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Estimating Credit Demand in Croatia

Draft version

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1. Introduction[1]

Literature about demand for loans is relatively scarce compared to the demand for money studies. It was monetary aggregates rather than credits that have traditionally been the intermediate target of monetary policy through which the central banks tried to achieve the price stability. Recently, research on loans demand has gained momentum, as some studies suggested that development of loans contained useful information about risks for future price stability historically reserved for monetary aggregates[2]. Besides that, the recent "credit boom" in the Central and Eastern Europe and EU new member states (CEE and NMS) in the past few years prompted research on causes of credit growth as well as on macroeconomic consequences and policy options. It has been shown that credit fuels consumption and import demand, contributes to the widening of the current account deficit and to the increase of foreign debt via bank borrowing abroad[3]. Rapid credit growth also has implications on financial stability, and a large body of literature linked credit overexpansion and banking crises. All of these issues have been relevant for Croatia and motivated us to gain deeper insight in the main driving forces behind the credit demand.

It is generally difficult to distinguish between demand and supply factors when estimating behavioral relationship of credit aggregates. Supply effects have traditionally played more prominent role in recent credit booms in the CEE and NMS, and therefore, literature on "credit booms" and "lending channel" has predominantly been focusing on the supply side factors. The banking sectors in transition region in the 1990's have experienced remarkable changes in institutional environment and in banks' ownership, which was particularly evident in the CEE and the Baltic states. Financial deepening, increase in competition among banks, foreign banks entry and other supply side factors were the main drivers of loan growth as well as of declining interest rates. As a result of these changes, by 2000 the banks in the region have reached a relatively advanced level of development.

Since 2000, as supply factors influencing credit developments have become more stable, the role of the demand factors has gained greater importance. Stronger GDP growth has led to an increase in demand for loans via income effect, as increased income can sustain higher loans repayments, and via wealth effect, as higher valued collateral can be offered to secure higher loan repayment. In addition, improving overall economic conditions, growing optimism by consumers and enterprises and sharp decline of interest rates have also strongly contributed to most recent acceleration of credit growth. Therefore, although credit demand offers only partial explanation of credit developments and hinges on the assumption on the limited supply effects, an expanding strand of recent credit literature focuses on the demand factors alone. In light of this, the main objective of our study was to investigate the demand side of credit developments in Croatia.

More specifically, we wanted to take a closer look at the following questions:

- how do demand determinants explain the credit growth in Croatia;
- was credit growth, as explained by our model, excessive during the past 10 years and
- does recent boom in property prices help explain credit demand in Croatia.

[1] We are indebted to Evan Kraft for his invaluable comments. We would also like to thank Maroje Lang, Davor Kunovac, Ivo Krznar and Ana Maria Čeh.

[2] Nicoletti-Altimari (2001), Calza et al. (2003)

[3] IMF (2004), Hilbers et al. (2005), Duenwald et al.(2005), Kraft and Jankov (2005), Kraft (2006)

We look separately at demand for total loans to the private sector and to the households. In the model on demand for total loans, we use real GDP and interest rates. These variables are common explanatory variables in the literature, although no standard model is widely used. For loans to households we include consumption and wages, as well as interest rates on household loans. While credit growth in Croatia has been studied previously, mostly through panel data, important information on property prices was unavailable. We contribute to this literature by incorporating the newly constructed index on property prices.

Our estimation shows that the behavior of loans can be explained mainly by the developments of GDP (consumption for household loans) and real interest rates, while other explanatory variables did not prove to be significant determinants of the credit demand.

The paper is organized as follows. Firstly, we survey recent literature on credit growth determinants. Secondly, we overview credit developments in Croatia, focusing on the most recent credit surge and how it differs from the previous "lending booms". Thirdly, we proceed with estimating the demand function, having briefly established some descriptive statistical properties of the series. Fourthly, we try to refine the estimates by breaking down loans by sectors introducing sector specific demand factors. Finally, the last section draws some concluding remarks.

2. Literature review

Majority of the existing literature focused on modelling credit demand on aggregate level, mainly due to data unavailability for cross-country analyses on more disaggregated levels (i.e. sector or currency breakdowns). In the models, most studies employ a simple set of explanatory variables, which usually include GDP per capita or real GDP, some kind of (real or nominal) interest rate and the inflation rate (Calza et al., 2001, 2003; Brzoza-Brzezina, 2005; Boissay, Calvo-Gonzalez and Koźluk, 2006 and Kiss, Nagy and Vonnák, 2006).[4]

Calza et el. (2001) estimated credit demand on aggregate level in the euro area. As explanatory variables, they used real GDP and real weighted short-term and long-term interest rates, and found long-run relationship between loans to the private sector and interest rates and GDP. In the follow-up study, Calza et al. (2003) included a new measure of the cost of loans, obtained as a weighted average of bank lending rates, and extracted information content of the loan overhang/shortfall on the future inflation, concluding that loans disequilibria helps predict future changes in inflation. Similar analyses on aggregate credit demand have been conducted in De Nederlandsche Bank (2000) for several EU countries, Japan and USA and in Vega (1989) for Spain. Hofmann (2001) developed a similar model, although improved by adding property prices as additional explanatory variable, following the fact that a rise in housing prices is usually accompanied by an increase in credit to the private sector. Based on a cointegrating VAR analysis, Hofmann identified long-run relationship linking real credit positively to real GDP and real property prices, and negatively to real interest rate.

Schadler et al. (2004) estimated a vector error correction model (VECM) on quarterly euro area data for 1991-2002. The VECM of the demand for credit includes three variables: the credit-to-GDP ratio, a proxy for the cost of credit (long-run real interest rate on government bonds) and per capita income.

Several existing empirical studies on demand for credit were aimed at estimating demand for loans on a more disaggregated level, i.e. by institutional sectors. Fase et al. (1992) and Manrique and Sáez (1998) analyzed credit demand of households by including more precise measures of costs of loans, such as bank interest rates on mortgage credit and interest rates on credit for consumption, as well as by including other variables, such as property prices. Jeanfils (2000) reports equations for mortgage loans and consumer credit in the Banque National de Belgique's quarterly model of the domestic economy.

In studies of demand for loans to enterprises, some empirical analyses included additional explanatory variables, such as profitability measures (Focarelli and Rossi, 1998), inventory stocks (De Nederlandsche Bank, 2000), specific interest rates on loans to enterprises (De Bandt and Jacquinot, 1992) and ratios of wages to value added (Odonnat et el., 1997).

Several studies based on aggregate data have searched for empirical evidence for the bank lending channel of monetary policy, taking into account both demand and supply side of credit developments. For instance, Hülsewig et al. (2001) investigated the relevance of bank lending channel in the transmission of monetary policy in Germany on basis of aggregate bank loan data. With a VECM analysis, they identified long-term cointegration vectors, which can be interpreted as supply and demand relationships in the loan market. On the demand

[4] Table with review of studies analyzing determinants of credit growth is enclosed at the end.

side, explanatory variables were real GDP and yield on bonds outstanding issued by domestic residents, while on the supply side Hülsewig et al. used banks' equity position, again yield on bonds outstanding issued by domestic residents and short-term money market rate.

Panagopoulos and Spiliotis (1998) also combined both supply and demand equations in modelling credits to enterprises for Greece. In their analysis they used a wide range of additional variables: wages bill (as measure of companies' working capital needs), costs of raw materials, corporate tax payments, stock exchange price index, upper limit interest rates, interest rates on 3-month T-bills, inflation, banks' deposits invested in T-bills, banks' reserves and some credit quality factors (maturity, repayments etc.). The results of their study showed strong impact of wage bill to corporate demand for credits as well as of lagged credits on current credits. However, interest rates proved to be insignificant due to strong interest rate control imposed by the authorities in Greece during the analyzed period.

Several studies attempted to calculate equilibrium credit-to-GDP ratio, where they estimated relationships between credit-to-GDP ratio and variables determining both supply and demand for loans. Cottarelli et al. (2003) used a set of variables to define a model of equilibrium credit-to-GDP ratio: public debt-to-GDP ratio (as an indicator of the level of crowding out), per capita GDP (as an indicator of overall economic development of a country), inflation, indices of financial liberalization, bank entry requirements and quality of accounting standards. From comparing the actual and theoretical values of credit-to-GDP in Central European countries, the authors concluded that loan markets are still substantially undersized. However, the data series did not include recent strong credit developments in most of the CEE countries.

The study by Kiss, Nagy and Vonnák (2006) estimated a dynamic panel (Pooled Mean Group Estimator) model including GDP per capita, real interest rate and inflation of 11 euro area countries (excluding Luxembourg) to generate out-of-sample estimates for private sector credit-to-GDP ratios of the three Baltic countries and 5 CEE countries (Czech Republic, Hungary, Poland, Slovakia and Slovenia). They found that only Estonia and Latvia may have recently come close to equilibrium, while the other countries still have credit-to-GDP ratios below the estimated equilibrium levels.

Égert et al. (2006) also analyzed the equilibrium level of private credit-to-GDP ratio in 11 CEE countries (including Croatia), expanding the list of explanatory variables (adding spread between lending and deposit rates, credit registries, government credit, house prices). Regarding (over)shooting the equilibrium credit growth, their results show that Croatia is the only country which might have reached the equilibrium credit-to-GDP ratio by 2004, with five analyzed countries close to equilibrium (Bulgaria, Estonia, Hungary, Latvia and Slovenia) and others still on the undershooting side in 2004.

Similar approach was taken by Boissay et al. (2005), who looked for credit growth in "excess" of that warranted by the fundamentals. Credit growth was modelled as a function of macroeconomic fundamentals and a gap between the actual credit-to-GDP ratio and an equilibrium level. The model derived short-run credit elasticities with regards to explanatory variables as well as estimates of expected credit growth. Equations for both aggregate credit demand and aggregate credit supply were estimated, with the explanatory variables being real GDP, real interbank rate, real retail lending rate, and *z* (linear and quadratic trend) that captured the effects of financial liberalization on credit supply. While GDP and interest rates are the main standard determinants of aggregate credit, the *z* factor is specific to transition

economies. Their results indicate excessive credit growth in the three Baltic States and in Bulgaria and to a lesser extent also in Hungary and Croatia (Croatia experienced average quarterly excessive credit growth over the period 2001-2004 of 2.9%, ranking Croatia second to the last, Slovenia being last with only 0.3% excessive growth, Bulgaria first with 7.8% and the Baltic countries and Hungary somewhere in between).

In studies that cover credit growth and banking sector in Croatia, Kraft and Jankov (2005) examined the origins of first two lending booms, assessed their consequences, and discussed policy responses. They found that rapid loan growth increased the probability of credit quality deterioration and stimulated current account and foreign debt problems. Following their conclusions and in light of recently continued substantial credit growth in Croatia, Kraft (2006) conducted a more detailed analysis of the causes and implications of household lending in Croatia. Besides analyzing the consequences of a household credit growth in Croatia, in his study Kraft estimated a cross-country model of household lending by using 90 countries data. His results showed strong positive relationship between GDP per capita and household credits and negative relationship between inflation and household credits. Corruption and transition indicators also proved to have significant impact on the level of household credits. Examination of residuals from the estimated cross-country model showed that Croatia seems to be an outlier, however, when structural reforms were taken into account, Croatia's household lending is no longer exceptional.

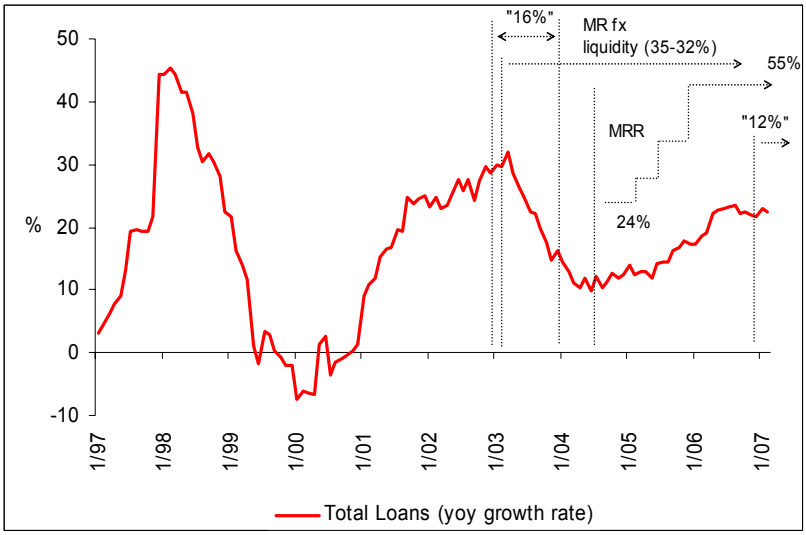
Lang and Krznar (2004) in their model of bank lending channel of transmission mechanism in Croatia focused more on credit supply factors, namely monetary policy changes, specific bank characteristic (size, liquidity, capitalization and ownership) and the interaction between monetary policy and banks' characteristics (the demand side is partially covered by including GDP into the model). Although the results of their estimations have not shown strong evidence of the bank lending channel in Croatia, they show that economic activity (GDP) has a positive and statistically significant influence on banks' credit policy, indicating that credit demand is one of the essential factors of credit policies.

Šonje (2006) estimated long-term equations for demand for loans to households and for housing loans in Croatia, using weighted average interest rates, average net wages as determinants of income and wealth index as proxy of consumer wealth. Results from seven estimated equations show that wealth effect on both households and housing credits seems to be robust, with long-run elasticities between 1.10 and 1.51 for household loans and 1.16 and 2.19 for housing loans, while long-run interest rate elasticity of demand for credit was estimated around -1.

3. Stylized facts about loans developments

The developments on the Croatian loan market in the last decade can roughly be divided in three phases (for a complete discussion on banking sector and lending booms in Croatia see Kraft and Jankov (2005)).

Figure 1: Total Banks' Loans



1. 16%: CNB measure penalizing quarterly loans growth above 4%.
2. MR fx liquidity: minimally required liquid assets in foreign currency held against fx liabilities.
3. MRR: marginal reserve requirement, reserve requirement levied on increase in foreign liabilities.
4. 12%: CNB measure penalizing loans growth in 2007 above 12%.

Source: CNB

The first lending boom started early in 1996, reaching its maximum in February 1998, with annual credit growth rate of 45.4%. Rehabilitation of the three regional banks in September 1996 brought interbank interest rates down from 30% to only 9%. GDP growth recovered to 5.9% 1996 and 6.8% in 1997.

Although credits to households were achieving substantially higher growth rates compared to credits to private enterprises, the main generator of credit expansion in absolute terms was the sector of enterprises. It was the low creditworthiness of these enterprises, many of which were connected with the banks, that triggered the banking crisis that followed the first lending boom.

Table 1. Main Macroeconomic Indicators in Croatia

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Loans to the private sector growth, %	3.1	44.4	22.4	-7.5	9.0	23.1	30.0	14.6	14.0	17.2	22.9
Inflation, retail prices, %	3.4	3.8	6.0	3.9	5.5	2.4	1.8	1.7	2.7	3.6	2.0
Real GDP growth, %	5.9	6.8	2.5	-0.9	2.9	4.4	5.6	5.3	3.8	4.3	4.8
Current account, % of GDP	-4.8	-12.3	-6.8	-7.0	-2.4	-3.7	-8.6	-7.1	-4.9	-6.4	-7.6
Foreign debt, % of GDP	27.0	38.0	47.6	54.1	60.6	60.7	61.5	75.5	80.2	82.5	84.7

Sources: CNB and Central Bureau of Statistics

During the crisis, which started in 1998 and peaked in the first quarter of 1999, some 16 banks representing 16.2% of total banking assets failed (two of them were subsequently rehabilitated). The banking crisis, along with other structural and political problems, led to economic recession. The GDP fell by 0.9% in 1999 and unemployment grew. Loans to the

private sector started to fall in the first half of 1999 and reached the bottom in December at 7.5% lower level compared to end of 1998.

In late 1999 and early 2000 Croatian banking sector entered a new phase becoming in majority foreign own. Foreign banks in Croatia, as in other CEE countries, brought further lowering of interest rates, stronger competition and improved governance. They also brought strong capital inflows leading not only to the significant lending pick-up, but the increase in foreign debt. The economy emerged from the recession and resumed economic growth.

The recovery of lending started in the second half of 2000. By mid-2001 total loans reached annual growth of near 20%, what can be characterized as the beginning of the second lending boom, accelerating up to 30.0% at the end of the year. Declining interest rates on one side and GDP growth on the other fuelled by the strong growth of personal consumption and net exports and contributed to the increase of credit demand.

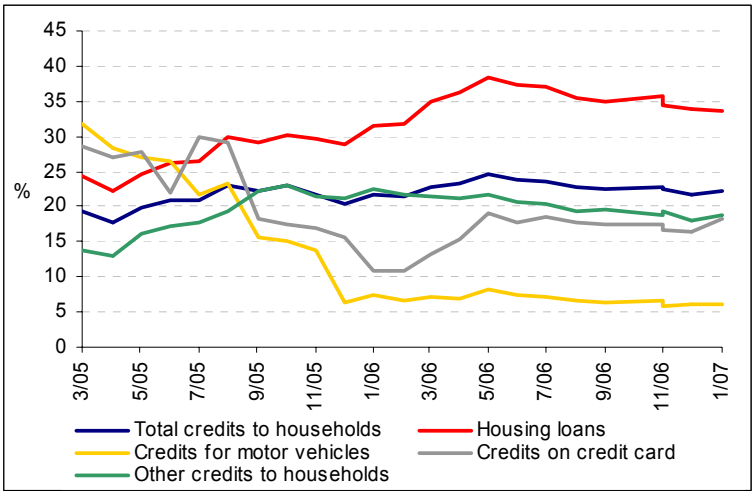
The analysis of the structure of the second credit boom reveals that household lending again expanded considerably faster than corporate lending[5] (household loans in 2002 rose by 43.0%, whereas corporate loans rose by 20.6%). Consumer loans still represented by far the largest share of household lending, but housing loans have been gradually increasing - from 19.5% of total household lending in 2000 to 38.0% in 2003.

In order to slow down growth of domestic credits and foreign borrowing, at the beginning of 2003 the Croatian National Bank introduced two new monetary measures. One of the measures imposed financial penalties for the banks if their domestic credit growth exceeds 16% in the entire 2003, allowing a three-month growth dynamics of 4% (Figure 1, note 1: "16%"). The effects of "the 16% rule" were seen quickly, as most banks reduced their loan growth to stay under the 4%-per-quarter level. Overall, the annual growth rate of bank lending fell from 30.0% at end-2002 to 14.6% at end-2003. The other decision prescribed a requirement for banks to maintain, on a daily basis, foreign exchange claims at a minimum level of 35% relative to their foreign exchange sources of funds (Figure 1, note 2: "MR fx liquidity"). Minimum required fx liquidity decreased to 32% from February 2005.

However, growing activity by leasing companies, formed as independent entities owned by domestic banks or foreign parent banks, made it possible for banks to circumvent this measure. Additionally, some banks directed customers to their foreign owners, thereby increasing foreign borrowing. When leasing and foreign borrowing are taken into consideration, the growth in total credit made available to the economy was much less constrained. The "narrow" measure of lending (loan growth taken from the MFI statistics) underestimates the total growth of private sector indebtedness, although enterprises are more likely to borrow from abroad then households.

[5] However, the experience of credit booms in other countries has shown that high rates of credit growth in the household sector commonly precede a likewise evolution in credit to enterprises by one year (Ko, 2006).

Figure 2: Household credits growth, annual growth rate, %

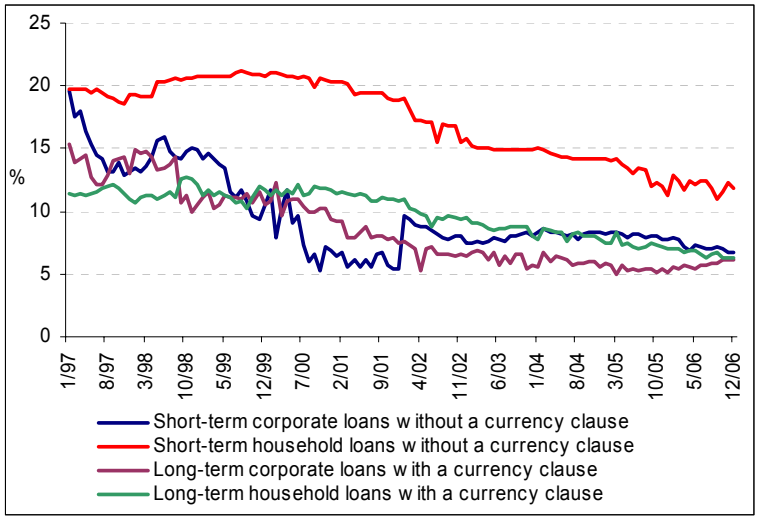


Source: CNB

One of the increasingly important macroeconomic issues was substantial growth of Croatian total external debt, which has reached troublesome levels (at end-2005 share of external debt in GDP reached 82.5% and continued to increase further in 2006). This was the main trigger for central bank action with the intention to slow down external borrowing of commercial banks. After introducing the obligation of covering minimum 35% of all fx liabilities with liquid fx assets in 2003, in July 2004 the central bank introduced a new measure, which directly impacts the costs of banks' foreign borrowing, called marginal reserve requirement (MRR), (Figure 1, note 3: "MRR"). The basis for the calculation of MRR is net increase of bank foreign liabilities and the rate amounted 24%. Since the banks continued with foreign borrowing even after introducing MRR, the central bank expanded the base for the calculation of MRR on several occasions and increased the MRR rate for four times. The last increase was at end-2005 and since then the MRR rate amounts 55%.

The CNB measures were not aimed only at constraining external debt growth, but also to slow down the fast lending growth. However, in 2006 bank credits to the private sector did not decelerate as it was expected. In the summer of 2006 annual growth rate of bank lending to the private sector further accelerated, reaching up to 24% (average annual growth rate growth in 2006 was 21.9%), what could be considered as the third phase of rapid credit growth. Decline of interest rates on short-term credits during 2006, both to households and to enterprises, and to long-term credits to households suggests that intensive competition among banks helps interest rates to stay on the lower level (Figure 3), further stimulating credit demand. In addition, high credit growth could also be attributed, to some extent, to convergence process towards the European Union (Ko, 2006).

Figure 3: Average lending interest rates

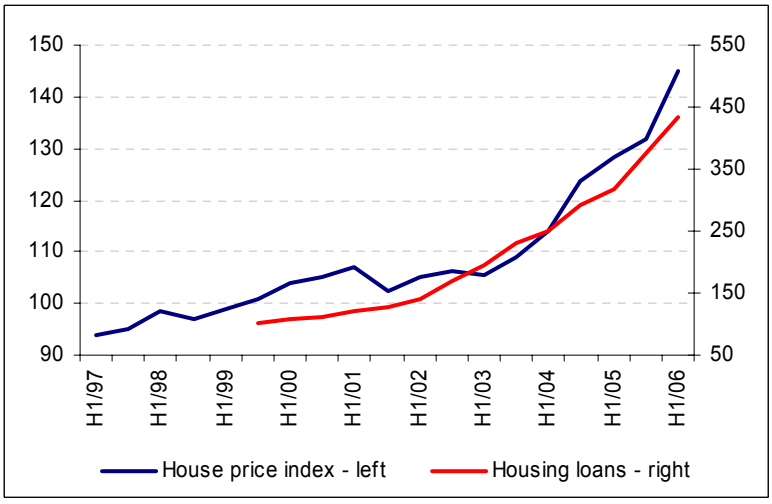


Source: CNB

In terms of sector structure of the strong credit growth in 2006, household loans were continuously recording annual growth rates well above 20%. Strong growth was mainly caused by boom of housing loans, which became the fastest-growing component of household loans, achieving on average 37.1% annual growth rate in 2006. The increasing role of housing loans highlights the risks associated with house price developments[6].

Rise in property prices, shown as house prices index (1999=100), rose from 100 in 1999 to 145 end 2006. Housing loans more than quadrupled in the same period, representing about 39% of all loans to households at the end of 2006.

Figure 4: House prices index and housing loans (base indices 1999=100)



Source: CNB

[6] Changes in property prices may have a significant impact on credit demand via wealth effect. Since long-term loans are often secured with real estate collateral, property prices may have a significant effect on the borrowing capacity of the private sector. An increase in asset prices increases the value of collateralisable assets and thus the creditworthiness of firms and households (Hofmann, 2001). However, in case asset prices bubble bursts, substantial problems regarding credit repayments may influence both banks and their clients.

Positive sign in 2006 is acceleration in growth of lending to enterprises. In the second half of 2006, loans to enterprises exceeded for the first time annual growth rates of loans to households and reached 24.4% at end-December. Increase of banks' credits to enterprises corresponded with significant acceleration of investment activities. Assuming that credits are used for improving production capacities, increasing profitability or building new production facilities, this may have positive effects for future sustainable growth.

In addition, direct foreign borrowing by private enterprises and lending by leasing companies, initiated in 2003, strongly increased in 2005 and 2006. This was stimulated by domestic banks, which encouraged their clients to borrow directly from their parent banks abroad or from their related leasing companies, in order to evade the CNB measures on bank foreign borrowing. Direct consequence of these trends is the fact that Croatia displays by far the highest cross-border lending activities among all new EU members and EU candidate countries (Ko, 2006). Furthermore, although direct foreign borrowing by the private sector is several times lower in comparison to the banking sector, its steady growth since 2003 suggests that, without the CNB measures, credit activity of domestic banks would have been even stronger.

Although credit boom in 2006 is, by its structure, relatively "healthier" than previous periods of booms, the rapid pace of credit expansion by itself poses the risk of a deteriorating banks' asset quality. Moreover, the fact that the majority of sources of financing is coming from abroad, increasing exposure to foreign shocks and the fact that one of the major generators of the lending boom are housing loans, boosted by growth of housing prices, brings concerns whether this could jeopardize macroeconomic and financial stability. Therefore, from the beginning of 2007 the central bank introduced a new measure to restrict excessive lending growth to 12% annual growth. The growth above 12% will be "taxed" by obligatory purchase of non-interest bearing CNB bills in amount of 50% of excess credit growth. There are strong indications that quantitative ceiling on the credit growth will influence the banks' behavior during the 2007.

4. The model

Based on the classical determinants of the demand function, total loans were estimated as a function of scale variable (GDP) and the cost of loans (interest rates), using simple OLS regression model.

$$loans = \underset{+}{f}(gdp, \underset{-}{ir})$$

In doing so, two strong, albeit implicit assumptions are made: firstly, that this functional relationship represents a demand rather than supply side, and secondly, that the direction of causality goes from GDP and interest rates to loans. Both assumptions can be challenged.

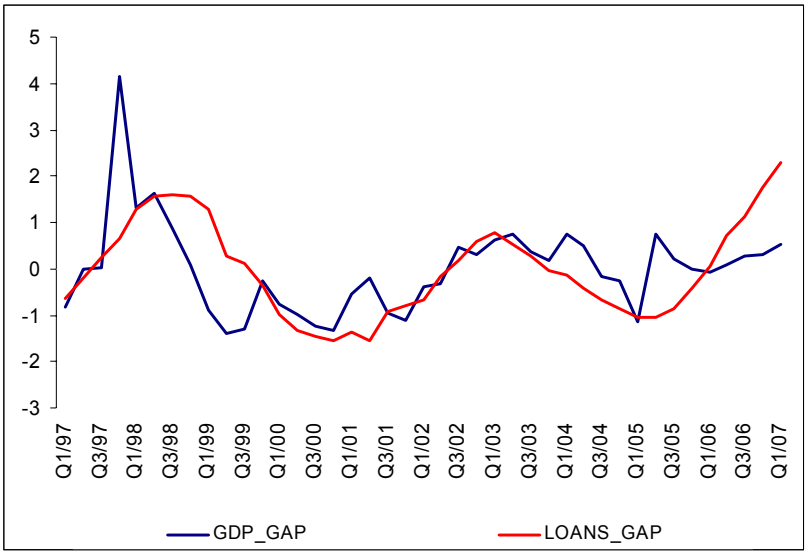
Credit modeled as a function of economic activity and interest rates may represent a demand relationship, but may also capture supply effects. The coincidence of cycles in credit and economic activity may reflect adjustments of credit demand to changes in economic activity. Favorable economic conditions and prospects stimulate consumption and investment demand, thus increasing the demand for credit. A positive correlation between credit aggregates and economic activity may, however, also be explained from a credit supply perspective.

The warning that the estimated relationship should be interpreted with caution, i.e. that it relies on the strong assumption that supply side effects did not play a significant role, is issued routinely in the literature surveyed, and simultaneous modeling of credit demand and credit supply is usually mentioned as a remedy. Nonetheless, in the credit demand literature little is done aside from acknowledging this "supply-versus-demand-puzzle". For instance, Hoffman (2001) does not "attempt to explicitly model a credit supply function, since time series data on important credit supply factors...is not readily available".

Second problem with the demand function is also acknowledged in the literature surveyed, and it is the two-way relationships between credits, economic activity and interest rates. In many countries, episodes of strong credit expansion coincide with robust GDP growth, while slowdowns in credit growth are accompanied by downswings in economic activity, but this does not constitute causality. This is a well-known identification problem: just because a fall in output coincides with a fall in loans does not establish that the former was caused by the latter (Kasyap et al., 1993). A sizeable literature explores the causality between the credit (or financial deepening more generally) and growth, and evidence is found to support the view that credit and growth are mutually reinforcing (IMF, 2004).

More formally, assumptions on exogeneity "determined outside the system under analysis" and causality in the Granger sense "presence/absence of feedback between variables" (Hendry, 1995) are made. Our expectation is that, although supply side plays a significant role in financial sector transition, we can still learn about the demand specific factors and their influence on credit growth.

Figure 5: Loans, GDP and interest rate gaps



Source: Authors' calculations based on CNB and Central Bureau of Statistics data

The first step in our analysis was to check the simple correlations between loans and GDP. Loans and GDP gaps (Figure 5) exhibit a high degree of correlation, with the correlation coefficient of 0.5. Correlations in first differences, levels and gaps between loans and other regressor variables are reported in the Table 2.

Table 2: Correlation matrix between loans and variables in equations for credit demand

		GDP	IR	CPI	Kuna /dollar exchange rate	Kuna /euro exchange rate	Trend	Loans (-1)
Total loans to private sector	$\Delta_4$log	0.504	-0.169	0.093	-0.563	-0.329	0.271	0.922
	log level	0.987	-0.952	0.930	-0.472	0.245	0.844	0.997
	gap	0.499	-0.328	0.289	-0.523	-0.304	0.609	0.883

Note: First row shows correlations of Δlog of all variables, second row of (log) levels of variables, third row deviation from the H-P trend.
Source: Authors' calculations based on CNB and Central Bureau of Statistics data

Then we checked the stationarity of series in levels. Augmented Dickey-Fuller and Phillips-Peron unit root tests statistics were calculated to indicate the order of integration in each time series. The results of unit root tests, based on a unit-root null hypothesis versus a trend stationary alternative failed to reject the presence of a unit root in levels, but not in first differences (reported in Appendix 6.1.).

However, the test on unit root in loans remained ambiguous. ADF test strongly rejects H_0 of unit root in loans in levels while PP does not. It is difficult to distinguish between trend stationary and difference stationary processes even asymptotically, and especially in small samples. If loans are not an I(1) process but a trend stationary process, differencing it, rather then de-trending to render it stationary, would induce MA(1) process in residuals, and coefficient $\hat{\beta}$ from OLS equation would be a biased estimator. To assess this bias, after estimation, the bootstrap exercise was done to calculate the empirical distribution of $\hat{\beta}$ coefficient and t-statistics. (Appendix 6.4.).

The loans to the private sector are estimated as a function of GDP and interest rate. Baseline specification is as follows:

$$\Delta \log loans = \beta_0 + \beta_1 \Delta \log Y_t + \beta_2 \Delta\ ir_t + \varepsilon_i \qquad (1)$$

-0.06	3.09	-8.75	
(-1.29)	***(5.05)	***(-3.52)	$\overline{R}^2 = 0.43$, *n=35*

*** *denotes rejection of null hypothesis at 1% significance level*

All series were seasonally adjusted using X-12 procedure and in log form (except interest rate), so equations were in the semi-log linear form. Quarterly data was first differenced on the fourth lag to approximate YoY growth rates, which were chosen to dampen the "noise" contained in the higher frequency data. Unadjusted sample starts at 1997q1 and runs until 2006q3, yielding 39 observations. Detailed variable description is in Data annex (Appendix 6.5.).

Loans are total loans to private sector including households and enterprises, *Y* is GDP in constant prices (1997=100) and *ir* is real interest rate for kuna loans indexed to foreign currency. Elasticity of loans in respect to GDP of 3.09 (-8.75 in respect to IR) approximates a yearly percentage change in loans with respect to 1% change in GDP (1% change for IR). All coefficients are significant and have expected signs, confirming that loans are positively related to the real GDP and negatively related to the real interest rates. The magnitude of coefficients, somewhat higher then reported in the literature, stems from yearly, rather then quarterly growth rates.

Our baseline result of GDP elasticity of 3.09 is not directly comparable as most of the other studies report long-run coefficients[7]. Calza et al. (2001) report an elasticity in the eurozone of 1.34, followed by Calza et al. (2003) with elasticity of 1.6 for the same group of countries, Hofmann (2001) finds elasticities between 1.04 and 2.49 for a group of 16 industrial countries, Hülsewig et al. (2001) 1.11 for Germany and Brzoza-Brzezina (2005) between 1.45 and 3.39 in the analysis of six European countries.

As for the real interest rates, coefficient is -8.87, which seems rather high. The sample period covers strong decline of interest rates from 1997 to 2002, somewhat slower decline from 2002 to 2005 and a leveling off from 2005 onwards and it is the beginning of the sample period that drives the interest rates coefficient.

The interest rate coefficients reported in various studies seem to vary more then GDP coefficients. For instance, Calza et al. (2001) find a semi-elasticity of –1.01 for the Euro zone, Hülsewig et al. (2001) -0.69 for Germany and Hoffman (2001) reports numbers between -0.01 and -0.08. Whereupon Calza et al. (2003) estimate semi-elasticity of -5.05 and Brzoza-Brzezina (2005) reports that "the interest rate semi-elasticity varies between -4.42 in Hungary and -10.81 in Portugal".

[7] The estimation of long run relationship is hindered, not only because of the short data span, but primarily because of the ambiguity of the order of integration on loans. If loans are not an I(1) process but a trend stationary process while GDP and IR are I(1), the cointegrating vector cannot be found using standard cointegration procedure.

The common denominator seems to be that the elasticity of loans to changes in GDP is above unity. The (negative) elasticity of loans to interest rates is higher in the countries that have experienced a substantial decline in interest rates.

Further expanding of equation (1) goes in three directions and yields extensions of baseline specification reported in Table 3. These extensions were motivated by trying explanatory power of other variables and especially by including variables that have been used in literature to control for the supply side.

First, lagged dependent variable was included on the right hand side, to account for the persistence in loans (equation 2, 4, 6, 8, 10, 12). Second, a linear trend was introduced to account for catching-up process and financial deepening during transition although financial liberalization and financial deepening are difficult to measure. Following Boissay et al. (2005) we assumed that the effects of supply side factors could be approximated by a linear time trend *z* (equations 3, 4, 7 and 8). Lastly, we tried various other specifications with the macroeconomic variables that might be relevant in the Croatian macroeconomic context: inflation, nominal kuna/euro, and nominal kuna/dollar exchange rate.

Table 3: OLS results - total loans, other specifications, n=35

Eqations / Variables	Eq. 1	Eq. 2	Eq. 3	Eq. 4	Eq. 5	Eq. 6	Eq. 7	Eq. 8	Eq. 9	Eq. 10	Eq. 11	Eq. 12
	(t-stat)											
Constant	-0.06	-0.03	-0.07	-0.02	-0.11 ***	-0.05 **	-0.09	-0.08 ***	-0.04	0.00	-0.05	-0.01
	(-1.29)	(-1.97)	(-1.56)	(-1.33)	(-2.10)	(-2.17)	(-1.46)	(-4.33)	(-0.92)	(-0.32)	(-1.07)	(-0.43)
Loans(-1)		0.76 ***		0.79 ***		0.75 ***		0.83 ***		0.79 ***		0.81 ***
		(-13.05)		(12.92)		(12.7)		(17.8)		-20.01		(18.82)
GDP	3.09 ***	1.3 ***	3.08 ***	1.15 ***	3.34 ***	1.41 ***	3.20 ***	1.26 ***	2.75 ***	0.48 ***	2.95 ***	0.49 *
	(5.05)	(4.77)	(5.24)	(3.95)	(5.49)	(4.80)	(4.98)	(5.74)	(3.60)	(2.12)	(3.84)	(1.99)
Interest rate	-8.75 ***	-1.79	-7.59 ***	-1.89*	-8.36 ***	-1.84	-7.81 ***	-2.64 ***	-8.91 ***	-1.82 ***	-8.83 **	-1.74 **
	(-3.52)	(-1.64)	(-3.08)	(-1.75)	(-3.46)	(-1.69)	(-3.08)	(-3.20)	(-3.55)	(-2.48)	(-3.48)	(-2.22)
Trend			0.06 *	-0.03			0.04	-0.15 ***				
			(1.90)	(-1.32)			(0.75)	(-4.96)				
CPI					1.27*	0.32	0.57	2.02 ***				
					(1.80)	(1.01)	(0.48)	(4.85)				
Exchange rate kuna/USD									-0.51	-1.09 ***		
									(-0.75)	(-6.11)		
Exchange rate kuna/euro											-0.22	-1.04 ***
											(-0.32)	(-5.38)
Number of obs.	35	34	35	34	35	34	35	34	35	34	35	34
Adjusted R^2	0.43	0.91	0.47	0.91	0.47	0.91	0.46	0.95	0.42	0.96	0.47	0.96
AIC	-2.07	-3.94	-2.12	-3.93	-2.11	-3.91	-2.07	-4.49	-2.03	-4.71	-2.01	-4.57
Schwarz	-1.93	-3.76	-1.94	-3.71	-1.93	-3.69	-1.85	-4.22	-1.85	-4.48	1.83	-4.35
F-Statistic	13.88	108.41	11.20	83.39	10.97	81.62	8.25	123.34	9.32	189.09	9.03	164.28
Probabilty	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**** denotes rejection of null hypothesis at 1% significance level, ** at 5% significance level and * at 10% significance level.*

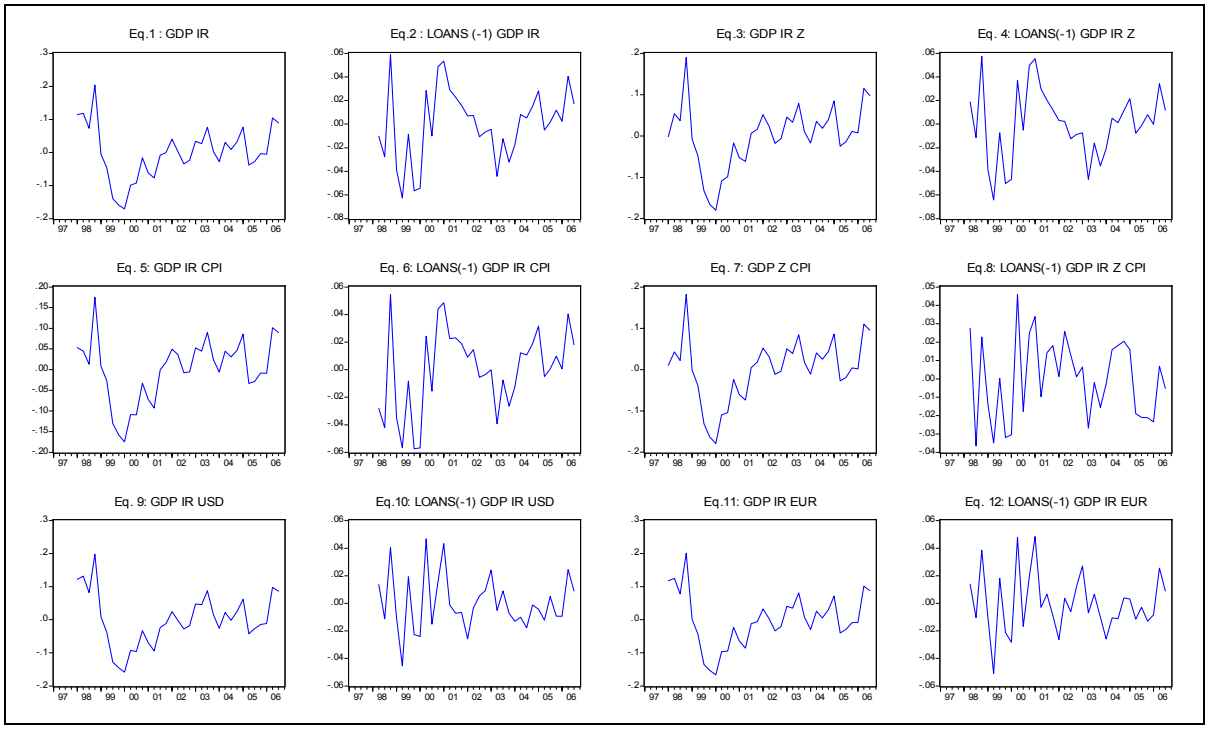
In almost all specifications baseline regressors (GDP and interest rate) are significant and have expected sign, supporting their robustness as explanatory variables. Lagged dependent variable, expectedly, is always significant with the expected sign. Trend variable *z* does not significantly change the coefficient with the GDP and interest rates compared to the baseline specification (Eq. 3). This suggests that, at least in the limited scope of our model, supply side would not significantly alter the weight of GDP and interest rates as explanatory variables. CPI entered with the positive sign (inflation increases demand for loans). We expected *a priori* that inflation would not be significant, as all variables are real rather then nominal. In two specifications, however, CPI is significant at 10% (Eq. 5) and 1% (Eq. 8). Exchange rate

entered with the expected negative sign, suggesting that appreciation increases demand for loans.

4.1. Standard specification tests

Residual tests point to the existence of autocorrelation, which is more pronounced in the first part of the sample. Standardized residuals (Figure 6) show presence of autocorrelation in all specifications without lagged dependent variable (odd numbered graphs). As described in section 3, 1997 and the beginning of 1998 were years of exceptionally high credit growth, followed by the banking crisis in the second part of 1998 and 1999. Hence, the values fitted in any equation systematically underestimate the observed values during the first lending boom in 1997, giving rise to high positive residuals, and the opposite happens during the crises that followed the first lending boom. Introducing persistence through lagged dependent variable (even numbered equations), by definition improves the fit, although residuals remain "noisy". In spite of the significant coefficients with the lagged depended variable, AIC and Schwartz criterion, systematically favor more parsimonious specifications, not justifying inclusion of lagged dependent variable.

Figure 6: Graph of standardized residuals of equations 1 through 12



Source: Authors' calculations based on CNB and Central Bureau of Statistics data

Test for omitted variables was done for all variables other than baseline regressors to test the explanatory power of the additional variables. Tested variables were lagged dependent variable $loans_{t-1}$ (H_o: not omitted rejected at 1%), the trend variable *z* (H_o rejected at 5%), *CPI* (H_o rejected at 10% significance), and exchange rate (H_o not rejected). This test suggested that $loans_{t-1}$, *z* and *CPI* are justifiably included in the expanded specification, while exchange rates were not, as in Eq. 8. For detailed results on omitted variable tests, see Appendix 6.2. In spite of the results of these tests, AIC and Schwartz criterion systematically favor more

parsimonious specification. This is why we also prefer the simple specification - it explains the loan developments reasonably well, while preserving the degrees of freedom, which is important in the small sample with 40 observations.

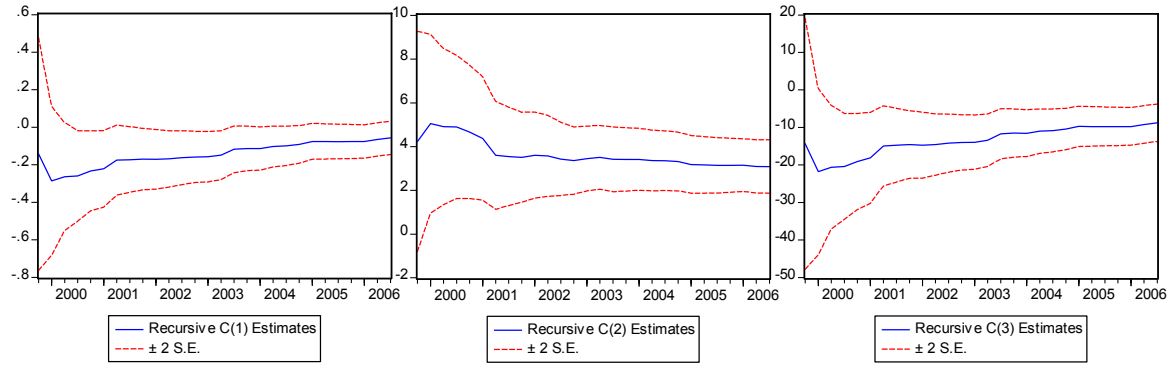
The problem of multicollinearity might be present, as it was plausible that interest rate influences GDP. However, variance inflation factor (VIF), calculated as $1/(1-R^2)$ from regression $\Delta \log Y_t = \beta_0 + \beta_1 \Delta ir_t + \varepsilon_i$ is 1.3, indicating that the multicollinearity is not severe.[8]

Stability of equation specification over the sample period was tested using the recursive least squares. The equation was estimated repeatedly using ever larger subsets of data. If the model were valid, the recursive residuals should be independently and normally distributed with the zero mean and constant variance. The recursive residuals that lied outside the standard error banks suggested instability of the parameters of the equation. The plot included the sample points where the hypothesis of parameter constancy would be rejected at 5, 10 or 15% levels. The points with the p-values less then 5% corresponded to those points where the recursive residuals went outside the two standard error bounds, hence there was evidence of instability in that period.

The plots of recursive residuals confirmed that all specifications perform somewhat better in the later part of the sample (from 2002 onwards). Residuals were more stable in that part of the sample with residuals going outside the 2SE band only in the first part of the sample. Inclusion of more regressors did not improve the stability of specification, measured by this test.

The same conclusion is supported by recursive coefficient test (not reported, except for the baseline specification - Figure 7. Stability test for Equation 1 calculated as recursive coefficients suggests that the coefficient are less stable further away in the past with the confidence band being wide at the beginning of the sample period, narrowing towards the end of the sample.

Figure 7: Recursive coefficients of equation loans =-0.06 + 3.09*gdp+(-8.87)*ir



Source: Authors' calculations based on CNB and Central Bureau of Statistics data

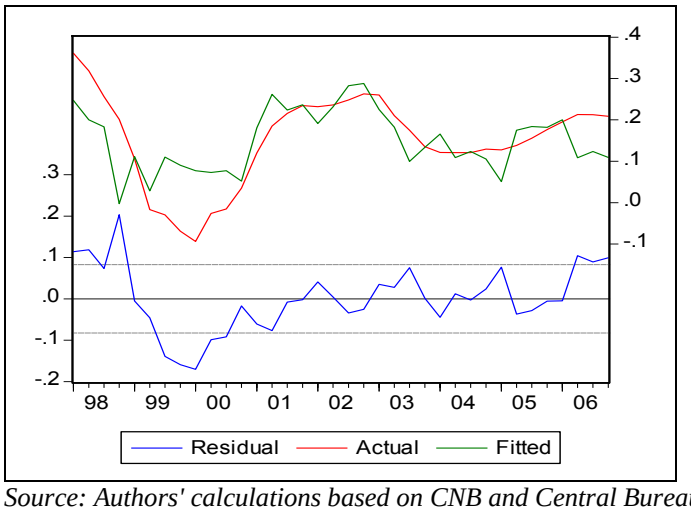
[8] While there is no formal critical value of VIF, a common rule of thumb is that VIF of 5 or more indicates serious multicollinearity problem.

4.2. Results

The results can be summarized as follows:

- the baseline specification seem to satisfactory explain the observed developments of credit;
- the extension of the baseline equation, including the variables used to control for the supply specific factors, did not significantly change the results and especially did not change the assessment of periods of excessive credit growth vs. period when the credit growth was in line with the fundamentals;
- credit growth during the lending boom of the late 1990's and in 2006 remains above the fitted line in all specifications (graphs for the extended equations are in the Appendix 6.5.) and during the recession that followed the first lending boom credit plunged well below the fitted line;
- Inclusion of the lagged dependent variable "smoothes" the curve, and improves the fit, but even then actual growth remains slightly above the fitted line until 1998Q1 and in 2006.

Figure 8: Loans (yearly growth rates), baseline specification, Eq. 1



Source: Authors' calculations based on CNB and Central Bureau of Statistics data

4.3. Loans to households

Household credit demand, in its baseline specification, includes standard explanatory variables similarly to the demand equation for total loans. These variables are consumption, and interest rates on total household credits. In the extended specification, wages replace consumption as a scale variable. Strong and continuous growth of property prices is also considered as one of the main driving forces of rapid credit growth. Inclusion of house price index was tried as explanatory variable in extended specifications, since housing loans have been the most intensively growing segment of total loans spurring much research interest recently.

Table 4 shows correlation between loans to households, interest rates on household loans, consumption, wages and hedonic index, in first difference (as used in equations) and in levels.

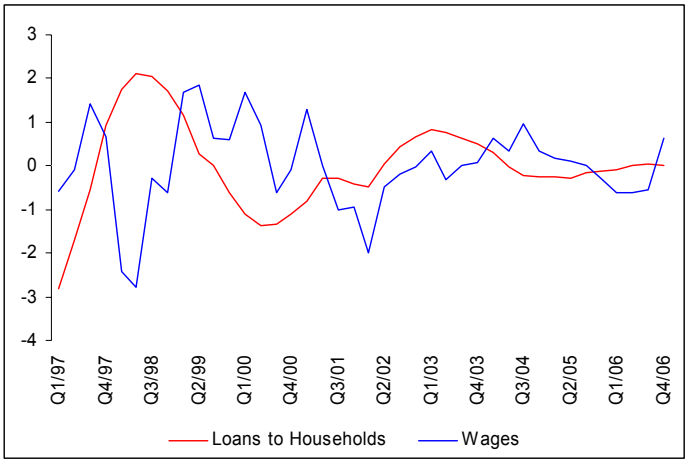
Table 4: Correlation matrix between loans and variables in equation for household credit demand

		Interest rate_H	Consumption	Wages	House prices	Loans(-1)
Loans to households	$\Delta_4$log	-0.48	0.32	-0.44	-0.13	0.92
	log	-0.98	0.94	0.96	0.86	0.99

Note: First row shows correlations of Δlog of variables, second row of (log) levels of variables.
Source: Authors' calculations based on CNB and Central Bureau of Statistics data

Correlations between $\Delta_4$log variables are strong and have expected signs except wages and house price index. Wages seem to move in the opposite direction from loans. While it is a priori expected for a scale variable to move in the same direction as loans, it might be that the negative relation stems from the significant share of short-term loans (including revolving overdrafts on household current accounts) in the total loans, that are likely to increase with the decrease (or slower growth) of wages.

Figure 9: Wage and households loans gaps (normalized)

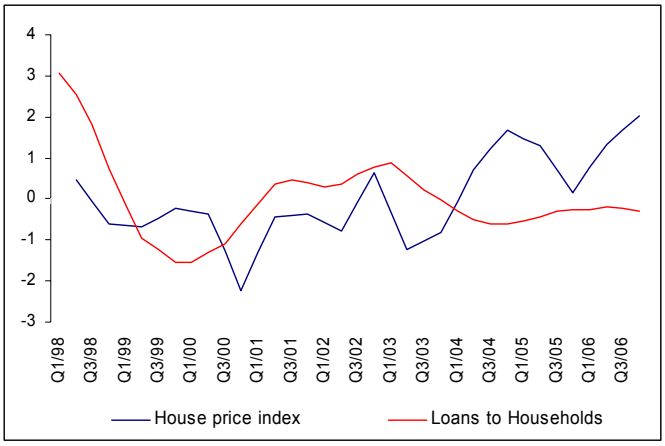


Source: Authors' calculations based on CNB and Central Bureau of Statistics data

Negative sign for the correlation between loans to households and housing prices in first differences is also somewhat unexpected. Although correlation in levels is very high, looking at the YoY growth rates, it seems that the household loans were growing at a somewhat slower pace when the house prices were growing the fastest (Figure 10). Observed negative correlation of -0.13 does not necessarily mean that the usual assumption of rapid credit growth to the households being driven by growth of property prices is wrong. Rather that the

two series could not grow at different pace for a long time diverging far in the longer run. However, reliability and low data frequency (semi-annual) of house price index makes any assessment difficult.

Figure 10: YoY growth rates of house prices and household loans (normalized)



Source: Authors' calculations based on CNB data

Correlation between interest rates (on household loans) and household loans is quite strong and negative (-0.48), as expected, as is the correlation between personal consumption and loans of 0.31.

Initial specification includes consumption, as this component of GDP is most likely to influence demand for household loans[9], and interest rate on household loans, as explanatory variables for household loans:

$$\Delta \log Loans\_h = \beta_0 + \beta_1 \Delta \log cons_t + \beta_2 ir\_h_t + \varepsilon_i \qquad (2)$$

where *Loans_h* are total loans to the household sector, *cons* is consumption and *ir_h* is interest rate on long-term kuna loans to households indexed to foreign currency.

This specification is then expanded by the house prices index. In the next step, we change all equations by replacing explanatory variable *consumption* with real *wages* . All equations were tried with and without lagged dependent variable. Expansion of baseline specification yielded 8 equations, estimated with OLS method (Table 5).

[9] Loans to households, in turn, influence personal consumption. The discussion on exogeneity and causality is relevant here as well.

Table 5: OLS results - loans to households

Variables \ Equations	Eq. 1_h (t-stat)	Eq. 2_h	Eq. 3_h	Eq. 4_h	Eq. 5_h	Eq. 6_h	Eq. 7_h	Eq. 8_h
Constant	0.15 ***	0.00	0.19 ***	0.00	0.16 ***	0.06 ***	0.25 ***	0.07 ***
	(3.79)	(-0.02)	(4.38)	(-0.29)	(2.91)	(3.82)	(3.90)	(3.31)
Loans to households (-1)		0.83 ***		0.83 ***		0.78 ***		0.77 ***
		(21.68)		(20.42)		-17.89		(16.55)
Baseline regressors: Interest rates on loans to households	-11.11 ***	-0.46	-7.67 ***	-0.51	-10.52 ***	-1.88 *	-6.67 *	-1.70
	(-2.87)	(-0.49)	(-2.13)	(0.59)	(-2.87)	(-1.79)	(-1.95)	(-1.54)
Baseline regressors: Consumption	-0.21	0.87 ***	0.06	0.87 ***				
	(-0.35)	(6.12)	(0.11)	-5.90				
Wages					-0.20	-0.90 ***	-0.93	-0.99 ***
					(-0.25)	(-4.15)	(-1.20)	(-4.08)
House price index			-0.58	0.06			-0.78	-0.11
			(-1.28)	(0.48)			(-1.66)	(-0.74)
Number of obs.	35	34	35	34	35	34	35	34
Adjusted R^2	0,16	0.95	0,15	0.94	0,16	0,92	0,19	0,92
AIC	-1.32	-4.33	-1.53	-4.24	-1.35	-3.99	-1.58	-3.9
Schwarz	-1.19	-4.15	-1.35	-4.01	-1.22	-3.82	1,40	-3.67
F-Statistic	4.32	194.00	2.84	136.89	4.41	135.78	3.45	95.45
Probabilty	0.02	0.00	0.06	0.00	0.02	0.00	0.03	0.00

**** denotes rejection of null hypothesis at 1% significance level, ** at 5% significance level and * at 10% significance level.*

Interest rates are significantly negative throughout various specifications with coefficients being expectedly higher in equations not including lagged dependent variable. High levels of coefficients, reaching value of -11.11 or -10.52 in equations Eq.1_h and Eq.5_h respectively, suggest high sensitivity of household credit demand to changes in interest rates.

Looking at other coefficients, it seems that consumption is better explanatory variable than real wages. While coefficients with both variables proved to be significant only when lagged dependent variable is included, negative sign with wages is unexpected.

Due to the persistence in variable $Loans\_h_{t-1}$, explains much of the original series, as it was case with the total loans. At the same time, interest rates on loans to households become insignificant.

Similar specifications were tried on the housing loans, as it was expected for house prices to correlate with this subsample of total household loans better, but it did not yield any different results. Therefore, we can conclude that house price index did not contribute to explaining household credit demand. The length of the series for this specification is particularly problematic as, interest rates on housing loans are reported only from 2002.

As it was the case in the equations with total loans, AIC and Schwartz criterion systematically favor specifications that are more parsimonious.

5. Concluding remarks

1) We estimated ***demand for total loans*** in Croatia using OLS method on standard credit demand determinants. Results showed that the behavior of loans can be explained mainly by the developments of real GDP and real interest rates. It seems that in spite of rather simple specification, GDP captures most important forces behind the loan demand. Other variables were tried to test the robustness of baseline specification but their importance as additional variables to explain the loan growth was limited. These variables were trend variable (to account for supply side effects), inflation and nominal exchange rate (USD and EUR).

In the baseline specification as well as in extended specifications, credit growth during the credit boom in the late 1990's and in 2006 was "excessive" in the sense that the observed credit growth was higher than implied by the macroeconomic variables. However, by our estimation, the fast credit growth episode from 2002-2003 remained in line with the fundamentals. This is because GDP growth, fueled by the personal consumption, was also very strong in that period.

2) The ***household demand for credit*** was looked at with the specific interest, as there is a burgeoning lending booms literature focusing on relationship between house prices and credit growth. Results show that coefficient with the interest rates on household loans were significantly negative in all specifications. Consumption proved better scale variable than real wages, while somewhat unexpectedly, house price index did not contribute to explaining household credit demand. At this point, we can only conclude that strong growth in house prices coincided with the strong growth of household loans observed in the last 5 years.

As a policy implication, while the assessment of the causality between GDP and loans was not in the focus of this paper, it is clear that they move together with the high degree synchronism. Monitoring real sector developments and loans as a deviation from trend could prove invaluable tool for assessing the position of economy on the business cycle. For instance, quantitative "ceiling" on credit growth in 2003 has been introduced when both GDP and loans were at their "peaks", while the similar instrument in 2006 was introduced *prior* to the "peak".

Follow-up studies should make use this high correlation between loans and GDP movement for identification of their possible long run relationship. Furthermore, it might be fruitful to continue monitoring house and property (as well as equity) prices, in the context of credit growth, as these data become more reliable in the course of time. In addition, supply considerations need to be incorporated in the analysis in the more systematic way in order to better discriminate between supply and demand effects.

6. Appendix

6.1. ADF and PP tests

Variable	ADF		PP	
	Constant	Constant and trend	Constant	Constant and trend
CONS	1,166	-1,975	-0,070	-1,895
d(CONS)	-7,138***	-7,747***	-5,860***	-5,962***
GDP	0,046	-2,091	0,27	-1,896
d(GDP)	-8,317***	-8,348***	-8,317***	-8,434***
IR	-2,025	-1,510	-2,897*	-1,402
d(IR)	-7,161***	-7,521***	-7,161***	-7,455***
LOANS	1,835	-4,908***	-0,297	-1,888
d(LOANS)	-2,714*	-4,705***	-2,815*	-2,763
WAGES	-2,533	-2,185	-4,263***	-2,136
d(WAGES)	-5,405***	-5,821***	-5,397***	-6,100***
IR_HOUSE	0,131	-3,757**	0,284	-3,501*
d(IR_HOUSE)	-4,041***	-4,112**	-10,068***	-10,322***
LOANS_HOUSE	-0,138	-5,304***	-1,779	-3,329*
d(LOANS_HOUSE)	-2,568	-2,220	-2,580	-2,270
HOUSE PRICE INDEX	3,302	1,438	4,493	0,246
d(HOUSE PRICE INDEX)	-2,048	-8,502***	-7,153***	-8,502***
CPI	-3,052**	-2,200	-3,306**	-2,403
d(CPI)	-4,585***	-5,484***	-4,683***	-5,483***
EUR	-3,696***	-3,320*	-2,417	-1,738
d(EUR)	-4,253***	-4,786***	-4,451***	-4,854***
USD	-0,908	-1,483	-1,082	-1,550
d(USD)	-4,204***	-4,722***	-4,337***	-4,816***

denotes rejection of unit root null hypothesis at 10% significance level, ** at 5% significance level, * at 1 % significance level*

6.2. Omitted variables test

Test for omitted variables in the equation

$$\Delta \log Loans = \beta_0 + \beta_1 \Delta \log Y_t + \beta_1 \Delta ir_t + \varepsilon_i \quad (1)$$

Omitted Variables: CPI	
F-statistic	*3,23
Log likelihood ratio	*3,47

Omitted Variables: HRK_EUR	
F-statistic	0,10
Log likelihood ratio	0,11

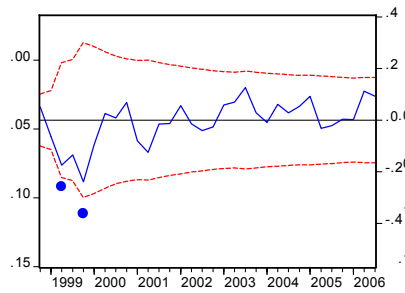
Omitted Variables: LOANS(-1)	
F-statistic	***170,42
Log likelihood ratio	***64,57

Omitted Variables: Z	
F-statistic	*3,60
Log likelihood ratio	**3,84

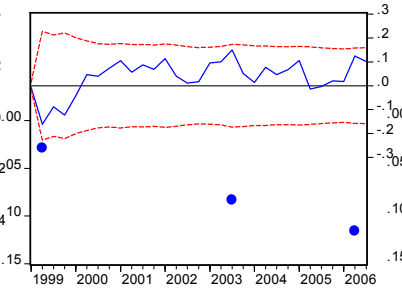
Omitted Variables: Z CPI	
F-statistic	1,87
Log likelihood ratio	4,11

6.3. One-step forecast test

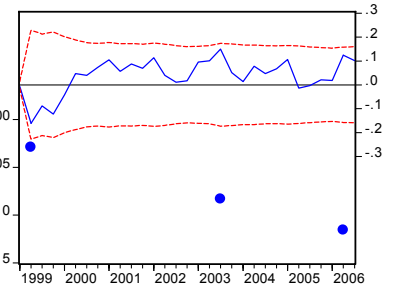
Eq.1: GDP IR



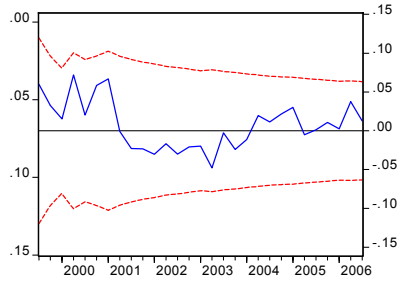
Eq. 2: LOANS(-1) GDP IR



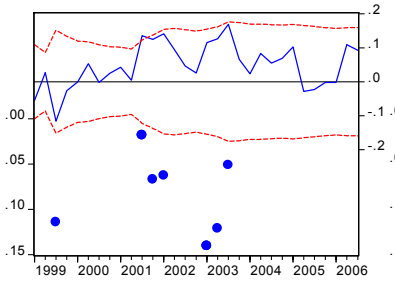
Eq. 3: GDP IR Z



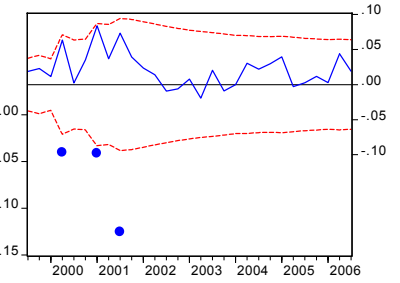
Eq. 4: LOANS(-1) GDP IR Z



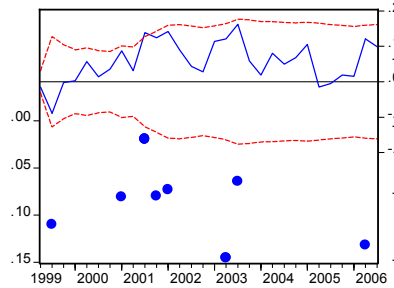
Eq. 5: GDP IR CPI



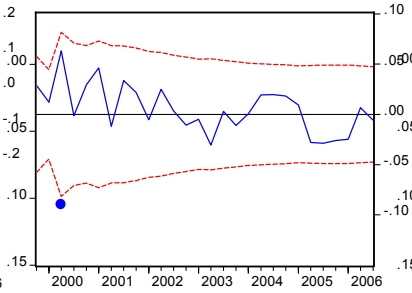
Eq 6. : LOANS (-1) GDP IR CPI



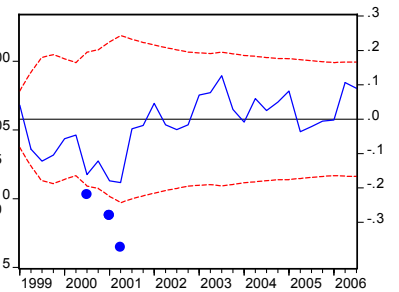
Eq. 7: GDP IR Z CPI



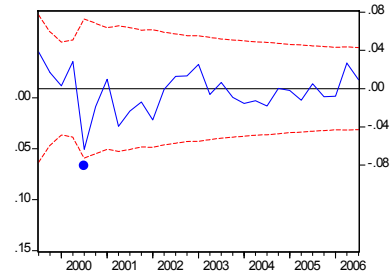
Eq. 8: LOANS (-1) GDP IR Z CPI



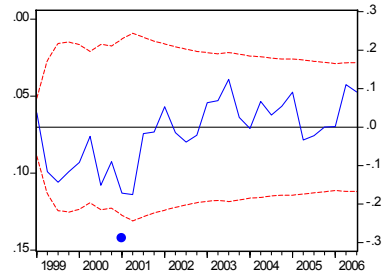
Eq 9. GDP IR USD



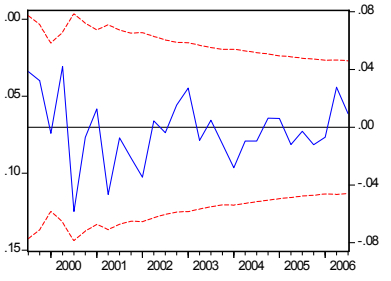
Eq. 10: LOANS(-1)GDP IR USD



Eq.11 GDP IR EUR



Eq 12. LOANS(-1) GDP IR EUR



6.4. Bootstrapping

Estimator $\hat{\beta}$ converges in to the normal distribution if the sample size tends to infinity even if the error distribution is unknown (by CLT). The bootstrap is often used to verify whether results based on the asymptotic theory yield a satisfactory approximation if the sample is small or errors are non-normal.

When N goes to infinity empirical distribution converges to the actual sampling distribution. Therefore, statistics based on sampling from this empirical distribution converges to the statistics from the (unknown) actual sampling distribution.

In our case, 25 out of 36 observations of $\hat{\varepsilon}$ were drawn with replacement, an vector $\tilde{\varepsilon}^j$ (25 x 1) was created. Artificial loans data were generated $loans^j = X\hat{\beta} + \tilde{\varepsilon}^j$ .Then, $\tilde{\beta}^j$ was estimated in then usual way $\tilde{\beta}^j = (X^{j\prime} X^j)^{-1} X^j loans^j$, repeating the re-sampling and estimation 5000 times, *j=1 to 5000.* While there are formal ways to determine *i* (Andrews et al., 2000), rule of thumb was used that *i* should be large enough that the empirical distribution of $\tilde{\beta}$ does not change with an increase of *i*. The exercise was repeated for the t statistic.

The bias is defined as a difference between the mean of the empirical distribution and statistic from the empirical distribution.

Figure 11: Empirical distribution of the coefficient β

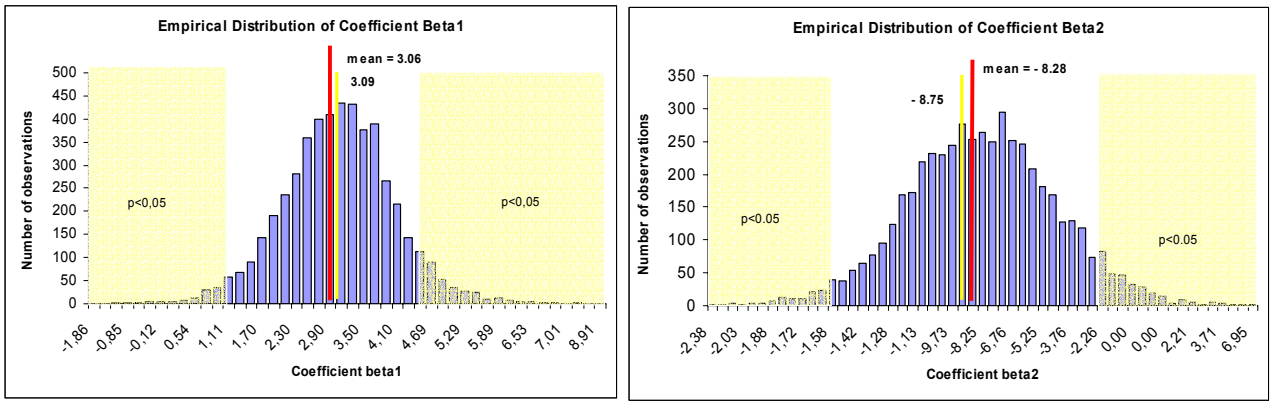
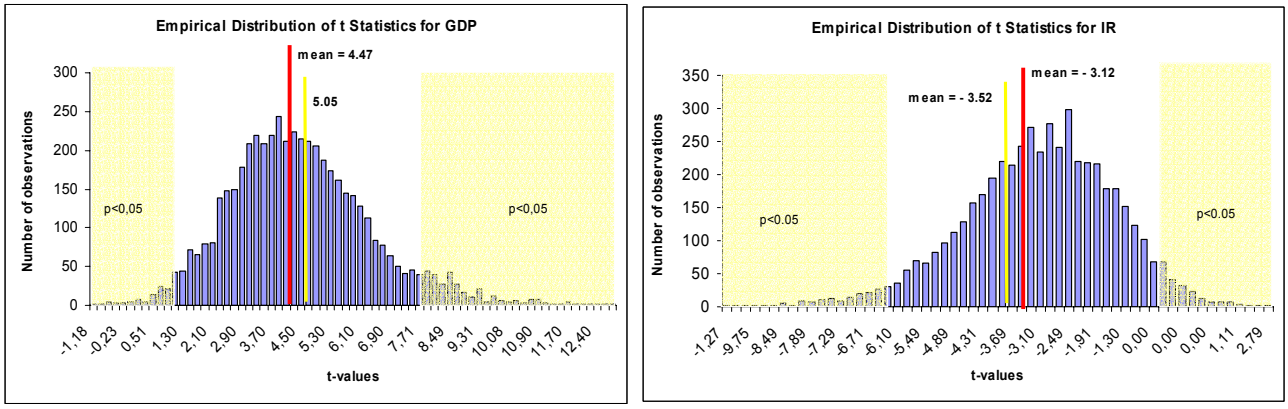


Figure 12: Empirical distribution of the t statistics



The bootstrap, in our case, was done because of the small sample and because a DGP for loans was unclear. Based on the above analysis, we conclude that the coefficients from the Eq.1 are reliable.

Table 6: Bootstrap results

	Coefficients from Eq. 1				**t statistic from Eq. 1**			
			Difference (bias)				Difference (bias)	
	$\hat{\beta}$	Mean of the empirical distribution	in abs. terms	in % of σ	t statistic	Mean of the empirical distribution	in abs. terms	in % of σ
GDP	3.09	3.06	0.03	3.0%	5.05	4.47	0.58	48.6%
Interest rate	-8.75	-8.28	-0.47	12.7%	-3.52	-3.12	-0.40	25.3%

6.5. Data annex

GDP	Real quarterly ***GDP*** (seasonally adjusted, using X-12-ARIMA), in billion HRK
CONS	Real quarterly ***consumption*** (seasonally adjusted, using X-12-ARIMA), in billion HRK
EUR	Nominal ***kuna/euro exchange rate***, quarterly average of monthly averages
USD	Nominal ***kuna/US dollar exchange rate***, quarterly average of monthly averages
CPI	Quarterly average of monthly year-on-year rates of change of retail price index until 1997:12, and ***consumer price index*** from 1998:1; in %
IR	Quarterly average of weighted average of banks' monthly ***real interest rates*** on long-term kuna credits indexed to foreign currency[10]; in % on annual basis.
IR_HOUSE	Quarterly average of weighted average of banks' monthly ***real interest rates*** on long-term kuna credits indexed to foreign currency granted to households, in % on annual basis.
LOANS	***Total loans*** to the private sector, calculated as sum of banks' loans in kuna and banks' loans in foreign currency converted to kuna using constant exchange rate (exchange rate computed on the basis of currency structure of foreign currency loans at end-2000); in billion HRK
LOANS_HOUSE	***Loans to households***; calculated as sum of banks' loans to households in kuna and banks' loans to households in foreign currency converted to kuna using constant exchange rate (weighted on the base of currency structure of foreign currency loans at end-2000); in billion HRK
HOUSE PRICE INDEX	Semi-annual ***hedonic index***, base year 1999=100, linear conversion to quarterly frequency
WAGES	Quarterly average of real monthly net ***wages*** in Croatian economy, in HRK

[10] Up to December 2001, data refer to credits granted to all legal persons (which included enterprises, the public sector, financial institutions and non-residents) and households; starting from January 2002, data refer only to credits granted to enterprises and households

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8. Table - Selected empirical studies

Author(s)	Countries	Time series	Dependent variable	Explanatory variables	Econometric method	Results
Boissay et al. (2005)	BG, RO, HR, 8 CEE EU member countries; 11 developed countries (used as benchmark)	quarterly data for 1998-2004 for CEE countries; quarterly data for 1960-2004 for 11 developed countries (benchmark)	credit-to-GDP ratio aggregate loans; long-term loans; short-term loans; loans in domestic currency; loans in foreign currency; loans to corporations; loans to households	real GDP; real interbank rate; real retail lending rate; time trend (capturing effects of financial liberalization)	one-country ECM model and panel estimation	Authors conclude that credit growth in a number of countries in the CEE region cannot be fully explained by their fast economic growth, declining interest rates or the catching-up in incomes. This holds especially for countries with fixed exchange rate regimes. Their results indicate excessive credit growth in the three Baltic States and in Bulgaria and to a lesser extent also in Hungary and Croatia.
Brzoza-Brzezina (2005)	EL, IE, PT, PL, HU, CZ	quarterly data for 1981:Q1-2004:Q2 (for EL, IE from 1983:Q1; for CZ, PL from 1995:Q1; for HU from 1995:Q4)	total real loans to the private sector for EL, IE, PT real loans to the private sector in domestic currency for CZ, PL, HU	log of real GDP; real interest rate (3-month money market rate), deflated by GDP deflator	VEC model, in-sample estimation	Positive relationship between GDP and real loans with elasticities between 1.45 (IE) and 3.39 (HU). Negative relationship between interest rates and loans, semi-elasticities between -4.42 (HU) and -10.81 (PT).
Calza et al. (2001)	eurozone	quarterly data for 1980:Q1-1999:Q4	real loans to the private sector	real GDP; real short- and long-term interest rates	VECM estimation (Johansen methodology)	Long-run real loans are positively related to real GDP and negatively to real short-term and long-term interest rates (elasticities +1.34, -1.01 and 1.79 for GDP, LT IR nad ST IR respectively).
Calza et al. (2003)	eurozone	quarterly data for 1981:Q1-2001:Q3	real loans to the private sector	real GDP; inflation; weighted average of bank lending rates	VECM estimation (Johansen methodology)	Loans are positively related to real GDP (with an elasticity of 1.48) and negatively to the real weighted lending rate (with a semi-elasticity of –5.08). Authors find that the deviations of the real stock of loans from the equilibrium level implied by the model seem to contain information on future changes in inflation.
Cottarelli et al. (2003)	a panel of 24 non-transition and developing countries	yearly data for 1973-1996	credit-to-GDP ratio	GDP per capita, public debt-to-GDP ratio, inflation (as threshold with limit at 4%), financial liberalization measures, legal, regulatory, and corporate culture of the country	Random effects panel regression	Comparison of actual credit-to-GDP ratio in CEE countries with "equilibrium" ratio (from the model) shows that loan markets in CEE are still undesized.
Duenwald et al.(2005)	BG, RO, UA	quarterly data for 1999:Q2-2004:Q4	trade balance-to-GDP ratio	lagged trade balance; GDP growth; lagged credit flow; lagged fiscal balance	cross-section GLS estimation	The results suggest that changes in the flow of credit and the fiscal balance had significant (and opposite) effects on the trade balances in Bulgaria and Romania. In Ukraine, in contrast, concerns about the credit boom have largely reflected financial sector vulnerabilities.
Égert et al. (2006)	11 CEE countries (for estimation purposes 43 countries are used)	quarterly data, begins between 1975 and 1980 for the OECD countries, between 1980 and 1993 for the emerging market economies, and between 1990 and 1996 for the transition economies; it ends in 2004.	credit-to-GDP ratio	PPP-based GDP; banks' credit to government sector; short- and long-term nominal interest rate; inflation; house prices; financial liberalisation index; credit registries	ECM model (OLS, DOLS, MGE) for estimation of parameters used on panel composed of small open OECD economies; out-of-sample for applying parameters to transition countries	Credit to the public sector, nominal interest rates, the inflation rate and the spread between lending and deposit rates turn out to be the major determinants of credit growth in the CEE-5, while GDP per capita is the only variable that enters the estimated equations in a robust manner for the Baltic and SEE countries. Croatia is the only country which might have reached the equilibrium credit-to-GDP ratio by 2004, with five analyzed countries close to equilibrium (BG, EE, HU, LV and SI) and others still on the undershooting side in 2004.
Hofmann (2001)	16 industrialized countries	quarterly data for 1980:Q1-1998:Q4	real loans to the private sector	real GDP; real ex-post short-term interest rate (3-month interbank money market rate); property price index (weighted average of residential and commercial property prices), deflated by CPI	VAR cointegration analysis (Johansen)	Cointegration tests suggest that the long-run credit development cannot be explained by standard credit demand factors, but once property prices are added to the system, they identify long-run relationships linking real credit positively to real GDP (elasticity 1.04 to 2.49) and real property prices (elasticity 0.23 to 1.68) and negatively to the real interest rate (elasticity -0.01 to -0.08).

Author(s)	Countries	Time series	Dependent variable	Explanatory variables	Econometric method	Results
Hülsewig et al. (2001)	Germany	quarterly data for 1975:Q1-1998:Q4	real loans to the private sector	banks' equity position, deflated by GDP deflator; yield on bonds outstanding issued by domestic residents; 3-month money market rate inflation; real GDP	VECM estimation (Johansen methodology)	Demand for loans is positively related to real GDP and negatively to the lending rate. The income elasticity of loan demand is roughly 1.11, yield on bonds elasticity -0.096 and the sample mean of medium-term capital market rent is 7.22, which leads to a value of interest rate elasticity of -0.69.
Kiss et al. (2006)	eurozone (excluding Luxembourg)	yearly data for 1980-2002 (for sectoral breakdown 1995-2002)	credit-to-nominal GDP ratio; sectoral credit-to-nominal GDP ratio (household and corporate sector)	PPP-based GDP per capita; real short-term interest rate; inflation	VECM estimation using multi-country panel data	Positive relationship between aggregate credit-to-GDP and PPP-based per capita GDP (elasticity 0.51) and negative relationship with CPI (elasticity -2.04) and RIR (elasticity -1.88) Results for sectoral estimations somewhat different (higher elasticities of sector credit-to-GDP ratios to RIR; households -8.14, corporate -2.69; inflation has opposite effects on credits to households (-11.18) and to corporate sector (+1.78))
Kraft (2006)	Croatia	quarterly data for 1996-2005	merchandise trade balance-to-GDP ratio	fiscal balance (as ratio to GDP); flow of new loans to enterprises (as ratio to GDP); flow of new loans to households (as ratio to GDP); GDP rate of change	cross-section GLS estimation	Econometric results suggest that in Croatia, even in the short-run, the bias to lending to households has had a negative effect on the trade balance, and in fact a greater negative effect than lending to enterprises.
	90 countries	yearly data for 2002-2005	household loans-to-GDP ratio	GDP per capita; commercial bank assets/comm.+central bank assets; net interest margin; inflation; corruption index; stock market capitalization; legal origin	cross-country OLS regression	Strong positive relationship between GDP per capita and dependent variable (elasticity between 0.34 and 0.62) and negative relationship between inflation and dependent variable (elasticity between -0.31 and -0.57). Additionally, there is significant impact of corruption index (coefficient between 0.15 and 0.17) and of transition indicator. Indicators of banking system development were insignificant. However, further analysis of the residuals showed that banking reform, representing the credit supply side, is highly significant.
Lang, M., Krznar, I. (2004)	Croatia	monthly data for 1999:06 - 2003:12, dissagregated by banks	loans to the private sector	GDP (interpolated from quarterly to monthly level); banks' size; banks' liquidity; banks' capitalization; banks' ownership; interaction between monetary policy and banks' characteristics	SUR weighted least squares estimation method	Monetary policy's direct influence results in an expected (negative) and statistically significant sign in relation to banks' credit growth. However, the estimation of the models has not shown strong evidence of the bank lending channel in Croatia. Economic activity (GDP) had a positive and statistically significant influence on credit policy in the models, indicating that credit demand is one of the essential factors of banks' credit policies.
Panagopoulos, Y., Spiliotis, A. (1998)	Greece	quarterly data for 1971:Q1-1993:Q3	nominal loans to enterprises	wages bill, costs of raw materials, corporate tax payments, stock exchange price index, upper limit interest rates; interest rates on 3-month T-bills; inflation; banks' deposits invested in T-bills; banks' reserves; quality factors (maturity, repayments etc.)	cointegration analysis (OLS) and VECM (Johansen multivariate cointegration technique)	Components of company working-capital needs, especially the wage bill, are important determinants of credit demand. The same was found for the impact of previous loans on current loans. Interest rates proved to be insignificant due to strong interest rate control imposed by the authorities. Other variables also proved to be less significant.
Schadler et al. (2004)	new CEE member states (and eurozone for estimation purposes)	quarterly data for 1991-2002	credit-to-GDP ratio	long-term real interest rate on government bonds; income per capita	VECM estimation for aggregate eurozone, out-of-sample estimation for new CEE member states	Long-run relationship indicates that the credit ratio is positively related to per capita income and negatively related to the real rate of interest. The coefficient on the income term can be interpreted as a semi-elasticity: its estimated magnitude implies that a 10%-increase in per capita income raises the credit to GDP ratio by about 3 percentage points in the long run. A rise in the real interest rate by 1% lowers the equilibrium credit ratio by nearly 2%.
Šonje (2006)	Croatia	quarterly data for 1995:07-2006:07	real loans to households	weighted average interest rate, average net wage, wealth index (WPI; proportional to EUR/HRK nominal ER and CPI)	OLS model, cointegration	Estimated parameter that reflects the wealth effect is between 1.10 and 1.51 for household loans and 1.16 to 2.19 for housing loans.
		for housing loans quarterly data for 1999:07-2006:07	real housing loans	interest rates on kuna housing loans with f/c clause, average net wage, wealth index (WPI; proportional to nominal ER EUR/HRK and CPI)	OLS model, cointegration	Parameter that reflects the interest rate elasticity is estimated to be around -1.