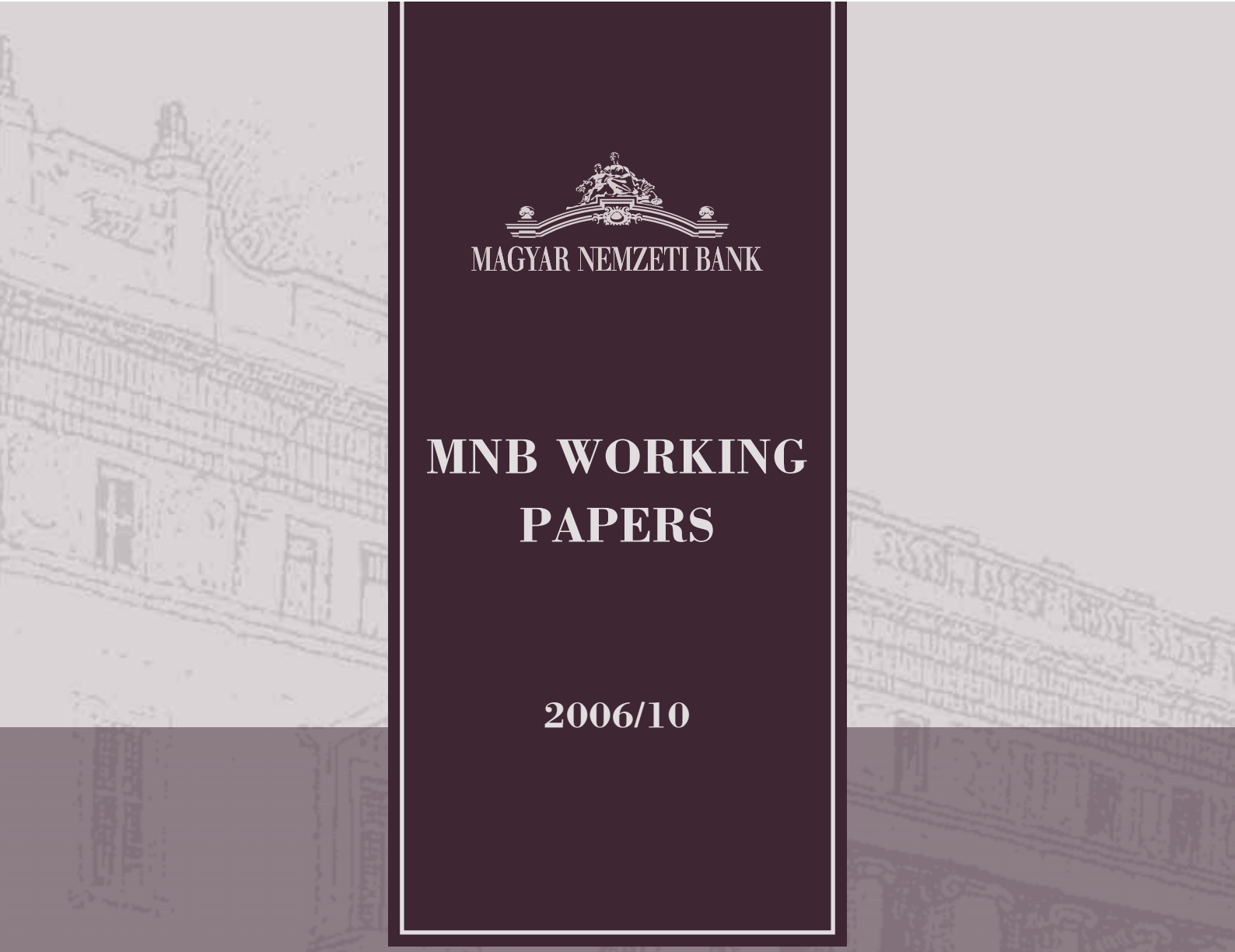

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GERGELY KISS–MÁRTON NAGY–BALÁZS VONNÁK

Credit Growth in Central and Eastern Europe: Convergence or Boom?

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Credit Growth in Central and Eastern Europe: Convergence or Boom?

(Hitelnövekedés Kelet-Közép-Európában: felzárkózás vagy hitelboom?)

Written by: Gergely Kiss*–Márton Nagy**–Balázs Vonnák***

Magyar Nemzeti Bank

Szabadság tér 8–9, H–1850 Budapest

http://www.mnb.hu

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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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Contents

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 Latvia and Estonia credit growth is found to be significantly faster than what would be justified along the equilibrium path.

JEL classification: E44, O16.
Keywords: financial deepening, credit growth, transition economies, panel econometrics, endogeneity bias.

Összefoglalás

A magánszektor hitelei az elmúlt években igen gyorsan nőttek számos új EU-tagországban. Alapvető kérdés, hogy e folyamat egyensúlyi felzárkózásnak, vagy inkább kockázatokat is hordozó túlzott hitelnövekedésnek tekinthető-e. A tanulmányban panel ökonometriai eszközökkel az egyensúlyi GDP-arányos hitelállományt próbáljuk megbecsülni, ennek keretében a megfigyelt dinamikát egyensúlyi trendre és túlzott növekedési (boom) komponensre bontjuk fel. Rugalmassága és hatékonysága okán a tanulmányban az összevont csoportátlag (pooled mean group estimator) becslést használtuk. Instrumentális becsléssel vizsgáltuk, hogy az endogenitás befolyásolja-e becsléseink konzisztenciáját. Az eredmények azt mutatják, hogy az új EU-tagországokban a hitelnövekedés jelentős része megmagyarázható a makrogazdasági fundamentumokkal. Általánosságban elmondható, hogy a régióban a hitel-GDP arány alacsonyabb, mint amit a fundamentumok indokolnának. Mindazonáltal Észtországban és Lettországban a hitelnövekedés szignifikánsan gyorsabb, mint ami az egyensúlyi pálya alapján adódna.

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.

Due to the lack of an appropriate structural model that could fully explain the equilibrium credit dynamics, one should turn to less theory-based approaches. Indeed, several recently published studies tried to identify equilibrium or trend growth of credit using econometric tools. Here we mention just a few examples. Calza et al. (2001 and 2003) estimated an error correction model (ECM) on aggregate eurozone data, identifying the equilibrium with the long run relationship. Schadler et al. (2004) used similar estimates for calculating new EU members trend growth out-of-sample. Brzoza-Brzezina (2005) estimated ECM for three CEE countries separately. In order to increase the number of observations, Cotarelli et al. (2003) used panel data of 24 developed and non-transition emerging countries. They estimated a static random effect model and derived trend dynamics of credit for transition countries out-of-sample. Backé et al. (2006) did various panel estimations on various groups of countries and the preferred model was imposed on CEE countries out-of-sample.

Our paper improves upon previous results in a number of aspects. First, we used panel of eurozone member countries' data to identify the structural relationship between credit and fundamentals. Second, we chose the error correction model to describe the dynamics of credit in an intuitive way. Third, we obtained long-run elasticities by applying the pooled mean group (PMG) estimator advocated in Pesaran, Shin and Smith (1999). The PMG is probably the most flexible and efficient estimator for dynamic panel models of a size like ours. Fourth, we calculated equilibrium credit for CEE countries out-of-sample in order to avoid transition bias. Fifth, since some of the explanatory variables seem to be determined simultaneously with the credit stock, concern of endogeneity bias emerges. We tested therefore whether possible endogeneity invalidates our results. And finally, we applied the same methodology to sectoral data (household and corporate sector) which gave deeper insight into the possible causes for rapid credit growth.

Our study shares several features with that of Backé et al. (2006). The two approaches are similar first of all in using panel data for estimation and calculating long-run relationship out-of-sample for CEE countries. There are, however, important differences as well. Whereas we use an error correction specification, Backé et al. (2005) draw their conclusion based on a static model. We prefer the first approach as it is more capable to capture long run relationship even if some countries in the sample were permanently above or below the equilibrium. We also go further in identification of possible sources of credit booms by analyzing sectoral data. Finally, we test for possible endogeneity bias which is a necessary, though omitted, step in the literature.

Following out-of-sample estimation approach we first estimate the long-run relationship between credit and the explanatory variables on the group of 12 eurozone member countries. Next we calculate what credit level the explanatory variables with the estimated parameters would justify in CEE countries. We then compare the actual credit dynamics with the estimated equilibrium. Our approach has the advantage that we eliminate the possible transition bias, which could emerge if too many transition economies were included in the sample. It has to be noted though, that the unexplained heterogeneity in credit stocks across eurozone countries amplifies the uncertainty of the equilibrium in CEE countries. We argue, however, that this uncertainty cannot be substantially reduced as it stems mainly from the lack of perfect benchmark for CEE countries, not from the weakness of our estimation strategy.

With the estimated ECM one can get an idea not only about the equilibrium level and its growth rate but also about the catching-up dynamics of credit. This information enables us to construct three alternative measures of credit boom by

comparing observed levels and dynamics to the estimated benchmarks. As our approach is rather an empirical one, we do not prefer any of these measures to the others, so we judge whether CEE countries are in credit boom by looking at all three indicators simultaneously. Nevertheless, by reporting the measures for each CEE countries, we give the reader the freedom to weight them differently and to arrive at a distinct conclusion.

The structure of the study is as follows: Section 2 provides the theoretical and empirical background of equilibrium level of credit. Section 3 describes the causes and consequences of credit boom as well as the empirical techniques of identifying credit booms. Section 4 presents the model framework, and Section 5 describes the econometric results with a consistency check. Section 6 applies the results for out-of-sample estimation for CEE countries, and finally Section 7 concludes.

2. Financial deepening and equilibrium credit growth

In this section we review some theoretical explanations of credit development, then overview the empirical literature, focusing on potential explanatory variables which can determine the equilibrium level of credit.

FINANCIAL INTERMEDIATION, ECONOMIC GROWTH AND CYCLES

At a theoretical level, credit growth can be separated into three components: trend (which reflects financial deepening), cycle and boom. The most appropriate starting point for the discussion of the trend of credit growth 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 (see for example Romer 1986), on the other hand, consider the interaction between economic agents and growth rate through their financial savings, which can be intermediated towards investment in form of 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. According to Gross (2001), 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. Within the context of growth models, the financial intermediation and economic growth are not only linked with each other through costs of re-channelling savings, but through the benefits of an effectively working financial sector (risk-sharing, maturity transformation, information allocation, etc.). Based on these theoretical arguments, a vast empirical literature has evolved starting with Goldsmith (1969), confirming the positive relationship between growth and financial intermediation. Regarding the causality, most papers find the link leading from financial development to economic growth (for surveys of relevant studies see Levine [1997] and Detragiache and Kenichi [2004]). In this paper we investigate one particular aspect of the nexus: the long-term effects of economic factors on the deepening of the financial intermediation, which is often captured by credit growth.

Following the discussion of the trend deepening we turn to the cyclical component. The theoretical models of the academic literature, explaining the cyclical component, can be divided into two major groups depending on whether their (pro-) cyclical nature derives from behaviour in the real economy or in the financial sector.

The financial accelerator models explain cyclical component through real business cycles with collateralized credit. Kiyotaki and Moore (1997) shows that temporary technology shocks can generate persistent fluctuations in output and credit due to the change in collateral value of secured debts and borrowers' credit limits. When economic conditions worsen and collateral values decrease, even borrowers with profitable projects find it difficult to obtain funding. When economic conditions improve and collateral values rise, these firms are able to gain access to external finance and this adds to the economic stimulus.

In contrast to this, behavioural models examine the responses of financial market participants to changes in risk linked to the economic cycles over time. (e.g. procyclicality of the banking sector). Borio et al. (2001) highlights that in an economic boom, the mis-measurement of risk can contribute to credit supply, to low lending spreads and to financial institutions holding relatively low capital and provisions. In recessions, when risk and loan defaults are assessed to be high, the reverse tends to be the case. This kind of procyclicality also interacts with the real economy in ways that can amplify economic fluctuations.

In our study, we focus on the estimation of fundamentally justified credit growth implied mainly by the deepening of financial intermediation, which we identify with the trend component of the credit growth. We also allow for some cyclical

movements and consider it to constitute the "equilibrium" path together with trend deepening. Our task is to find the empirically relevant and economically plausible explanatory variables of the equilibrium level of credit.

DETERMINANTS OF EQUILIBRIUM LEVEL OF CREDIT[1]

In this section, we explore the explanatory variables that were used for estimations of level of credit in previous empirical papers; our survey covers 9 papers (see the detailed list in the Appendix).

One of the most often used variables for credit equilibrium 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 demand, supply 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 demand, as with economic growth the capital intensity of production increases. From supply side economic growth is also expected to correlate positively with credit as the banks are more/less willing to lend in an economic upturn/downturn. 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. 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 5.

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 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.

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[1] By the term of equilibrium we mean only steady state, i.e. long-term equilibrium. In credit boom the credit market is also in equilibrium (demand equals to supply), but this state can not be considered long-lived.

[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 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.

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 et al. (2006) does not cover Central European transition countries and smaller EU members. Apart from liberalisation, Cottarelli et 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) and Backé et al. (2005) include *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 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. Credit boom

In this section, first the reasons and consequences of credit booms are presented, then empirical techniques for detecting credit booms are overviewed.

MAIN REASONS

The factors leading to the appearance of fundamentally unjustified credit booms can be divided according to whether they facilitate the "excessive" growth[4] of banks' supply of loans or the demand for loans by the private sector. On the supply side, deregulation accompanied by reduction in banks' reserve requirements and poorly regulated capital account liberalisation as well as the sharp increase of capital inflows due to external factors (e.g. low international interest rates) could lead to excessive credit expansion.[5]

From the perspective of banks' behaviour increasing competition among banks could also contribute to a credit boom. Intense competition causes the narrowing of margins and banks try to counterbalance this negative impact on profitability by increasing the volume of loans. This could lead to excessive credit expansion if sharper competition is coupled with a significant increase in banks' willingness to take risks.

An excessive growth in the private sector's credit demand can be caused by positive shocks (related to technology, etc.) if the output elasticity of credit demand is strongly pro-cyclical.

Excessively optimistic expectations relating to economic prospects could strengthen both credit demand and supply. According to the "new environment hypothesis" this could be due to the low inflation environment, see Issing (2003). On the one hand, the successful maintenance of price stability may strengthen financial stability through a number of channels (e.g. the more predictable return on investments), on the other hand it may also contribute to the appearance of overoptimistic economic expectations that could result in an increase in spending and growing indebtedness due to low interest rates.

In addition to the excessive optimism of economic agents, implicit or explicit government "bail-out" guarantees may also contribute to the appearance of credit booms (moral hazard). In the case of a number of emerging countries for example the formal or informal commitment to the exchange rates was considered as an implicit guarantee, which significantly encouraged indebtedness in foreign exchange.

POSSIBLE CONSEQUENCES

In what follows, 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[6] 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, 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

[4] We use the terms "excessive credit growth" and "credit boom" interchangeably.
[5] See Gourinchas et al. (2001) and Cottarelli et al. (2003) for more details.
[6] This can also be interpreted as an increase in non-tradable prices relative to tradable ones: an appreciation of the domestic real exchange rate.

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.

EMPIRICAL IDENTIFICATION

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 normal cyclical pattern) and a potentially risky credit boom (excessive growth of credit demand and/or supply). It is especially challenging in the case of transition economies, where credit ratios have grown from very low levels. The main problem is that relying solely on past observations of credit stock in catching-up countries can lead to misleading results as in these cases a low level of equilibrium is estimated and credit boom at the end of the sample is detected. Some methods cannot take into consideration the adjustment process through which a faster-than-average credit growth may be justified.

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-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-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-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.

4. Modelling framework

In this section we describe the variables, data and the estimation procedure.

VARIABLES

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 MFIs' 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. Following the best practice of the literature, we expressed credit as a ratio to nominal GDP.

Based on the choices in previous estimations and data availability, 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 2, 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 macroeconomic variables, characteristics of institutional framework (e.g. legal origin, creditor right, quality of law enforcement, accounting standards or degree of liberalisation, etc.) can also prove to be an important explanatory variable. To this end, we also experimented with additional possible indices in the estimations. It was however challenging to find indices that capture different dimensions of institutional system, are available for the countries and period in our sample and explain heterogeneity in the depth of financial intermediation above the differences already reflected in economic development (per capita GDP). To capture this effect we experimented with the overall economic freedom index of the Fraser Institute, which was available for all EU countries, from 1980. This index incorporates institutional effects (size of the government, legal system, property rights) macroeconomic characteristics (inflation rate, variability, openness to international trade) and more financial sector specific factors, like ownership and competition in the banking sector.

We also experimented with a few other variables to explain credit development. 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

As noted earlier, we relied on out-of-sample estimations, based on data from eurozone countries, rather than estimating directly on CEE data. The main motivation for applying out-of-sample estimation is the fact that in case of in-sample estimations the initial low level of financial intermediation in the CEE countries could lead to serious estimation biases. Estimating on eurozone members' data seemed a natural choice, as 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. However, using an even broader and less homogenous set of countries for out-of-sample estimation, omitted variables would expand the unexplained cross-country variance to an extent that out-of-sample application of the estimated relationship would produce highly insignificant results.

We compiled an aggregate yearly dataset of eurozone countries for the period 1980-2002. The source of most of the data is Eurostat; credit aggregates (MFIs' credit to the private sector) were kindly provided by the ECB. We consider estimation results on this dataset as the 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 financial accounts published by Eurostat.

For the CEE countries MFIs credit was used both at aggregate level and also at sectoral level, as financial accounts are not available in these countries for the period of 1995-2004. In this context it should be noted that direct lending from abroad is more frequent in the CEE countries than in the eurozone members, thus the actual level of indebtedness of private and corporate sectors, based on domestic data, might be underestimated. In case of household sector of some CEE countries the underestimation can be caused by the significant role of non-bank financial intermediaries, e.g. leasing companies in consumer lending.

ESTIMATION

We employed a two-step strategy, based on out-of-sample estimation. First, we used eurozone data for panel estimation, as discussed in detail in the followings, and in the second step we used the estimated long-run parameters for CEE countries.

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 results 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.[7] 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:

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

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

where c and $\bar{c}$ stand for the actual and equilibrium credit/GDP ratio, respectively, 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[8], 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 (trend) relationship between explanatory variables (included in the f vector) and the equilibrium level of credit/GDP, where β captures the common long-run dynamics.

It is important to highlight the role of the speed of adjustment parameter *(ϕ).* During the assessment of CEE credit dynamics we will treat it as a benchmark for normal pace of catching-up. However, this coefficient measures the average convergence speed within a narrow environment around the long run equilibrium. Since the transition dynamics involves a convergence from a level which is definitely far from long run equilibrium, the use of estimated speed of adjustment in eurozone countries is a simplification. However, we have no better guess for the maximum credit growth that is acceptable because of the catching-up.

The panel data models can follow either in-sample or out-of-sample approach. We applied out-of-sample exercise as in-sample approach may lead to biased estimates of the equilibrium level.[9] Out-of-sample estimation is based on a two-step procedure for estimation the equilibrium credit/GDP ratio for CEE countries. In the first-step the common parameters and country specific constants of equilibrium relation are estimated for eurozone countries. In the second step the equilibrium levels of credit/GDP for the eight CEE countries are then calculated on the basis of the estimated structural relationship. All in all, the out-of-sample approach assumes that the parameters of structural relationship are homogeneous in long run between the benchmark and the CEE countries.

[7] In contrast with this, Boissay et al. (2005) assume different long-run and common short-run relationships, which is in our opinion a more questionable approach.

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

[9] According to the in-sample approach the equilibrium levels are estimated for each country, taking into account the own characteristics of each individual economy. Thus, the cross-sectional heterogeneity and the initial low level of financial deepening in the transition countries can cause problem of a bias in the estimation of parameters and constant terms. For more on this issue see Maeso-Fernandez et al. (2004).

5. Results for eurozone countries

In what follows, we present the aggregate and sectoral results for eurozone member countries and review the related endogeneity bias test.

ESTIMATED LONG-TERM RELATIONSHIP

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 optimizing algorithms to find the maximum of the likelihood function.[10] In our final 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 the Fraser Institute's liberalization index, or openness, did not improve the results.[11] 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 Hausman-test, which indicated that the joint assumption of homogeneity of all variables cannot be rejected, with the associated p-value being 0.58.

Table 1

Coefficient estimates (t-statistics in parentheses)

	Coefficients
Per capita GDP (log)	0.51 (5.36)
Real interest rate	-1.88 (-4.33)
Inflation	-2.04 (-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 private sector 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, see Table 7.

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 private sector credit/GDP ratio in a number of countries, such as Spain, Portugal and Ireland. In other

[10] We used the Gauss code of PSS, which is freely downloadable.

[11] Although the original parameters remained robust, the additional variables were either insignificant (Fraser index) or had a counterintuitive sign (openness). The strong correlation between the Fraser liberalization index and other explanatory variables might explain why the liberalization index had little additional explanatory power in the model.

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.[12] One could easily find plausible justifications for reverse causality or simultaneity for the real interest rate, too. However, 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.[13]

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.

[12] Kovandzic et al. (2005) presents a detailed discussion of how these situations affect coefficient estimates and how to address them by GMM estimation.
[13] For reference studies on this issue see the introduction of Alesina et al. (2002).

SECTORAL BREAKDOWN

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

	Aggregate	Household	Corporate
Per capita GDP (log)	1.12 (18.32)	1.37 (6.47)	0.45 (5.5)
Real interest rate	-3.58 (-10.26)	-8.14 (-7.61)	-2.69 (-16.45)
Inflation	-1.59 (-5.84)	-11.18 (-6.81)	1.78 (6.68)
Joint Hausman test of homogeneity, p-values	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.

6. Detecting credit booms in Central and Eastern European countries

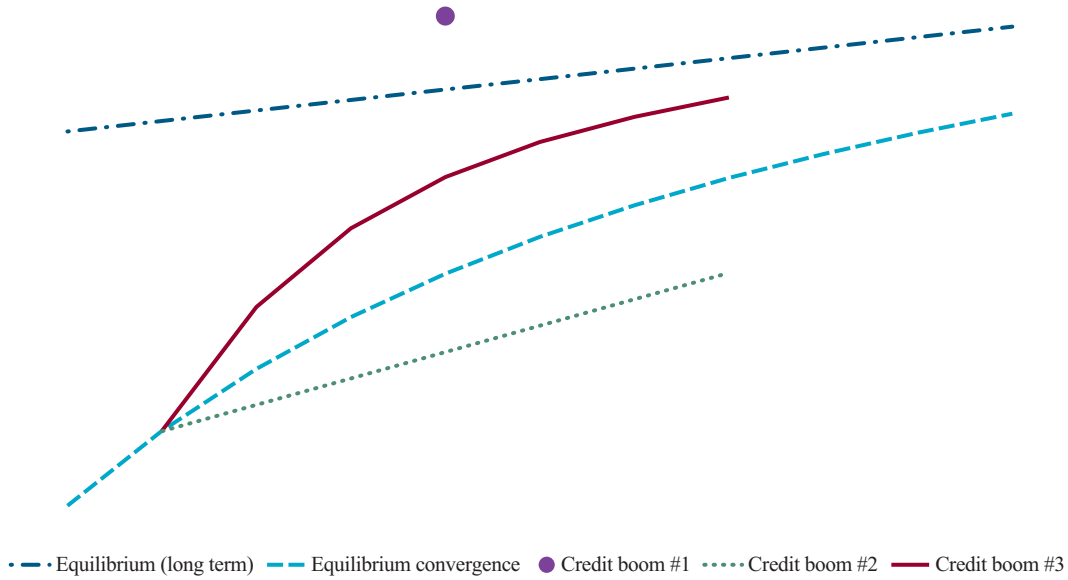
In this section, first we introduce alternative definitions of excessive credit growth, and then evaluate the risk of credit booms in Central Eastern European countries on aggregate as well as on sectoral levels.

EMPIRICAL DEFINITION OF CREDIT BOOM

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 speed of adjustment parameter. Note that type 3 credit boom implies type 2 whenever actual credit is below the equilibrium. If all three types of credit boom exist at the same time, there is a high risk of the presence of excessive credit expansion.

The third measure tries to take into account that when converging to the long-run equilibrium, some growth path can be regarded as short or medium term equilibrium even if it implies a growth rate higher than long-run equilibrium. It should be noted again that the use of the estimated speed of adjustment is not theoretically founded but we have no better benchmark for transition dynamics.

RISK OF HAVING AN EXCESSIVE CREDIT GROWTH

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[14], growth of credit and also a "normal" catching up dynamics for the 8 new EU members in Central Europe and the Baltics using the parameter estimation of eurozone panel (Table 1).

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) list 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. Later in this section we return to the possible institutional characteristics captured by the constant term.

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 estimates based on Luxemburg's country specific effect from the chart as it would imply extremely high equilibrium levels.

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. Because of the lack of unique out-of-sample results and motivated by the intention to avoid arbitrariness, we formulate our conclusions in form of probability statements. We assign low, medium or high probabilities to the risk that a certain country exhibited the symptoms of credit boom in 2004 and 2005. For the assessment of type 3 credit boom we used equilibrium based on Portugal's constant (highest) and the fastest adjustment parameter from the panel estimation.[15]

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.

[14] As noted earlier, for the CEE calculations domestic MFIs' balance sheet was used.
[15] Doing so we allow for rapid catching-up process.

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. In addition, if not only the domestic, but the stock of foreign loans (cross-border loans from foreign banks and trade credits) of private sector is also taken into account[16], signal of Type 1 credit boom would be much stronger for Latvia and Estonia. Furthermore, credit/GDP growth dynamics (Type 2 and 3) in Estonia and Latvia have recently been also 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 would get equilibrium estimates lower than actual data for CEE countries only if we considered Greece as a reference country.

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

Stylized facts 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 Slovakia 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". Moreover, the risk of having credit booms in Estonia and Hungary would increase further if not only the role of banks, but that of the non-bank financial intermediaries were also considered.[17] 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.

[16] As data for loans from abroad in the eurozone and CEE countries were available for 2004-2005 our judgement in case of type 1 credit boom can be extended by a simple static analysis. In this period the foreign loans of private sector to GDP averaged around 8% in the eurozone, compared to around 20% in Estonia, Latvia and Slovakia, 15% in Lithuania and Czech Republic, 10% in Poland and Hungary and approximately 3% in Slovenia. On the contrary, due to the lack of comparable time series for the whole period under investigation, private sector's foreign loans cannot be incorporated in the evaluation of type 2 and type 3 credit booms.

[17] In Estonia, Hungary, Czech Republic and Slovakia the ratio of household loans from non-bank financial intermediaries to total household loans amounted to 13%, 20%, 17% and 15% respectively in 2004.

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 ratios are 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. Furthermore, in the Czech Republic and Slovakia the restructuring 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. Finally, it should be highlighted that the risk of having credit boom based on the level of credit/GDP (Type 1 rule) would increase significantly in case of Latvia, Estonia and Slovakia if investigation incorporated not only the domestic, but also the stock of cross-boarder loans.[18]

COUNTRY-SPECIFIC CONSTANTS

As mentioned earlier an alternative method for out-of-sample estimation is to try to find some sort of economic interpretation of the constants, and based on this relationship try to narrow the range of the out-of-sample estimation. In order to try to find a more robust economic interpretation of the constant terms, the constants of the disaggregated dataset for households and the corporate sector were also considered.

We have experimented with a number of alternative indices that were not available for the whole time period under investigation, thus could not be incorporated in the model. We used an index that captures financial liberalization, the Heritage Fund's banking, financial sector sub-index, which was available form 1996. A further index at the aggregate level was the net interest margin (NIM), reflecting the level of competition and efficiency of the banking sector, see Holló and Nagy (2006) for more details. In these cases the average value of the indices of the eurozone countries for the 1980-2002 period were used. It is important to note that, as mentioned earlier, a similar liberalization index, the Fraser Institute's index did not turn out to be a significant explanatory variable in the panel estimation.

At the sectoral level the stock exchange capitalization was used for possible effect in the corporate sector as well developed equity markets may reduce the role of the banking sector in financial intermediation. Recognizing the dominant role of mortgage indebtedness in households' loan portfolio we experimented with mortgage related indices in case of households. Mercer Oliver Wyman (2004, MOW) compiled a mortgage market completeness indicator for selected EU countries, covering the structural features of mortgage lending, such as product range, average LTV ratios and early repayment fees. Unfortunately the MOW indicator is only available for six bigger eurozone countries, we used the share of mortgage debt to total household debt as a measure of mortgage market development.

The following table shows the correlation of the constants of the different estimations with the most promising indices.

Table 4

Correlation of the constant terms

	Financial indices		Sectoral indices	
	Net interest margin	Heritage fund	Stock capitalization	Mortgage weight
Aggregate	0.31	-0.25	-0.56	0.19
Household	0.46	0.03	-0.02	0.53
Corporate	0.38	0.28	-0.41	0.15

[18] We used the same ratios to the evaluation as in footnote 14 since the cross-boarder lending of private sector equals to that of the corporate sector.

As Table 4 shows, the results are far from being unambiguous. There is considerable correlation between net interest margin and the three groups of constants, while the Heritage Fund index showed little, or even counter-intuitive correlation. The cost of financial intermediation in the CEE banking sectors proxied by the net interest margins significantly exceeded that of the euro-zone in the previous years. Thus, taking into account the net interest margins' negative effects on the depth of financial intermediation the equilibrium credit/GDP in CEE countries seem to be rather in the lower part of the estimated range.

Looking at the sectoral indices both the stock capitalization and the mortgage weight lead to intuitive results. In case of the stock capitalization a negative correlation is expected, as higher ratio of stock financing in the economy corresponds to a lower dependence on bank financing. The results show that the correlation is significant in case of the corporate sector and at aggregate level, while there is no correlation with the households' constants. Results of the mortgage correlation complement the effect of the stock exchange, being significant for households. Based on the sectoral indices, the CEE countries are rather similar to countries like Portugal and Germany, where the stock exchange has a rather modest capitalization and mortgages have a predominant role. This simple exercise would imply that, based on the constant terms, CEE countries might have an equilibrium credit/GDP ratio in the upper half of the range.

Overall, we cannot draw firm conclusion from the investigation of the relationship between country-specific constants and alternative indices omitted from the model. The net interest margins in the CEE banking systems suggest higher, while stock capitalisation and mortgage weight indices presume lower risk of credit boom than estimated.

7. 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. Therefore, we constructed three different probability measures to assess whether credit dynamics in those countries can be deemed to be excessive.

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 can be 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 concept 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.

We investigated how other variables could decrease the unexplained cross-country variance of equilibrium credit level and how their inclusion would modify our judgement about risk of credit boom. We also assessed the consequence of ignoring direct foreign loans. We were unable to determine the net effect of possible distortions as these factors cause bias in opposite directions. The incorporation of these factors into the model can be a very fruitful area for future research.

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, as a whole, 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). 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 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.[19] 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 specifications. In the first, credit to GDP ratio, c was explained solely by per capita GDP *(y):*

$$c_j = \beta y_j + u_j , \tag{3}$$

where j is and index on the set of 124 countries, u is the unexplained heterogeneity. When we included nominal 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:

$$c_j = \beta y_j + \alpha_i i_j + \alpha_\pi \pi_j + u_j . \tag{4}$$

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

Since our country panel consists of developed economies, we also tested endogeneity on a subsample including the richest 44 countries where average per capita GDP between 1995 and 1998 exceeded 5650 USD at 1995 prices. Due to the small sample size, in this case we chose the simplest specification again (equation 3). Although a higher threshold for per capita GDP would have been more appropriate for our panel, dropping more 'poor' countries resulted in estimates that failed to pass the overidentification test.

We did not use all three instruments in all three 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 5 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 more developed countries.

Table 5

Cross-country estimates of the effect of development on credit

			1	2	3
OLS	GDP		0.64	0.59	0.83
		t-statistics	(10.4)	(9.1)	(4.6)
	NIR			-0.89	
		t-statistics		(-1.4)	
	CPI			-0.38	
		t-statistics		(-1.6)	
		Number of observations	124	91	44
		R^2	0.47	0.56	0.33
GMM	GDP		0.64	0.49	1.06
		t-statistics	(6.5)	(5.6)	(4.4)
		R^2	0.47	0.55	0.30
Instruments	ethnic		+	+	+
	linguistic		+	+	+
	religion				+
Tests		Overidentification-test p-value	0.97	0.74	0.48
		1st stage partial R^2	0.35	0.48	0.31
		Hausman-test p-value	*0.99*	*0.17*	*0.75*

The first block contains the main statistics of the OLS regression. The coefficient of GDP is around 0.6 in the first two cases with very low standard errors. This result is comparable to our dynamic estimates on large sample, starting in 1980. In the small sample the coefficient is somewhat higher. 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 their almost zero coefficients suggest the absence of endogeneity bias in each case.

Appendix 2: Tables and Graphs

Table 6

Literature survey

Authors, title	Target group	Methodology	Type of approach	Variables
Backé et al. (ECB) 2006: "Credit Growth in Central and Eastern Europe..."	11 Central and Eastern European countries	Pooled and fixed effect OLS, DOLS, MGE	out-of-sample	Private Credit/GDP: PPP-based GDP, government credit, short and long nominal interest rate, inflation, house prices, liberalisation index, credit registries
Boissay et al. (ECB) 2005: "Is Lending in Central and Eastern Europe developing too fast?"	11 Central and Eastern European countries	ECM for individual countries and panel estimation	in-sample	Private, household, corporate (in domestic and foreign currency) credit/GDP: Real interest rate, real yearly GDP, time trend
Brzoza-Brzezina (ECB) 2005: "Lending booms in the new EU Member States: will euro adoption matter?"	POR, IRL, GRE, HUN, CZE, POL	ECM for individual countries	in-sample	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	ECM on aggregate eurozone data	in-sample	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	ECM on aggregate eurozone data	in-sample	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 sector…"	15 Central European and Balkan countries, out of sample estimation	Random effect panel estimation of 24 developed and non-transition emerging countries	out-of-sample	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	in-sample	Private credit/GDP: links with trade balance
Hofmann (BIS) 2001: "The determinants of private credit in industrialised countries..."	16 developed countries	ECM for individual countries	in-sample	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	ECM, on aggregate eurozone data	out-of-sample	Private Credit/GDP: PPP-based GDP, long real interest rate

Table 7

Estimated speed of adjustment for eurozone countries

	Speed of adjustment	Half life* (in years)
Austria	-0.24	2.6
Belgium	-0.3	1.9
Finland	-0.1	6.4
France	-0.07	10.2
Germany	-0.08	8.2
Greece	-0.07	10.3
Ireland	-0.21	2.9
Italy	-0.33	1.7
Luxemburg	-0.002	346.2
The Netherlands	-0.06	11
Portugal	-0.11	6.2
Spain	-0.19	3.3

**Number of years after which the distance from equilibrium would halve in the absence of shocks and lagged effects.*

Chart 2

Estimation results for selected eurozone members

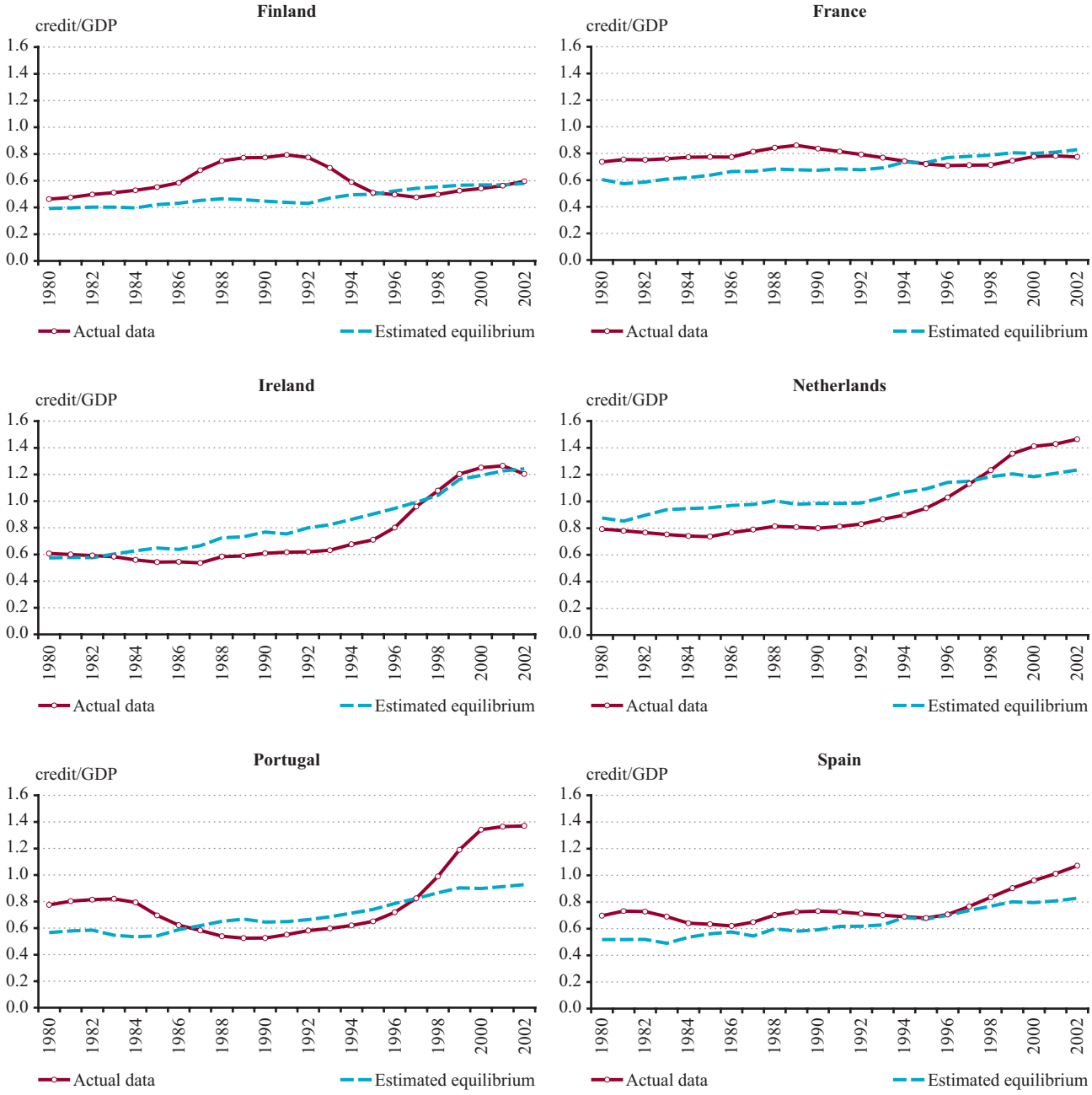
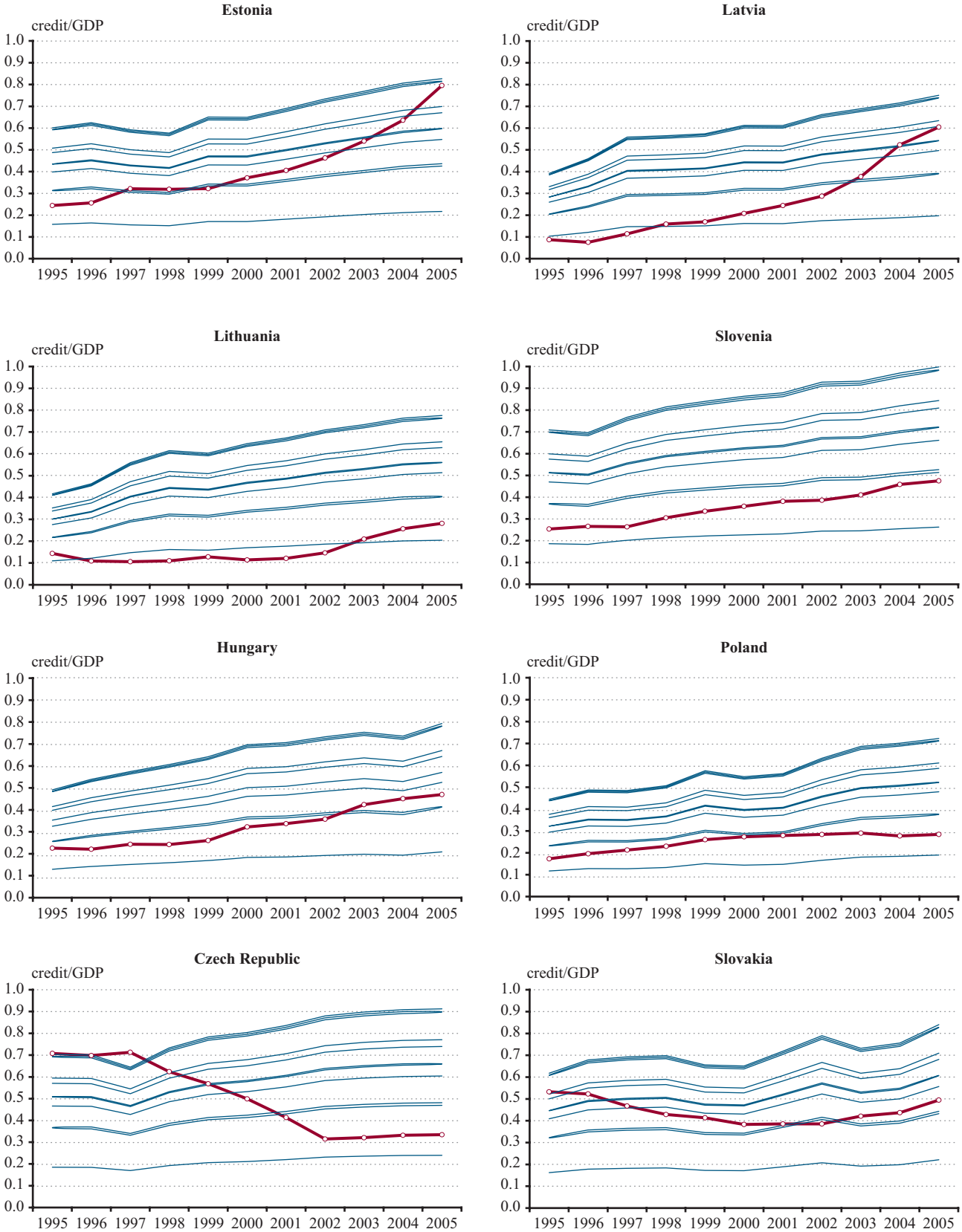


Chart 3

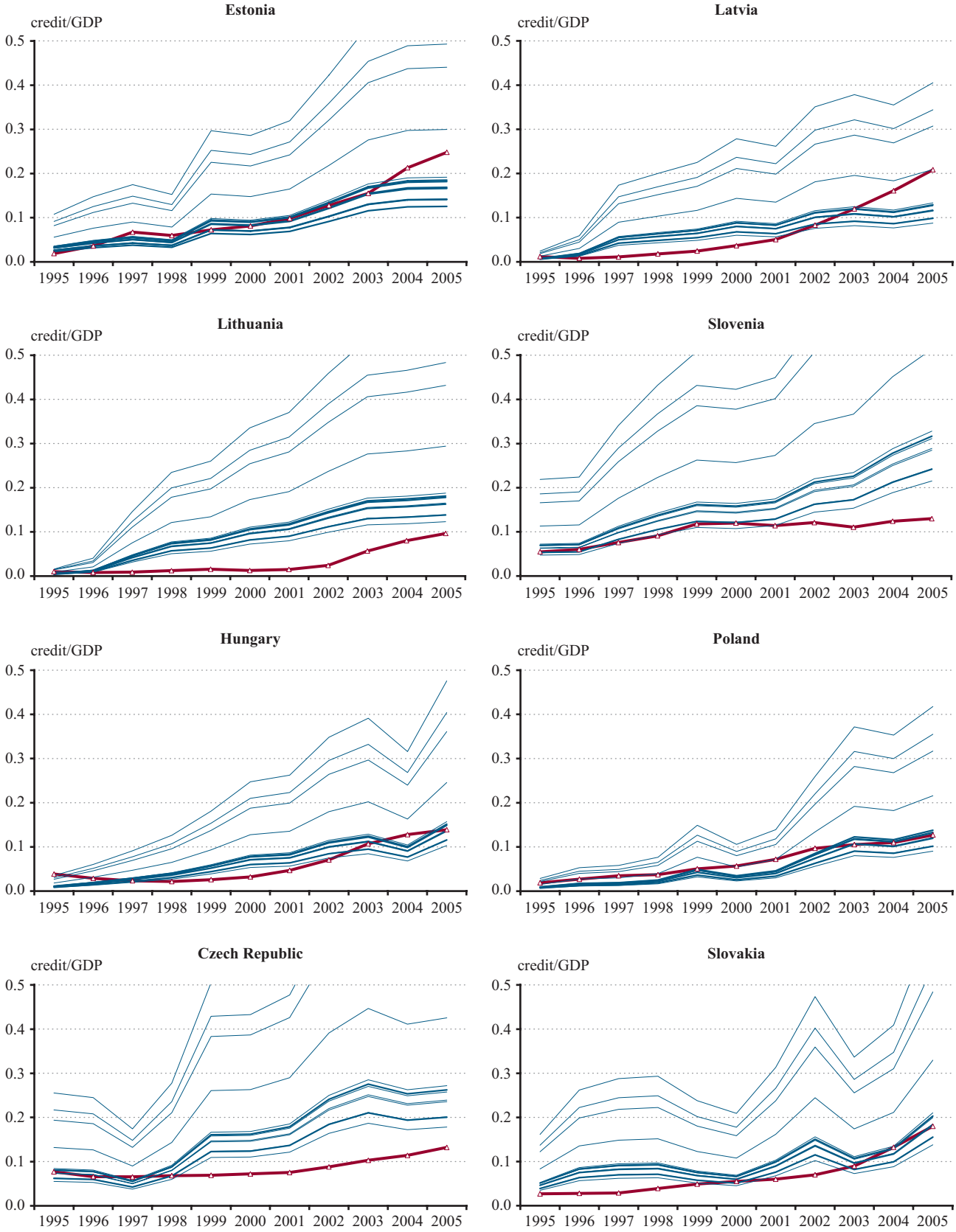
Out-of-sample estimations of equilibrium private sector credit in new EU countries



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

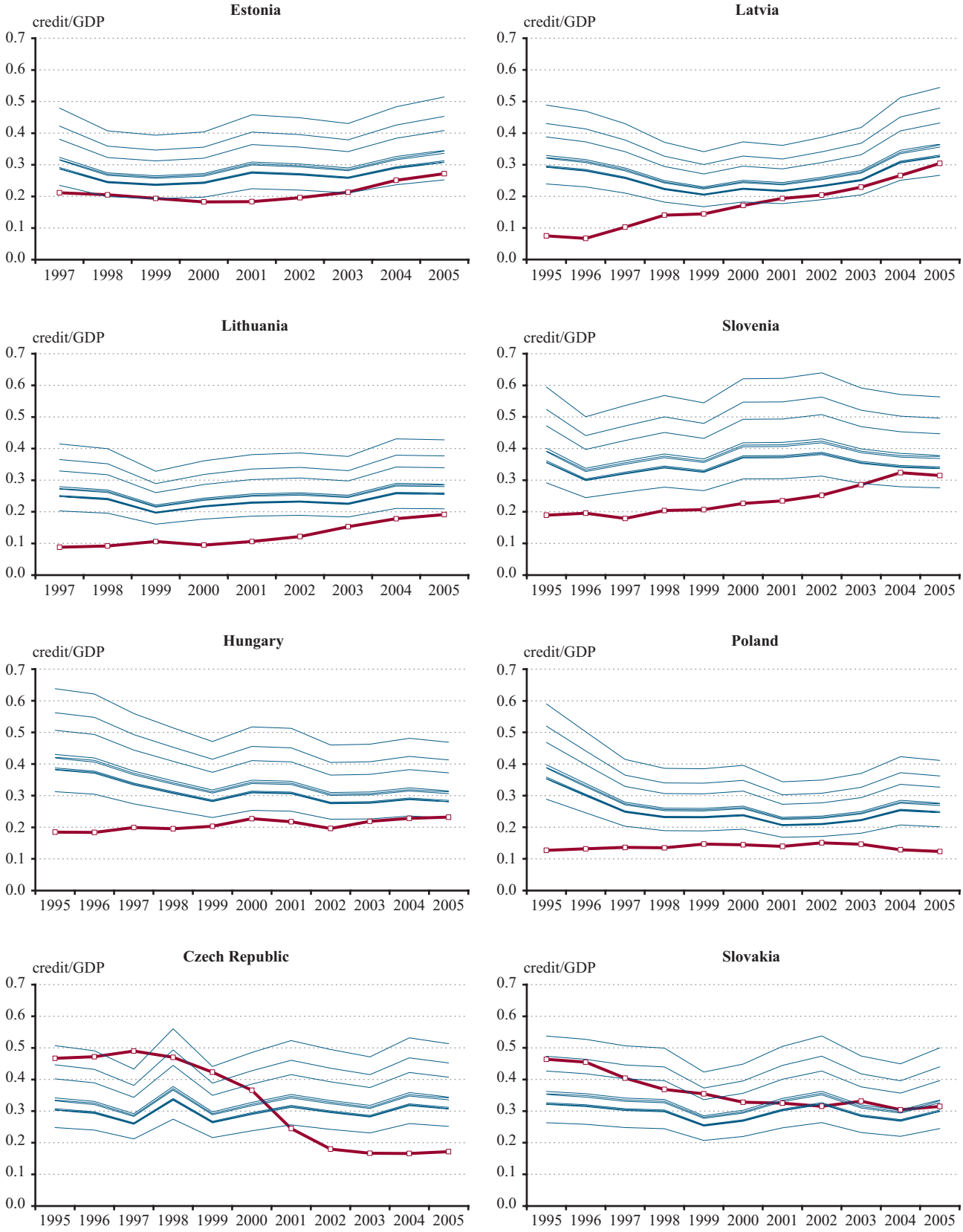
Out-of-sample estimations of equilibrium household credit in new EU countries



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

Chart 5

Out-of-sample estimation of equilibrium corporate credit in new EU countries



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

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