Credit Growth in Central and Eastern Europe: Trend, Cycle or Boom?

Gergely Kiss*, Márton Nagy♣, Balázs Vonnák♦

Abstract

Credit to the private sector has been growing very rapidly in a number of Central and Eastern European countries in recent years. The main question is whether this dynamics is an equilibrium convergence process or may rather pose stability risks. Using panel econometric techniques, this paper attempts to identify the equilibrium credit/GDP levels of the new EU countries, disentangling the observed growth into an equilibrium trend and an excess (boom) component. In the paper the pooled mean group estimator was used for its flexibility and efficiency. Using instrumental variable technique we tested whether long run endogeneity affects the consistency. The estimations show that large part of the credit growth in new member states can be explained by the catching-up process, and, in general, credit/GDP ratios are below the levels consistent with macroeconomic fundamentals. However, in some countries credit growth is significantly faster than what would be justified along the equilibrium path. The study finds that credit growth in Latvia and Estonia can be considered as potentially the most risky, beyond any plausible adjustment rate.

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* Economist, Economics Department, Magyar Nemzeti Bank, email: kissge@mnb.hu

♣ Principal economist, Financial Stability Department, Magyar Nemzeti Bank, email: nagymar@mnb.hu

♦ Principal economist, Economics Department, Magyar Nemzeti Bank, email: vonnakb@mnb.hu

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1. Introduction

Credit to the private sector has been growing very rapidly in a number of Central and Eastern European (CEE) countries in recent years. Undoubtedly, rapid credit expansion has become a key topic for policy discussion in the region. On the one hand, rapid credit growth can be justified by the very low initial level of intermediation in these countries and the convergence towards levels observed in developed EU countries. On the other hand, both empirical and theoretical arguments imply that too rapid credit growth, a credit boom, can have serious macroeconomic consequences, especially if it is accompanied by sizable external imbalances, which can also be observed in many CEE countries. In this regard, the major challenge is to identify the underlying causes of the rapid credit growth in order to distinguish between a fundamentally justified catching-up trend and a risky credit boom. Using panel econometric techniques, this papers aims to identify the equilibrium credit/GDP levels of the CEE countries, thus disentangling the observed growth into an equilibrium and an excess (boom) component. Section 2 provides the theoretical background. Section 3 presents the model and the econometric results with a consistency check in Section 4. Section 5 applies the results for out-of-sample estimation for CEE countries, and finally Section 6 concludes.

2. Theoretical and empirical framework

In this section some theoretical explanations of credit growth are presented, focusing on potential explanatory variables.

Financial intermediation, economic growth and business cycles

The most appropriate starting point for the discussion of the role of credit in the economy is the interaction between savings, the financial sector and economic growth. In the neo-classical Solow growth model, financial markets are not incorporated. In this model, the ultimate engines of growth in the steady state are technology shocks; savings can influence only the level of output but not the growth rate of the economy. Endogenous growth models, on the other hand, consider economic agents as influencing the growth rate through their savings, which can be invested in both physical and human capital.

Based on the assumption that all savings can be efficiently used for investment without any constraints, it is only savings that appears in the original growth models, whereas financial intermediation is omitted. However, it is quite straightforward to incorporate the financial sector into growth models through a cost parameter measuring the part of savings that is lost to the economy as that which cannot be channelled to investment. Efficient financial intermediation can minimize this loss, although it has to be noted that financial intermediation is always costly due to uncertainties, information asymmetries and transaction costs (Gross, 2001). Within the context of growth models, financial intermediation can, however, also have other positive effects. Productivity can increase in the economy through risk-sharing and maturity transformation by the financial sector. Based on these theoretical arguments, a vast empirical literature has evolved starting with Goldsmith (1969), most of them confirming the positive relationship between growth and financial intermediation, as well as the causality leading from financial development to economic growth (for surveys of relevant studies, see Levine, 1997 and Detragiache-Kenichi, 2004).

Thus far, we have seen that theoretical models and empirical results suggest the positive impact of the development of the financial sector on economic growth. In what follows, we focus on one particular aspect of financial development: the deepening of the financial markets, which is often captured by credit growth.

At a theoretical level, credit growth can be separated into three components: trend (which reflects financial deepening), cycle and boom. Following the discussion of the trend deepening we turn to the cyclical component.

The cyclical component is thoroughly discussed in theoretical models of real business cycles with collateralized credit. Kiyotaki and Moore (1997) shows that temporary technology shocks can generate persistent fluctuations in output, asset prices and credit. All credit is collateralized in their model, with some firms in the economy being credit-constrained. Durables are used for production and serve as collateral. This dual function of durables creates the interaction between asset prices and credit limits, amplifying productivity shocks. In case of a negative temporary shock to productivity at time *t*, the net wealth of credit-constrained firms falls. Furthermore, due to the credit constraint, investment of the effected firms also declines. To clear the durable (land) market, the demand on unconstrained firms has to increase, driving asset prices even lower through the user-cost condition. So far, this can be considered as a static, contemporaneous mechanism. However, lower investment in period *t* by the constrained firms leads to lower income in period *t+1*, which, in turn, leads to even lower net worth, forcing them to reduce investment in *t+1*, and so on. Looking at the dynamic effect, it is important to note that persistence and amplification reinforce each other. This reinforcement mechanism, often called the financial accelerator effect, can, in an extreme case, be a potential source of a credit boom.

Identifying a boom

Empirical studies of credit growth focus more on the identification of the boom component: trying to distinguish between equilibrium movements in credit (trend deepening and cyclical pattern) and a potentially risky credit boom. It is especially challenging in the case of transition economies, where credit ratios have grown from very low levels.

Before turning to the different methods of identifying a boom, we briefly summarize, based on IMF (2004), the major adverse consequences of credit booms. One type of effect is related to booms in GDP components. According to the study, in the last decades in emerging markets almost 70% of credit booms coincided with investment and consumption booms, while the probability of the coincidence of a credit boom and an output boom is significantly lower. In emerging markets, credit growth often leads to significant real appreciation of the domestic currency[1] and higher stock prices, which is followed by a subsequent and often dramatic drop in these asset prices. The bursting of a boom - a sharp adjustment in credit growth - can lead to a recession and the significant weakening of banks' balance sheets.

The other type of effect, associated with banking and currency crises, makes credit booms even more costly at the macroeconomic level. IMF (2004) calculations reveal that 75 and 85 per cent of emerging market credit booms coincided with banking and currency crises,

[1] This can also be interpreted as an increase in non-tradable prices relative to tradable ones: an appreciation of the domestic real exchange rate.

respectively. Strong foreign capital influx can constitute an important source of domestic credit growth, which can, in turn, finance increasing current account deficits. Thus, credit booms and high external deficits can reinforce each other's adverse effects. In the rest of the paper, we focus on banking and currency crises as potential consequences of credit booms and do not deal with episodes of growth slowdowns which were not accompanied by macro-stability problems.

In what follows, we try to summarize the different methods that are often used in the literature to identify credit booms and to explain equilibrium credit/GDP ratios. While most studies seek to identify credit booms by an econometric tool, some authors set up general "speed limits" and consider any credit expansion beyond a certain growth rate as excessive (see for example Honohan, 1997). A recent country-specific study Duenwald et al. (2005), dealing with Bulgaria, Romania and Ukraine, also considers fast credit growth risky in these countries, regardless of the evolution of other macroeconomic variables.

Another approach attempts to identify a trend in the evolution of credit using a univariate time series method (most often the Hodrick-Prescott filter). The estimated trend is considered as an equilibrium deepening of the financial sector. The credit boom is defined as credit growth that exceeds a certain threshold around the trend. The thresholds can be both determined as an absolute and a relative deviation from the trend, as introduced by Gourinchas et al. (2001). This approach can be economically meaningful in a number of emerging countries, where basic market forces have been driving the economy for decades. Nakornthab et al. (2003) presents such an analysis for Thailand, where the trend component of the credit/GDP ratio was estimated for 50 years (1951-2002). In case of transition economies, however, time series methods cannot yet lead to economically meaningful results due to short period under review the possible structural breaks caused by the transition during the '90s.

A third and perhaps most widely used approach explains the equilibrium level of credit/GDP ratio by some fundamental macroeconomic variables. Most papers carry out this type of estimation mainly for developed countries based on longer periods. Papers focusing on transition countries apply the estimated parameters of developed and other emerging countries with longer time series. The surveyed papers applied a wide range of econometric techniques and implemented in the sample or out of sample estimation. Some used one-country VECM models. Hofmann (2001) estimated equilibrium credit/GDP level in developed countries separately, while Brzoza-Brzezina (2005) tried to identify excessive credit growth in each of the selected new and old EU states applying in the sample estimation. Other studies aggregated national-level data for the eurozone and then carried out VECM estimation (see Calza et al, 2001 and 2003, and Schadler et al, 2004). Other authors used panel techniques, Cottarelli et al. (2003) pooled developed and non-transition developing countries together, while Tornell's sample consisted of 40 middle-income countries. Boissay et al. (2005) used data of Central and Eastern European countries and applied both one-country ECM model and panel technique for the estimation in the sample. Backé et al. (2005) estimated panel ECM model on various combinations of OECD and emerging countries and, similar to Cottarelli et al. (2003) and Schadler et al. (2004), applied their estimated parameters out of sample for the transition countries.

Determinants of equilibrium level of credit

For the estimations we present in Section 3, it is important to examine the potential variables and their economic justification. In this section, we explore the explanatory

variables that were used for estimations in previous papers; our survey covers 8 papers (see the detailed list in the Appendix).

One of the most often used variables for credit demand is GDP, usually PPP-based per capita, to capture the effect of development. As earlier mentioned, there are very robust arguments in favour of a positive relationship between credit supply-demand and economic growth. It is, however, less intuitive to find the causality leading from development to credit. The economic reasoning starts with the effect of economic growth on expected income and profit, improving the financial conditions of the private sector, and allowing for higher levels of indebtedness. A similar argument assumes that firms want to maintain the ratio between internal and external capital as the economy grows. This would require an increasing credit/GDP ratio, as with economic growth the capital intensity of production increases. However, there are arguments for a negative relationship as well. According to these views, increasing productivity through higher profits makes it possible to rely more on internal funds, decreasing credit demand. Similarly, households might want to increase debt levels to smooth consumption at times when their income is temporarily below expected levels. Notwithstanding the arguments in favour of a weak or even negative relationship, cross-country data (IMF 2004) illustrate well that there is almost unity correlation between per-capita GDP and credit/GDP ratios. PPP-based GDP is used in 4 papers in our survey, while in estimations for developed countries, real GDP is used by Calza et al. (2001 and 2003) and Hofmann (2001).

The second often used variable is the real interest rate, which also simultaneously determines the demand and supply of loans, i.e. the equilibrium in the credit market. It is, however, less straightforward to define the time series of the real interest rate that is the most relevant for total credit. First, nominal rates should, in principle, be adjusted for inflationary expectations; due to observation problems, however, the latter is usually substituted with contemporaneous inflation in empirical work. The second question involves the appropriate time horizon of the interest rate. Some studies address this issue by using both short and long real interest rates (e.g., Calza et al. 2003); others simply construct one aggregate time series. Third, studies generally use the market interest rate to calculate the real rate. This is justified by the assumption that the spread between actual loan rates and market rates remains constant[2] over time across the numerous components of private credit. Lastly, there is a very relevant question for a number of transition countries: the currency in which the real rate is measured. Where foreign currency lending plays a substantial role, aggregating local and foreign currency real rates is far from being straightforward. We will return to the issue of foreign currency credit in detail in Section 3.

The next variable is inflation. There are two arguments in favour of including inflation. One is the empirically observed close correlation between the level of inflation and its variance. The inseparable inflation volatility can be one of the major costs of high inflation: it can significantly hinder the functioning of financial markets through increased uncertainty. The other argument is based on the effect of high inflation on credit constraints. If nominal rates are high, even if the real interest rate is low, households or firms cannot have loans with sufficiently long duration. The shorter duration, in turn, will have an effect on the maximum amount of loan private agents can take.[3] As loan

[2] For a discussion of the transmission of market rates to lending rates in Hungary, see Horváth et al. (2004).

[3] This effect can be best illustrated by a mortgage loan which assumes that a household can spend one-third of its income on loan amortization. The maximum loan, expressed as a ratio to monthly income in the first

indexation - the simplest method that could tackle this type of consequence of high domestic nominal rates - has never been popular in most EU and transition countries, inflation can play a role in determining loan demand in these countries. Based on the non-linearity of these inflationary effects, Cottarelli et al. (2003) uses an inflation threshold as an explanatory variable, setting the limit at 4 percent.

A further set of possible explanatory variables includes different indices capturing structural features, such as financial liberalisation. The positive effect of liberalized financial and capital markets on financial deepening has been well documented in the literature (see for example McKinnon, 1973). Liberalisation indices can be especially useful when pooling data of very heterogeneous countries over a sufficiently long period. However, it should be noted that constructing liberalisation indices on a yearly basis can prove to be difficult; the thorough and very detailed database created by Abiad (2004) does not cover transition countries and smaller EU members. Apart from liberalisation, Cottarelli at al (2003) uses 3 additional indices on a set of 24 countries, which includes both developed and developing countries, controlling for entry restrictions to the banking sector, accounting standards and legal origin of the countries. There are arguments (Schadler et al. 2004), however, saying that structural features can help only in determining the supply of credit, and supply-side factors have only a limited impact on equilibrium credit ratios, more likely influencing the adjustment path to the equilibrium.

Public debt can also play a role in determining private credit through the crowding-out effect. Cottarelli et al. (2003) finds public debt as a stock variable to be more appropriate than different flow variables of the government budget. As long as governments rely significantly on foreign financing for any reason - either in the form of sovereign bond issuance abroad, or foreign investors buying bonds in the domestic market for local currency - the direct link between public debt and private credit is less than straightforward.

Hofmann (2001) includes property prices as an explanatory variable for determining real credit growth in 17 developed countries. Increasing property prices can have an impact on credit demand through the wealth effect, especially through the housing market. Due to financial innovation, using housing assets as collateral has become much more prevalent in recent years in a number of developed countries. This phenomenon has received a lot of attention especially in the US, as higher house prices have also led to record levels of house equity withdrawal. At the same time, there is a theoretical counter-argument which posits that, as property prices rise, rents will also increase, implying a negative wealth effect for renters and future home-buyers. A further link between property prices and credit is based on the q-theory. Higher property prices stimulate more construction, as new constructions become more profitable relative to acquisition costs and the increased construction activity leads to higher demand for loans.

Tornell and Westerman (2002) focuses on the corporate sector in investigating the co-movement between credit and a different set of explanatory variables, namely: the real exchange rate, non-tradable/tradable output ratio, real investment and GDP in middle-income countries. According to the study, the selection of these variables is justified by the link between credit booms and the asymmetric financing opportunities of tradable/non-tradable sectors and the risky currency mismatch in the balance sheet of both firms and

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period, will then depend on the nominal interest rate. Kiss and Vadas (2005) show that, while at a 2% nominal rate a household can take out a loan equivalent to more than 5 years' income, at 17% the amount of the loan would be equivalent to less than 2 years' income.

banks. In case of non-tradable firms, if they borrow in foreign currency, a real appreciation eases the debt burden, encouraging further credit growth. A similar effect is captured by the non-tradable/tradable output ratio, given that in middle-income countries, non-tradable firms are more credit-constrained; hence, the ratio of non-tradable output is expected to increase parallel with credit growth.

3. The model

In this section we describe the data, the estimation procedure and the results for eurozone member countries. We also present our endogeneity bias test.

Variables

This subsection introduces the credit aggregate and the set of explanatory variables based on the literature survey.

The first important variable to consider for the estimation is the credit aggregate. Domestic private sector credit in an open economy can be grouped both by the origin of the loan (foreign vs. domestic banks) and by currency. In the economy-wide aggregate estimation, we use credit data from domestic banks' balance sheets, thus excluding direct borrowing from foreign banks. In case of the sectoral estimations, we use national accounts, where foreign loans are also included.

It is important to emphasize that both domestic- and foreign-currency loans are included in the credit aggregate. While at a theoretical level it might prove more reliable to estimate domestic and foreign currency loans separately, this approach is constrained by data availability and can be less meaningful for policymakers. Brzoza-Brzezina (2005) used only domestic currency loans for Hungary, Poland and the Czech Republic in its estimations. In our opinion, along with the extra risk involved in non-hedged FX borrowing, it is the total credit level that is the most relevant in assessing the possibility of a credit boom. Credit is expressed as a ratio to nominal GDP.

Based on the choices in previous estimations, reviewed in Section 2, we decided to use GDP, the short real interest rate and inflation as the explanatory variables for the equilibrium credit/GDP estimation. GDP seemed an obvious choice, as it appears in almost all previous estimations, and we have good reason to believe that the recent very low level of intermediation in transition countries is going to increase parallel with real convergence towards the EU average GDP. With regard to the role of GDP, endogeneity can be an important econometric issue in estimation. We have previously seen that causality can work both ways: we presented arguments earlier going from higher GDP to increasing credit ratios; at the same time, there is both theoretical and empirical evidence, detailed in Section 1, that the development of the financial sector boosts economic growth and welfare.

The choice of the next variable, the real interest rate, seems at first glance to be quite straightforward. As earlier noted, both short and long real interest rates proved to be economically meaningful for most EU countries. However, in many transition countries foreign currency loans complicate the aggregation of the real interest rate variable. Using a weighted average of domestic and foreign real interest rates as an explanatory variable would be the solution, but we could not gather historical data on the share of foreign currency lending, therefore we used domestic interest rate data.

Quite apart from the theoretical arguments for inflation, we also expect inflation to partly capture the effect of foreign currency loans. One of the major incentives for the non-

tradable sector and households to borrow in foreign currency is to lengthen the duration of the loan, which otherwise would be hindered by the domestic inflation reflected in the higher nominal interest rates. Therefore, if inflation is decreasing and nominal domestic rates move in tandem with them, domestic loans will become more available to the economic agents. In this case it is only disinflation that can loosen the liquidity constraint of economic agents who cannot have access to foreign exchange loans. In other words, if inflation proves to be a significant explanatory variable, it can suggest that foreign currency loans do not play an excessive role in credit demand.

In addition to the most important explanatory variables we also experimented with other possible variables in the estimations. As an alternative to the real interest rate based on benchmark yields, we created a lending rate-based real interest rate, where the CPI deflator remained the same. This way we tried to measure, perhaps more precisely, the effective real interest rate relevant to the private sector. We also included the openness of the economy, defined as the ratio of exports+imports to GDP, as a potential proxy for the weight of the tradable sector, which is supposed to be less bound by domestic liquidity constraints. This effect is rather similar to what is partly expected to be captured by inflation. However, these additional explanatory variables did not lead to economically meaningful or statistically significant results.

Dataset

Our estimations are based on data from eurozone countries. The major reason for choosing this group is the fact that, since all new EU members have the obligation to adopt the euro, it can be assumed that, in the longer run, financial markets in the old and new member countries will become fully integrated. We also expect that the effect of factors we did not include in our specification is less relevant than on a broader set of countries.

We compiled an aggregate yearly dataset of eurozone countries for the period 1980-2003. The source of most of the data is Eurostat; credit aggregates were kindly provided by the ECB. We consider estimation results on this dataset as benchmark. For sectoral estimation we used a disaggregated dataset that consisted of household and corporate sector data for a shorter period (1995-2002) but the same set of countries, based on yearly Eurostat statistics.

Estimation

Similarly to other authors we modelled the credit dynamics within an error-correction framework. This approach postulates that the credit to GDP ratio is cointegrated with the explanatory variables and deviation from long run equilibrium diminishes endogenously by convergence of credit towards its equilibrium.

Our approach may improve on previous result for three reasons. First, in order to have large number of observations, we estimated on multi-country panel data. Second, our estimator is more flexible and efficient than those used by other authors. And finally, since endogeneity may invalidate the results, we also tested the consistency of our coefficient estimates.

For the estimation, we applied the pooled mean group (PMG) estimator described in details in Pesaran, Shin and Smith (1999, hereinafter PSS). This is actually a maximum likelihood estimation of the parameters of a dynamic panel model and has advantageous properties when the number of countries is comparable to the length of the time series. It is also robust to the degree of integration. But the main reason for selecting PMG is that it can be applied for models having rich and heterogeneous dynamics.

As in PSS, we assumed that the long-term relationship is the same across countries, while the short-term dynamics can differ across countries. In our case it means that the relationship between the equilibrium credit/GDP ratio and the explanatory variables (GDP, real interest rate, etc.) is assumed to be the same, whereas the dynamics around the equilibrium, and particularly the speed of adjustment, is allowed to differ. We find this specification appropriate as short term or cyclical movements are often determined by institutional features that can vary considerably across countries.

We assumed the following relationship between the credit/GDP ratio and the variables influencing equilibrium dynamics:

$$\Delta c_{it} = \phi_i \left(c_{i,t-1} - \bar{c}_{i,t-1} \right) + \sum_{j=1}^{m-1} \gamma_{ij} \, \Delta c_{i,t-j} + \sum_{j=0}^{n-1} \delta_{ij} \, \Delta f_{i,t-j} + \alpha_i + u_{it} \qquad (1)$$

$$\bar{c}_{it} = \beta' \, f_{it} \qquad (2)$$

where c and $\bar{c}$ stand for the actual and equilibrium credit/GDP ratio, respectively, f is the vector of explanatory variables and α_i is an unexplained country-specific effect which can correlate with the other explanatory variables. The first term in equation (1) describes the reaction of credit to its misalignment[4], where the speed of adjustment parameter is measured by the ϕ parameter. The sign of ϕ is expected to be negative, meaning that lower-than-equilibrium credit stock induces credit growth in the next period. γ, δ denote short-term dynamics. Equation (2) describes the long-term relationship between explanatory variables the equilibrium level of credit/GDP, where β captures the common long-run dynamics.

Results

Using the PSS model, we experimented with a number of different specifications. We estimated the model with different combinations of explanatory variables and lag structures determining the dynamic characteristics of the model and used alternative algorithms of the maximum likelihood estimation. In our preferred specification, GDP, the short real interest rate and inflation were the explanatory variables, all being significant and having the theoretically expected sign. Including additional variables, like openness, to capture the possible effects of foreign exchange lending or the real interest rate based on lending rates, led to counterintuitive results. We thus preferred the combination of the above-mentioned three variables. The number of lags of the first differences was determined by the Akaike information criterion allowing maximum two lags. The formal econometric test for the homogeneity of the long-term parameters is the joint Hausman-test, which indicated that the assumption of homogeneity cannot be rejected, with the associated p-value being 0.58.

[4] The misalignment itself drives credit/GDP back to the equilibrium in the error correction framework.

Table 1. Coefficient estimates

GDP	**0.51**
t-statistics	(-5.36)
RIR	**-1.88**
t-statistics	(-4.33)
CPI	**-2.04**
t-statistics	(-3.93)

Table 1 presents the results. In the final specification, a 1 per cent increase in PPP-based per capita GDP leads to a 0.5 per cent increase in the credit/GDP ratio, while the real interest rate (RIR) and inflation (CPI) have fairly similar effects: a 1 percentage point increase in these variables lowers the credit/GDP ratio by approximately 2 per cent. The sign and the size of the estimated adjustment parameters can be considered as indicators of co-integration between the variables, since the adjustment parameters should be negative in an error-correction framework. Positive or extreme negative values in the estimation indicate misspecification (e.g., lack of co-integration or omitted variables) of the model. The final specification gave plausible estimates of the speed of adjustment for all countries.

Although our results cannot be directly compared with previous estimations using aggregate eurozone data due to differences in data definitions and model specifications, our results are in line with that of Cottarelli et al. (2001 and 2003), Schadler (2004) and Backé et al. (2005). The range of the estimated parameters in the aggregate eurozone data for real GDP is 0.34 to 0.49, and -1.99 to -5.1 for the real interest rate.

The estimated equilibrium, based on the yearly model, and the actual credit/GDP ratio evolution is presented for selected countries in the Appendix (Chart 2). There is a wide range of equilibrium levels across countries, with even greater heterogeneity in actual levels. The most notable period was the convergence prior to euro adoption, when there was very fast growth in the credit/GDP ratio in a number of countries, such as Spain, Portugal and Ireland. In other countries, like France and Belgium, however, convergence had no impact on credit growth. Due to the fast growth during the run-up to euro adoption, the credit/GDP ratio was significantly above the estimated equilibrium level in certain countries. The biggest gap (48%) is found in Portugal, followed by Spain (30%), while in Ireland, the equilibrium had also been growing very fast, leaving the gap close to zero.

Testing for endogeneity bias

During our estimation procedure we assumed that all the explanatory variables are exogenous to the credit demand. Should this assumption fail, our estimated long run coefficients might be biased. There are indeed good reasons to think that the direction of causality between credit and its long run determinants is far from being straightforward, as explained in section 2. Firstly, credit stock itself can contribute to growth, that is reverse causality may exist. Secondly, there may be an omitted variable that drives credit and output simultaneously. Development of the financial intermediation can increase credit stock as well as promote more efficient resource allocation.[5] One could easily find plausible justifications for reverse causality or simultaneity for the real interest rate, too. However,

[5] Kovandzic et al. (2005) presents a detailed discussion of how these situations affect coefficient estimates and how to address them by GMM estimation.

here we address only the case of GDP per capita as we consider it to be the most questionable in regard with the exogeneity.

To check whether endogeneity affects the consistency of our estimates, the most proper treatment would be to expand our model by allowing for more than one long run relationships between our variables. This would involve estimation of a VECM model and imposing identifying assumptions in order to obtain structural relationships. The latter step requires some a priori knowledge about some parameters, and is therefore theoretically demanding as well as subject to arbitrariness.

Since we are not primarily interested in the full structure, nor do we have idea how to identify individual equations, we chose a more straightforward way to test the consistency of our results. We used instrumental variables approach to quantify how exogenous shocks to per capita GDP changes equilibrium stock of credit and assessed whether the result is similar to that of benchmark OLS estimation. The formal test is the Hausman-test.

The crucial point is to find variables that drive growth significantly, but are themselves not affected by the state of financial intermediation. Following Easterly and Levine (1997) and Alesina et al. (2002) we obtained exogenous variation of GDP from measures of ethnic, linguistic and religious fractionalization. We used the data of Alesina et al. (2002) that are probabilities of two randomly selected people belonging to different groups. Consequently, the measures range between 0 and 1, higher number indicating higher degree of fractionalization.

We prefer these instruments because their exogeneity and influence on development is fairly intuitive. On the contrary, other widely used instruments sometimes fail to have convincing explanation of the impact. Geographical location of countries, measured by the latitude, for example, is sure to be exogenous and shows high correlation with development, but the lack of intuitive mechanism renders it rather a dummy variable. On the contrary, the causal relationship between fragmentation and growth is more obvious through the quality of government and institutions.[6]

We estimated the effect of per capita GDP on credit/GDP ratio by GMM in three different set-ups. In each specification the difference between OLS and GMM estimates of GDP coefficient were small, which is an informal indication that the OLS estimates may be consistent. Formal Hausman-tests could not reject the null hypothesis of consistency. The relatively high explanatory power of the instruments together with the rejection of overidentification suggested that we have chosen a proper instrument set. The estimation details can be found in the appendix.

Overall, our cross-country experiment makes us believe that the dynamic panel estimates of long run credit equation are consistent. However, it is important to stress that we tested the consistency of the non-IV estimates of the long run coefficients in equation (1). Although we could reject that endogeneity bias exists, the result does not mean at all that there is no endogeneity.

Sectoral breakdown

In order to investigate in an econometric framework the possible distinct behaviour of households and non-financial corporations in credit demand we also attempted to estimate sectoral equilibrium levels of credit to GDP ratio and test the hypothesis on the existence

[6] For reference studies on this issue see the introduction of Alesina et al. (2002).

of credit boom. We applied the same explanatory variables as in the aggregated model. However due to lack of sufficiently long historical time dataset our sample runs only from 1995 to 2002. We used only one lagged differential of credit/GDP and no lags of the other variables. In order to have comparable aggregate benchmark estimates, the re-estimation of aggregate level data for 1995-2004 was also carried out. Table 2 shows the results.

Table 2. Sectoral results

	Aggregate	Household	Corporate
GDP	**1.12**	**1.37**	**0.45**
t-statistics	(-18.32)	(-6.47)	(-5.5)
RIR	**-3.58**	**-8.14**	**-2.69**
t-statistics	(-10.26)	(-7.61)	(-16.45)
CPI	**-1.59**	**-11.18**	**1.78**
t-statistics	(-5.84)	(-6.81)	(-6.68)
Joint Hausman test of homogeneity, p-value	0.11	0	0.81
Ratio of plausible adjustment parameters	75%	100%	83%

The estimated long-run coefficients for the entire private sector are all significant with the expected sign. The coefficient of per capita GDP and real interest rate are considerably higher than on the 1980-2002 sample. We consider the estimates of speed of adjustment as an informal test of cointegration. In the aggregate case 75 percent of them were between -1 and 0 suggesting that the ECM specification was reasonable. Nor did the Hausman-test indicate misspecification at usual significance level.

There are marked differences between the household and corporate sectors. The model seems to fit better the lending behaviour of households. First, the explanatory power is higher than for the enterprises and second, credit is more sensitive to the right hand side variables. The long-run effect of inflation is significant and has a negative sign confirming the existence of a long-term relationship linking households' credit demand to liquidity constraint. The coefficients of the real interest rate and the CPI are close to each other, as for the long sample estimation, suggesting that it is the nominal interest rate that really matters.

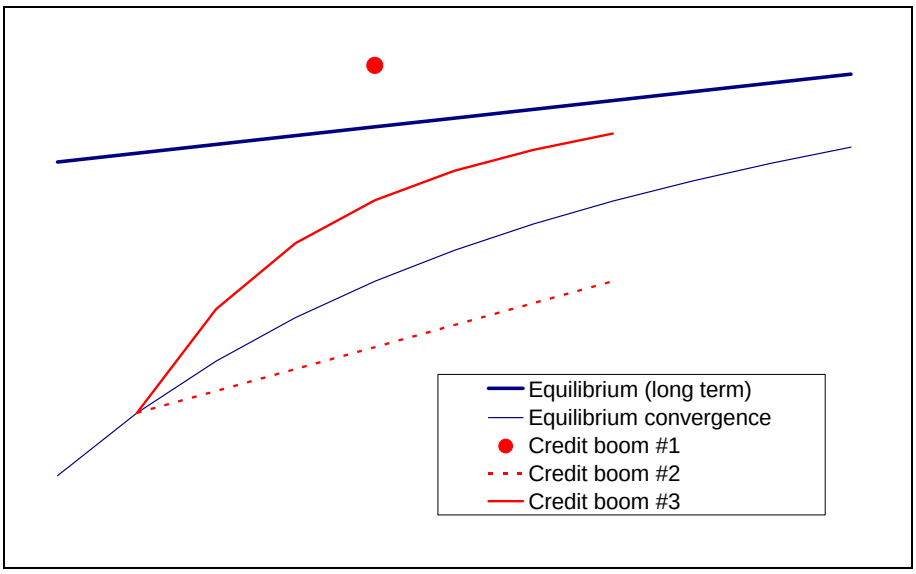
The estimated effect of inflation on corporate sector's credit is significantly positive, which is a puzzling result. The estimates for the enterprises' coefficient of per capita GDP and the real interest rate are much smaller than in case of the entire private sector and particularly compared with the households, indicating strong substitution effects of alternative financial sources. Since the households in the majority of the investigated countries finance their activities predominately in the form of loans it is a natural phenomenon that real interest rate and inflation matter mostly for credit demand.

The adjustment coefficients were mostly in the range that is consistent with our implicit assumption of the existence of cointegration. The Hausman-test suggested a heterogeneous effect of inflation on households' credit. Therefore, our model is misspecified. However, comparability is provided only if we restrict the long-run coefficients to be homogenous for both sectors, thus we proceed with these models bearing in mind that in addition to the low number of observations, inadequate specification may limit the reliability of our results.

4. Risk of having an excessive credit growth in Central Eastern European countries

In order to identify credit booms in our model framework we distinguish three different situations, when the level or the growth of observed credit to GDP ratio can be considered to be dangerous. Chart 1 illustrates these three possible interpretations of a credit boom.

Chart 1. Plausible definitions of credit booms



First, when the level is above the fundamentally justified equilibrium by a certain margin, it can be considered to be a credit boom. In the second case, the level is below the equilibrium, but the growth rate is faster than what would be observed along the long-term equilibrium path. In the third case, although the level is still below the equilibrium, the growth rate is even faster than what would be justified by the convergence path determined by the adjustment parameter.

With the aim of classifying the CEE countries' experiences according to the types of credit boom defined above, the next step is to proceed the calculation of the equilibrium level, growth of credit and also a "normal" catching up dynamics for the 8 new EU members in Central Europe and the Baltics (namely the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia) using the parameter estimation of eurozone panel (Table 1.). Based on the results of the different specifications, we chose to apply the parameters obtained from the yearly aggregate model. This choice was motivated by the fact that this estimation led to not only theoretically meaningful but also econometrically most acceptable results.

It is quite plain to use the common long-term parameters in the case of the out-of-sample estimation; however, choosing the country-specific constant is less straightforward. Maeso-Fernandez et al. (2004) lists plausible options for doing out-of-sample estimation based on results from fixed effect panel model. If there are strong reasons to believe that the country not included in the original panel shares the relevant but not modelled features of another country in the panel it is natural to use the constant term of the latter. In the absence of such natural benchmark, the simplest and rather safe approach is to create a range of uncertainty by using the minimum and the maximum constants.

In order to display the uncertainty coming from the unexplained cross-section heterogeneity we chose to plot out-of-sample equilibrium credit estimates using all country-specific effect. This treatment gives the reader the freedom to select the relevant benchmark based on his own assessment. The results can be seen on Chart 3. The countries with the highest and lowest unexplained values were Luxemburg and Greece, respectively. We omitted the equilibrium estimates based on Luxemburg's country specific effect from the chart as it produced unrealistic high values.

The most important observations that can be made based on the graphs is that the estimated ranges are rather wide for each country even after omitting Luxemburg, indicating significant uncertainty in the equilibrium credit/GDP ratios. This uncertainty also has important implications for the adjustment path since during the catching-up process, the speed along the corresponding equilibrium convergence path may depend significantly on the distance from the long-term equilibrium.

Table 3. Risks of having a credit boom in CEE countries

	Type 1	Type 2	Type 3
Estonia	medium	high	high
Latvia	medium	high	high
Lithuania	low	medium	low
Hungary	low	medium	low
Slovenia	low	medium	low
Poland	low	low	low
Slovakia	low	low	low
Czech Republic	low	low	low

The existence of the credit boom was evaluated for 2004-2005. We label Type 1 credit boom when actual credit/GDP is higher than the estimated equilibrium. Type 2 means faster growth rate of credit/GDP than that of equilibrium. The 3rd type is when the growth rate is faster than what the speed of adjustment to equilibrium would imply. We calculated the latter benchmark by using equilibrium based on Portugal constant (highest) and using the fastest adjustment parameter from the panel estimation. For more details see previous section.

Notwithstanding the uncertainties, the results clearly indicate that the risk of a potential credit boom among the new EU members is highest in two Baltic countries. In Latvia and Estonia, the credit/GDP ratio is in the upper half of the region determined by the eurozone estimation results, whereas it is still low in Lithuania, despite the very fast growth in recent years. Credit/GDP growth dynamics in Estonia and Latvia have recently been above any plausible threshold that could be generated by the adjustment mechanism in an error-correction model.

In the non-Baltic states the level of credit/GDP can be considered as being safely below the equilibrium, therefore growth in the future would correspond to equilibrium convergence, not necessarily indicating a credit boom. For 2004 we got equilibrium estimates lower than actual data for CEE countries only in case of the Greek country effect.

Credit is growing somewhat faster than the equilibrium level in Slovenia and Hungary, although in these cases the dynamics can easily be justified by convergence. It can also be noted that Hungary is the only country where the equilibrium credit/GDP ratio has not

been growing in the last two years, but this is partly a consequence of higher nominal interest rate. In 2005 the interest rate returned to a lower level, which *ceteris paribus* increases the equilibrium level of private credit. In three other countries - the Czech Republic, Poland and Slovakia - there has hardly been any growth in the credit/GDP ratios in recent years and the actual level is close to the low end of the range. The significant decline of the credit level at the end of the '90s in the Czech Republic and Slovakia can, to a large extent, be linked to the inevitable consolidation of the previously state-owned banking sector, which happened a few years earlier in the other countries.

Sectoral breakdown

As the constant term indicated significant differences between households and corporate sector, it is worth looking at the out-of-sample estimation on a sectoral basis. Stylized facts clearly show that the credit expansion in most of the Central-Eastern European and Baltic countries has been driven by lending to households during 1995-2004. Household credit relative to GDP has increased from an initially low level, although to different extents across countries. Hungary, Estonia and Latvia have experienced the most rapid credit growth in this period. Introduction of housing loan subsidy systems and the spreading of retail FX lending have led to the strengthening housing loan dynamics and increasing indebtedness of households. In the Czech Republic, Lithuania and Slovakia the mortgage lending started to pick up only recently, while in Slovenia it remained virtually unchanged relative to GDP. Finally, in Poland lending to households after persistent increase slowed in the last years. In some countries consumer lending has also witnessed growth, contributing to rapid credit expansion.

Development of credit to non-financial corporate sector portrays a mixed picture. In the Czech Republic and Slovenia the corporate credit to GDP ratio has sharply fallen since 1996-97 due to, firstly, the considerable portfolio-cleaning and tightening regulation and, secondly, strong substitution effects of FDI inflow and foreign direct lending. In contrast, in Estonia, Latvia, Lithuania and Slovenia corporate credit gained constantly depth in the last years as a consequence of economic upswing, improving outlook and decreasing interest rates. Finally, Hungary and Poland displayed relatively steady corporate credit to GDP ratios in the investigated period.

Investigating the results of the sectoral out-of-sample estimates (see Chart 4) for the new EU members we cannot exclude the existence of household's credit boom for Estonia, Latvia and Hungary since these countries' credit to GDP ratio can be found well within the estimated "equilibrium range". In addition, growth rate of household credit to GDP ratio in these countries has exceeded that of the equilibrium level in the investigated period, reflecting a type 2 credit boom. In the Czech Republic, Poland, Lithuania, Slovakia and Slovenia we did not detect any clear signs of a credit boom.

As for the non-financial corporations (see Chart 5) we cannot find unambiguous empirical evidence on credit boom episodes in the investigated countries based on the level and the dynamics of credit to GDP. In Latvia corporate credit to GDP ratio has sharply risen since 1997, surpassing constantly the growth rate of equilibrium. However the level of credit to GDP is still under the majority of equilibrium levels estimated on different country experiences. Estonia, Lithuania and Slovenia have experienced rapid growth but only recently and their credit to GDP ratio is also positioned close to the lower bound of the "equilibrium range". We found no indication of a credit boom either in Hungary or in Poland as the dynamics of credit growth relative to GDP was very subdued and credit/GDP ratios are below the equilibrium level. Finally, in the Czech Republic and

Slovakia the consolidation of the banking sector resulted in quickly decreasing credit ratios at the end of the '90s, thus the convergence process could only resume after the end of the consolidation.

5. Conclusions

This paper attempted to analyse credit growth in a macroeconomic framework using panel estimation for equilibrium level of private credit. We applied the pooled mean group estimators to obtain long run relationship between credit stock and its determinants. The chosen panel error-correction model could explain reasonably well the evolution of credit aggregates in eurozone countries since 1980. The major determinants of credit are PPP-based GDP per capita (representing the effect of economic development), the real interest rate (measuring the cost of credit), and inflation (capturing the effects of inflation volatility and liquidity constraints). The estimated parameters are consistent with theoretical predictions and previous estimations. The estimated long-run coefficients are in the range of the results of previous estimations for credit demand in the eurozone.

Although the explanatory variables proved to be empirically important, nearly half of cross-section variance remained unexplained by our model. The country-specific effects make therefore out-of-sample estimation for the new EU members more challenging, especially in the case of the adjustment path.

Credit/GDP ratios are, in general, below the levels justified by the macroeconomic variables in CEE countries. Out-of-sample estimations suggest that by and large credit growth observed in the last decade in these countries is justified by fundamentals; it represents the equilibrium deepening of the financial sector.

The overall results notwithstanding, in some new EU member states, credit growth is significantly faster than what would be justified along the equilibrium path. According to the country results, credit growth in Latvia and Estonia can be considered as potentially the most risky, beyond any plausible adjustment rate, while in Hungary, Lithuania and Slovenia, the observed fast credit growth can be explained by convergence. In the Czech Republic, Poland and Slovakia there are no signs at all of excessive credit growth.

Sectoral estimates revealed that the issue of equilibrium credit growth is particularly relevant in the household sector. In the case of enterprises our model had relatively low explanatory power. Out-of-sample calculations indicate that in the countries where risk of a credit boom is non-negligible, it is dominantly the household indebtedness that produces faster than equilibrium dynamics.

All in all, the results of the study highlight the importance of closely monitoring credit growth in many countries in the region. Although no unambiguous indication of a credit boom could be identified in the new EU member states, credit dynamics can be considered to be an increasing macroeconomic concern, especially in the Baltic states. Potential policy responses should take into account that the openness of financial markets within the EU and its implications for cross-border financial transactions can significantly constrain the effectiveness of national administrative measures. Designing efficient policy responses could prove to be especially challenging for countries with currency board arrangements, such as the Baltic countries. In other countries, like Poland and Hungary, the fast growing share of foreign-denominated loans to non-hedged borrowers could be an additional concern for monetary policy.

Against this background, the behaviour of the financial sector is a key issue. Financial market participants should be aware of the costs of a potential credit boom and thus should be more cautious in credit provision. Prudent activity is particularly important in the case of more risky segments, such as financing small firms or providing unsecured loans to households.

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Appendix 1: Test of endogeneity bias in GDP coefficient

Number of general equilibrium models proposed by Greenwood and Jovanovic (1990), Khan (2001), Erosa and Hidalgo (2004) as well as Amaral and Quintin (2005) have established theoretical link between financial development, economic development and growth. They have argued that growth and economic development provided the wherewithal to develop financial system, while financial intermediation in turn allowed for higher growth since investment could be more efficiently undertaken.

These possible directions of causality were also tested by several empirical studies applying GMM estimation technique to deal with the endogeneity problem. King and Levine (1993), Neusser and Kugler (1998) and Levine at al. (2000) found evidence that financial development promotes economic growth as intermediaries allocate savings efficiently and help fund investment in firms (supply-leading hypothesis). On the other hand, Goldsmith (1967), Jung (1986) and Cottarelli et al. (2003) showed that an increasing demand for financial services might induce an expansion in the financial sector as the real economy grows (demand-following hypothesis). Last but not least, Calderón and Liu (2002) tested bi-directional causality and found that growth and financial development were inextricably linked. One of their conclusions was that financial deepening contributes to higher growth more in developing countries than in developed ones.

Although there exists empirical evidence of supply-leading effect, the long-run elasticity of credit stock to GDP need not be biased. On one hand, studies detecting causality between financial development and growth typically used change in GDP, as opposed to our specification including per capita GDP in level. They also controlled for initial GDP arguing that lower output is likely to be associated with higher growth. As a consequence, the relationship between financial development and the level of GDP is not determined.

On the other hand, even in the presence of reverse causality, the specification we used specification may filter it out. Our ECM framework allows us to estimate only one long run equation. If there are more than one cointegrating relationships, the estimated one may be the linear combination of all, hence it is impossible to give intuitive interpretation to the coefficients.[7] The proper way would be to estimate a vector error-correction model (VECM) and somehow identify economically meaningful long-run relationships. In a VECM framework credit stock may react to disequilibrium in any cointegrating equation immediately, that is its coefficients before the ECM terms may be significantly different from zero. But if credit reacts directly only to misalignment in the "credit equation" (the one we are seeking), even the presence of multiple cointegration will not make our parameter estimates biased.

As bulk of the variability in output comes from cross-section as opposed to time dimension, we obtained much larger variability in GDP by collecting a bigger set of countries. By averaging for a longer period we got rid of dynamics. Data availability influenced both our specification and sample choice. In order to involve as many countries as possible we used credit, GDP, CPI and interest rate averaged from 1995 to 1998.

Since CPI and interest rate data was available for a smaller set of countries than credit and GDP, we used two different specification. In the first, credit to GDP ratio, c was explained solely by per capita GDP (y):

[7] See Hamilton (1994) on page 590.

$$c_j = \beta y_j + u_j \quad (3)$$

where *j* is and index on the set of 124 countries, *u* is the unexplained heterogeneity. When we included real interest rate and inflation (*i* and π, respectively), as in the ECM, our sample size shrunk to 91 countries. The specification in that case was:

$$c_j = \beta y_j + \alpha_r i_j + \alpha_\pi \pi_j + u_j \quad (4)$$

Since our country panel consists of developed economies, we also tested endogeneity on a subsample including those 37 countries where average per capita GDP between 1995 and 1998 exceeded 7000 USD at 1995 prices. In this case we chose the simple specification again (equation 3).

We did not use all three instruments in every regression. On large sample religious fractionalization proved to be incapable to explain cross-country heterogeneity of per capita GDP, therefore we omitted it. On the sample of developed countries, however, all three measures of fragmentation seemed to have some explanatory power. This observation is in line with the remark of Alesina et al. (2002), who claim that the exogeneity of belonging to some religious group can be sometimes questioned. They argue that in less developed countries with more repressive regime people may want to hide their true belief and declare themselves to belong to the religion that is more convenient for the official view. This mechanism may weaken the supposed negative correlation between development and religious fragmentation.

Table 4. Cross-country estimates of the effect of development on credit

		1	2	3
OLS	GDP	**0.64**	**0.59**	**0.58**
	t-statistics	(10.4)	(9.1)	(3.3)
	NIR		**-0.89**	
	t-statistics		(-1.4)	
	CPI		**-0.38**	
	t-statistics		(-1.6)	
	No of observations	124	91	37
	R^2	**0.47**	**0.56**	**0.23**
GMM	GDP	**0.64**	**0.49**	**0.64**
	t-statistics	(6.5)	(5.6)	(3.1)
	R^2	**0.47**	**0.55**	**0.20**
Instruments	ethnic	+	+	+
	linguistic	+	+	+
	religion			+
	Overident.-test p-value	**0.97**	**0.68**	**0.78**
	R^2 of 1st stage regression	**0.35**	**0.47**	**0.35**
	Hausman-test p-value	***0.99***	***0.15***	***0.99***

Table 4 summarizes the results. The columns numbered from 1 to 3 correspond to our three different specifications, the first one being the largest sample with per capita GDP as the only explanatory variable, the second one includes nominal interest rate (NIR) and inflation (CPI) as well, while the third is again only with GDP but on the subsample of developed countries.

The first block contains the main statistics of the OLS regression. The coefficient of GDP is around 0.6 in each case with very low standard errors. This result is comparable to our dynamic estimates on large sample, starting in 1980. The coefficient of nominal interest rate and CPI is much lower than in the dynamic model. The relevance of development in credit accumulation is highlighted by the fact that on large sample variation in per capita GDP explains almost the half of cross-country variance of credit to GDP ratio.

The second block presents the results from GMM estimation of the same model. The instruments are listed in the third block, where the p-values associated with the overidentification and Hausman-tests can be found as well as the R-squared of the auxiliary regression. As a test of endogeneity bias we applied the approach of Davidson and MacKinnon (1989, 1993). In the first step we regressed per capita GDP on all the exogenous variables. The residuals of this regression were then plugged into the basic regression, and its almost zero coefficient would suggest the absence of endogeneity bias.

Appendix 2: Tables and Graphs

Table 5. Literature survey

Authors, title	Target group	Methodology	Variables
Backé et al. (OENB) 2005 'Credit Growth in Central and Eastern Europe...'	11 Central and Eastern European countries	Pooled and fixed effect OLS, PMGE	Private Credit/GDP: PPP-based GDP, government credit, short and long nominal interest rate, inflation, house prices, liberalisation index, credit registries
Brzoza-Brzezina 2005 'Lending booms in Europe's periphery: South-Western Lessons for Central-Eastern Members'	POR, IRL, GRE, HUN, CZE, POL	VECM for individual countries	Private, domestic currency Credit/GDP for the CEC3, total credit for eurozone members
Calza et al. (ECB) 2001 'Modelling the demand for loans to the private sector in the euro area'	Eurozone	VECM on aggregate eurozone data	Private Credit/GDP: real GDP, short and long real interest rate
Calza et al. (ECB) 2003 'Aggregate loans to the euro area private sector'	Eurozone	VECM on aggregate eurozone data	Private Credit/GDP: real GDP, nominal interest rate, inflation
Cottarelli et al. (IMF) 2003 'Early birds, late risers, and sleeping beauties: bank credit growth to the private scetor…'	15 Central European and Balkan countries, out of sample estimation	Random effect panel estimation of 24 developed and non-transition emerging countries	Private Credit/GDP: Public debt/GDP, PPP-based GDP, inflation threshold, liberalization index, index for entry restrictions to the banking sector, accounting standards and legal origin
Duenwald et al. (IMF) 2005 'Too Much of a good thing? Credit booms in transition economies'	BLG, ROM, UKR	Panel estimation, fixed effect GLS	Private credit/GDP: links with trade balance
Hofmann (BIS) 2001 'The determinants of private credit in industrialised countries: do property prices matter?'	16 developed countries	VECM for individual countries	Private Credit/GDP: real GDP, short real interest rate, property price index
Schadler et al. (IMF) 2004 'Credit booms, demand booms and Euro adoption'	New EU members, based on out of sample estimation	VECM, on aggregate eurozone data	Private Credit/GDP: PPP-based GDP long real interest rate,

Chart 2. Estimation results for selected eurozone members

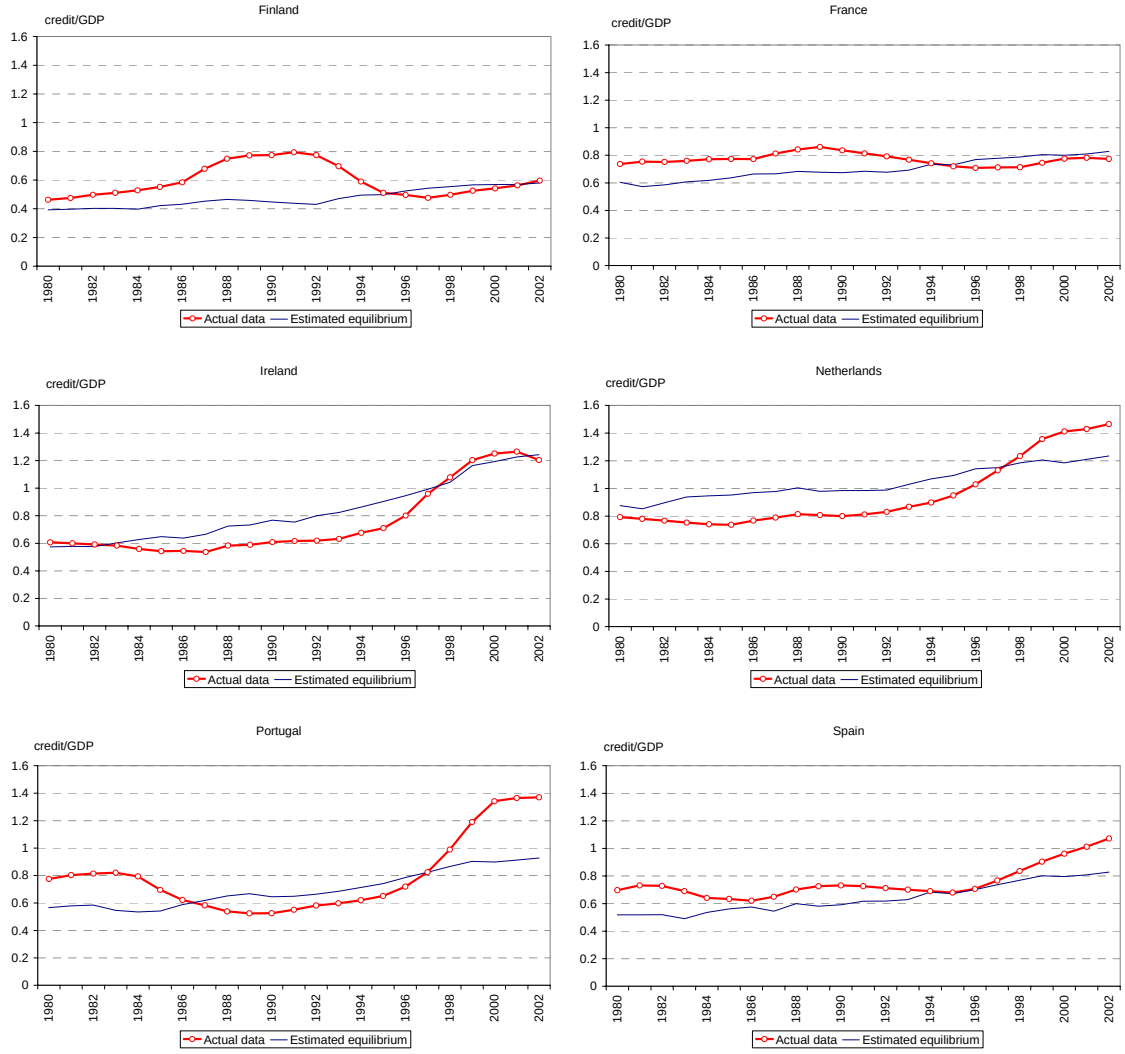
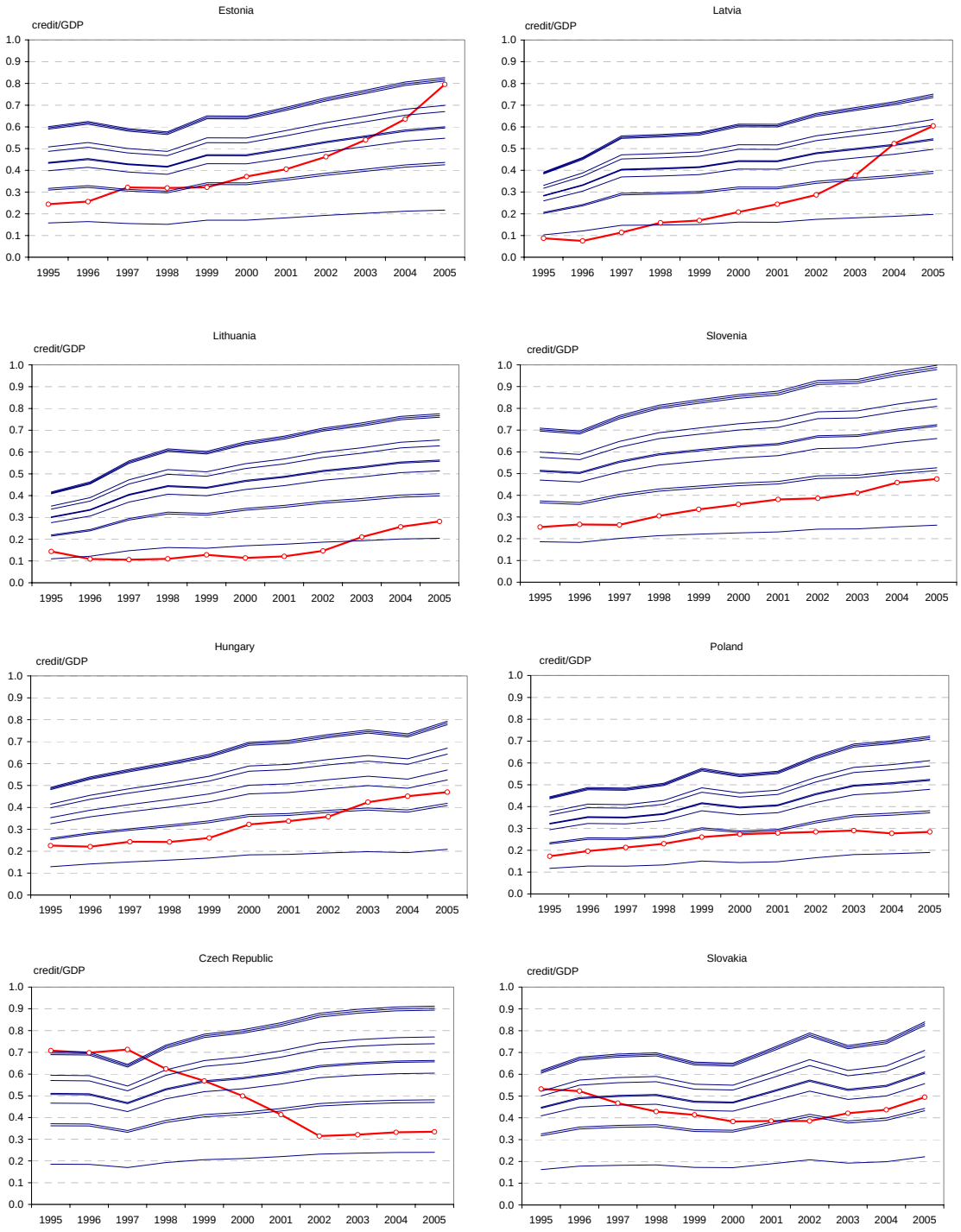
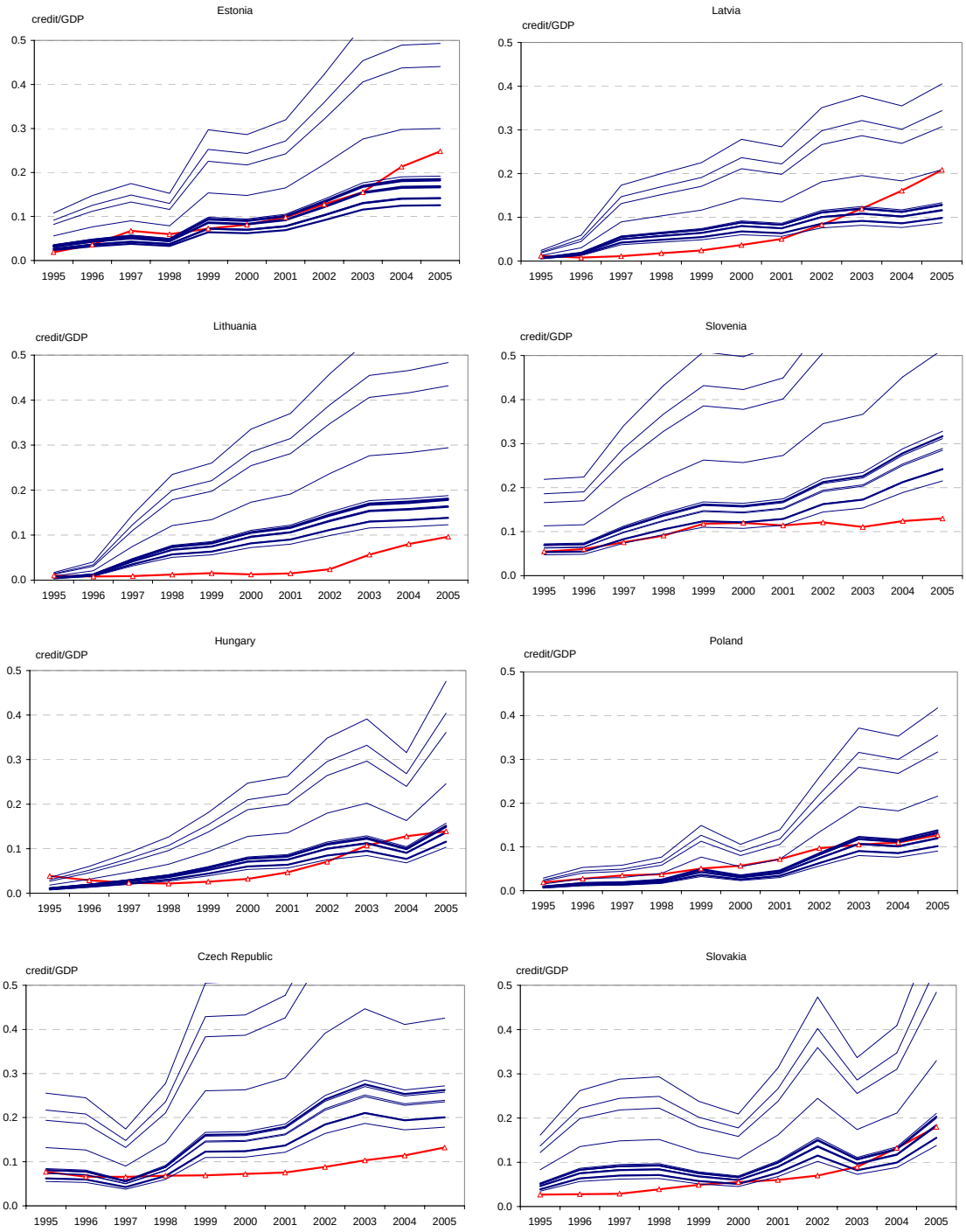


Chart 3. Out-of-sample estimations of equilibrium credit stock in new EU members



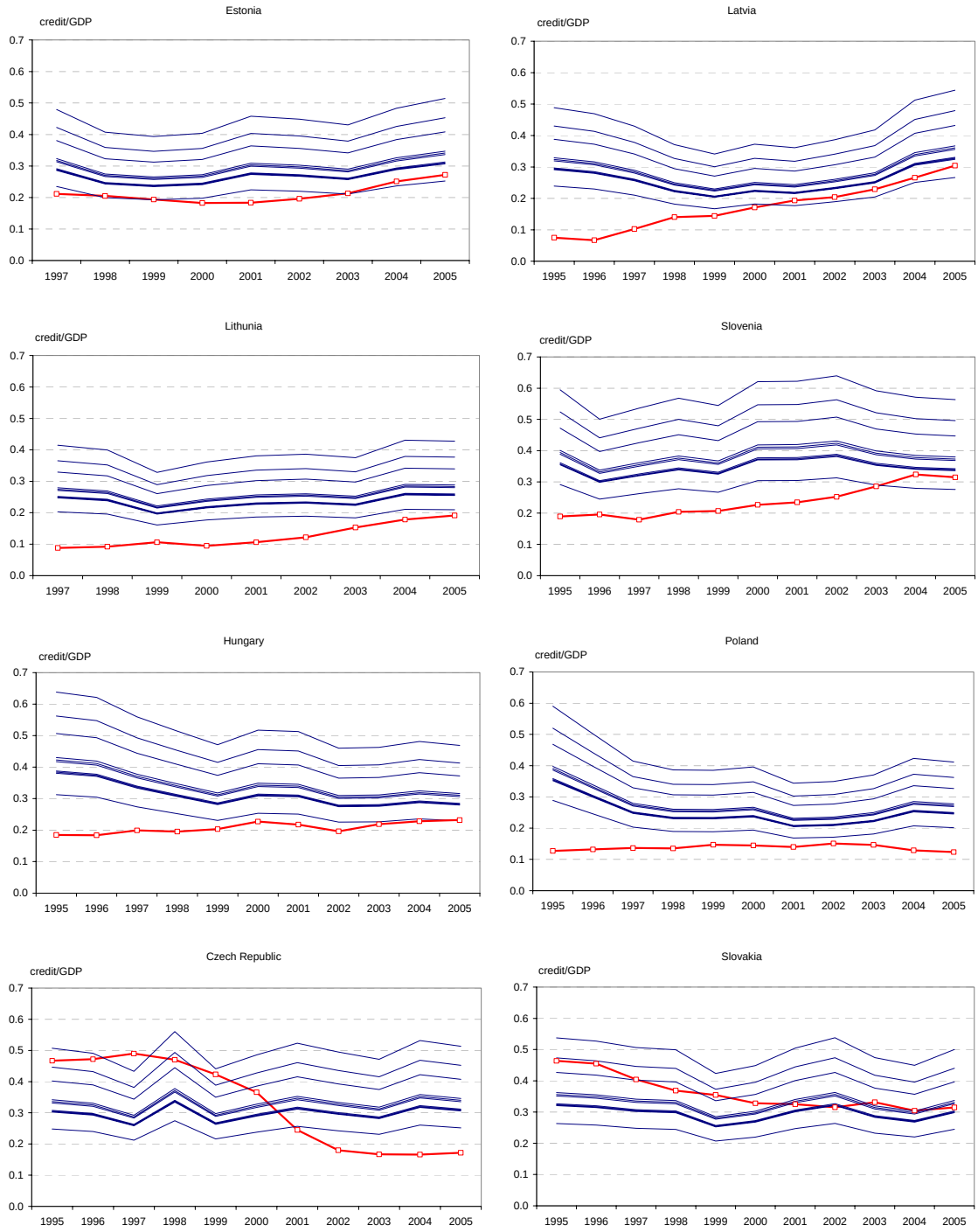
Thick line with marks indicates actual level, thin lines represent the range of estimated equilibriums with the different constants. The lowest equilibrium path is implied by imposing Greece's country effect. Estimates with Luxemburg's constant are omitted due to their extremely high value.

Chart 4. Out-of-sample estimations of equilibrium household credit



Thick line with marks indicates actual level, thin lines represent the range of estimated equilibriums with the different constants.

Chart 5. Out-of-sample estimation of equilibrium corporate credit



Thick line with marks indicates actual level, thin lines represent the range of estimated equilibriums with the different constants.