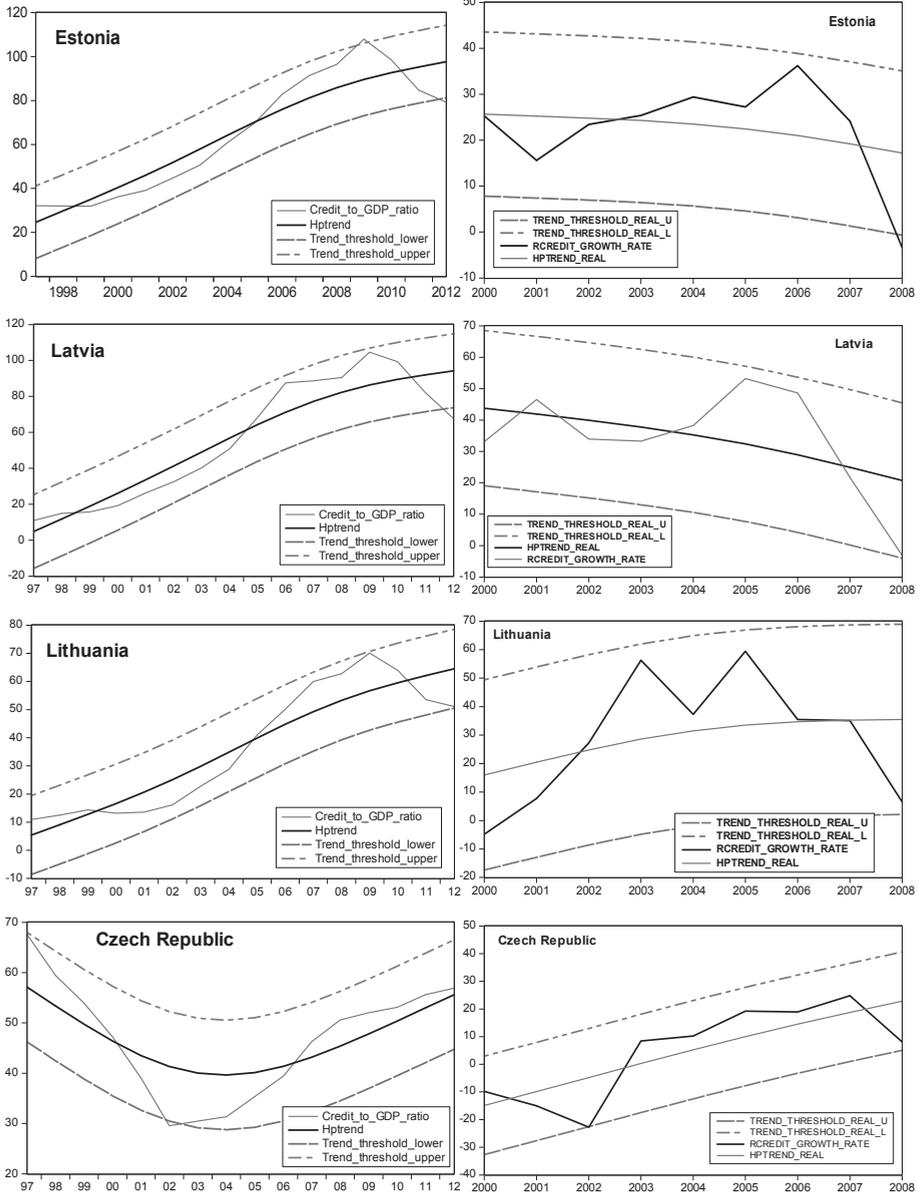
Variables	Panel v-stat	Panel rho-stat	Panel PP-stat	Panel ADF-stat	Group rho-stat	Group PP-stat	Group ADF-stat
Credit_to_gdp, Public_dept	4.60 [0.00]	0.21 [0.58]	-0.64 [0.26]	-2.95 [0.00]	2.78 [0.99]	1.53 [0.94]	-3.60 [0.00]
Credit_to_gdp, Stock_m_c	5.35 [0.00]	0.40 [0.65]	-1.18 [0.12]	-1.93 [0.03]	2.63 [0.99]	-0.13 [0.44]	-4.76 [0.00]
<b>Credit_to_gdp, Public_dept Stock_m_c</b>	<b>-5.74 [0.00]</b>	<b>0.64 [0.74]</b>	<b>-2.31 [0.01]</b>	<b>-3.75 [0.00]</b>	<b>3.69 [0.99]</b>	<b>-1.35 [0.09]</b>	<b>-3.93 [0.00]</b>

**Notes:** P-values are reported in parenthesis; the optimal lags are automatically selected by Schwarz information criterion: Newey-West automatic bandwidth selection and Bartlett kernel. Tests are performed using a sample of 14 countries. The specifications include an individual intercept and trend. Eviews 8.0 was used for panel cointegration tests.

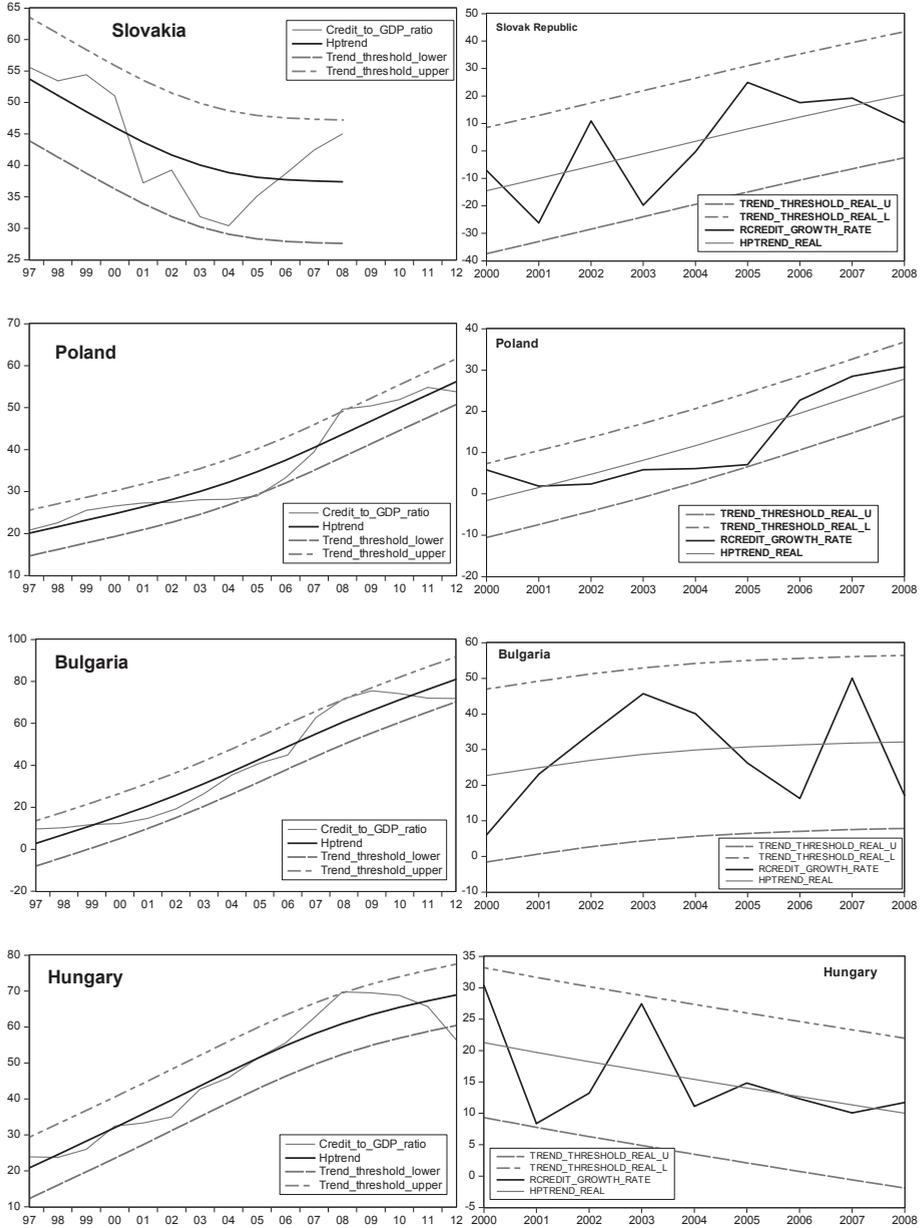
### Appendix 4: Statistical approach

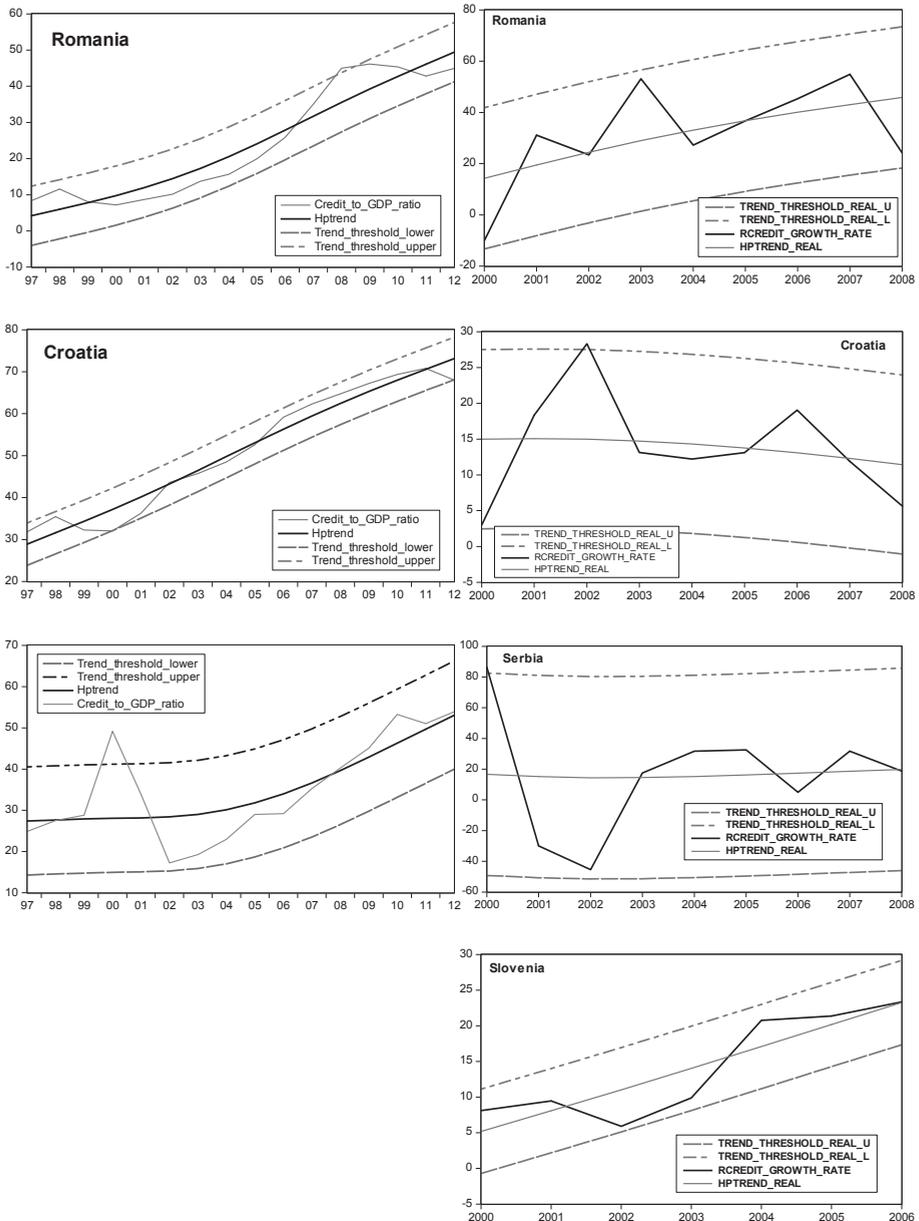
Credit-to-GDP ratio and real credit growth indicators within CESEE countries.

Credit/GDP ratio Real credit growth rate



## EXCESSIVE CREDIT GROWTH OR CATCHING UP: CEE AND SEE





**Source:** Authors' calculations based on data from IMF IFS for nominal credit (IFS line 22d) and CPI (IFS line 64), while data for credit/GDP ratio are constructed from WB (WDI) source.

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