

IS THERE A CREDIT CRUNCH IN THE CZECH REPUBLIC?

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Abstract

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We apply a disequilibrium model of credit demand and supply to test the credit crunch hypothesis. We suppose that firms face credit rationing and a realised outstanding loan will be the minimum desired level of commercial bank loans and bank limit for the firm. We adopted the disequilibrium model which consists of credit supply and credit demand equations. We suggest that actual observed credit growth rate at time t lies on the supply curve (excess demand), or on the demand curve (excess supply), or on both (equilibrium). Our model is estimated by the full-information maximum likelihood approach with a numerical maximization of the likelihood function. Our basic findings show that significant decrease in credits after the financial crisis in the year 2007 was caused by low economic and investment activity and reject the hypothesis that there is a credit crunch in the Czech Republic.

Keywords: money supply, money demand, maximum likelihood approach, credit, financial crisis, credit crunch, disequilibrium

INTRODUCTION

The economic crisis has spread from financial markets to real economies in countries around the world. There is a large amount of literature on the global transmission of previous financial crises which mostly finds strong evidence for the transmission of global shocks to liquidity and global capital flows (e.g. Brunnermeier, 2009; Brunnermeier and Pedersen, 2009; Calvo, 2009; Kalemli-Ozcan, Papaioannou and Perri, 2010). The studies have resulted in a worldwide slowdown of credit flows which have affected investment activities and the business cycle. The effect of changes in bank capital on banks lending is a key determinant of the linkage between financial conditions and real activity. Quantifying this transmission is one of the most important topics of the recent financial crisis, especially in the context of European recovery. The empirical analysis of 16 emerging European countries was provided by Popov and Udell (2012). They analysed the sensitivity of credit supply to banks' financial condition and found that decline in banking equity, Tier 1 capital and losses on financial assets reduced credit flows to firms during the crisis.

The question is, whether the link between the liquidity shocks (related to the recent crises) and economic activity exists also in countries that had no or virtually no relevant exposures to the US sub-prime market. Geršl and Komárková (2009) showed that the Czech banking system is one of the strongest in the EU as regards funding liquidity. Brzoza-Brzezina and Makarski (2011) constructed a small open economy DSGE model with a banking sector and showed a significant role of financial shocks. They found that the Polish banking sector contributed 1.5 percent to the decline in real GDP. The different effects of liquidity changes on capital flows is given by the quality of domestic institutions, country risk, strength of domestic macroeconomic fundamentals and other factors. Fratzscher (2012) found that these effects have been highly heterogeneous across countries.

We assume that the different effects of liquidity changes on credit flows are given by individual risks of specific banks. A well-capitalized bank or a bank with access to additional sources of capital should be able to accommodate possible funding liquidity shocks without reducing its assets and lending.

However, the banks actively manage their assets in order to maintain a constant capital ratio. If so, then loss results in a reduction in assets with the required reduction equal to the size of the capital loss scaled up by the inverse of its capital/leverage ratio.

Berrospide and Edge (2010) applied a number of different methods and panel datasets to examine how bank capital influences the extension of bank credit. Their empirical results showed modest effects of capital shortfalls and capital ratios on loan growth. They found that more important roles for other factors such as economic activity and increased perception of risk by banks.

In the paper we distinguish two main channels driving a sluggish lending activity, (1) credit rationing by banks and, (2) demand for credits.

The tightening of the conditions required to obtain banking credits increases the dangers of the liquidity squeeze becoming a credit crunch. A popular view seems to be that this decline in investment activities is driven by a credit crunch through a financial accelerator effect (e.g. Bernanke *et al.*, 1996; Fidrmuc *et al.*, 2010; and Korinek, 2011). Several studies have investigated different determinants of credit sources availability. Geršl and Jakubík (2009) or Memmel, Schmieder and Stein (2007) analyzed models of bank financing and its effects on the credit risk of the banks and credit availability. Jakubík and Teplý (2008) focused on scoring and its impact on creditworthiness of the Czech corporate sector.

Conversely, Peek and Rosengren (1995) argue that credit availability reflects normal procyclical pattern of both the creditworthiness of borrowers and credit demand. The use of credit by firms is explained by several theories. The financing theory suggests that firms with bank credits can offer higher trade credits to their customers to increase competitiveness in the market (Deloof and Van Overfelt, 2008). The financing advantage theory and transaction theory explain credit use by both suppliers and buyers (Schwartz, 1974; and Summers and Wilson, 2002). The marketing theory provides an alternative approach. The motivation of using trade credit creates a long-term relationship with customers and ensures long-term benefits through future sales to these customers (Summers and Wilson, 2002).

Recent literature distinguishes between more and less financially constrained firms with respect to to external sources and analyze access to external finance by firms (Shamshur, 2010; Kaplan and Zingales, 1997 and 2000; Moyen, 2004; Fazzari, Hubbard, and Petersen, 2000). Livdan, Sapriz and Zhang (2009) contribute that more financially constrained firms are riskier with higher profit potentials but this effect can be subsumed by size and book-to-market.

However, the key question from a policy perspective is whether the slowdown in credit flows is driven by supply (credit crunch hypothesis) or demand for credits. A credit crunch generally involves a reduction in the availability of credit

independent of a rise in the official interest rates. (Bijapur, 2010) Therefore, the solution might be aimed at changes in prudential policy (national regulatory framework of the banking system). If the slowdown in credit flows is mostly driven by credit demand and economic activity, then fiscal and monetary policy interactions aimed at expanding aggregate demand might be an effective instrument. Arestis (2011) suggests that recent development in theoretical economy (New Consensus in Macroeconomics) upgrades the role of monetary policy. Fiscal policy is an effective instrument only if it is properly coordinated with monetary policy.

The emphasis of past work has been mostly focused on empirical methods to identify the factors and their effects on the slowdown of credit flows. Tong and Wei (2009) proposed a methodology to identify the effects of capital flows on liquidity constraints and the role of the composition of pre-crisis capital inflows in the liquidity crunch. Calvo *et al.* (2006) show, that the recovery from financial crisis tends to take place without recovery in credit. They applied a partial equilibrium model and identified how much of the decline in credit is indeed due to a credit crunch and how much is driven by a reduction in the demand for credit.

A large number of studies applied a disequilibrium model of credit demand and supply to test the credit crunch hypothesis. This approach was pioneered by Clower (1965), Barro and Grossman (1971), Bénassy (1975) and Drèze (1975). Maddala and Nelson (1974) contributed that the maximum likelihood method is appropriate for disequilibrium models, which has been used for empirical analysis of credit markets in different countries. This methodological approach was applied to test the credit crunch hypothesis in different countries across the world by Hancock and Wilcox (1998), Agénor, Aizenman, and Hoffmaister (2004), Atanasova and Wilson (2004), Hurlin and Kierzenkowski (2007) and Poghosyan (2011).

Despite the wide range of empirical scientific literature in this field, empirical analysis of disequilibrium is missing in the Czech Republic. The main objective of this paper is to provide a disequilibrium model of credit demand and supply and discuss the possible causes of the credit slowdown after the financial crisis.

The paper is organized as follows. In the section Materials and Methods we describe the disequilibrium approach and specify demand and supply function with data sources. The next part of the paper describes the results of estimation and probability of demand and supply regime in the Czech Republic before and after the financial crisis. Finally we discuss and summarize the results.

MATERIALS AND METHODS

The datasets are provided by the publicly available database of the Czech National Bank (ARAD) and the Czech Statistical Office in the period 1999Q01–2013Q04 (in prices of the year 2005). First order

differences and logarithm transformation were applied. To test stationarity we applied ADF and KPSS test, normality was tested by Pearson's chi-squared test.

To identify disequilibrium in the credit market Madala and Nelson (1974) applied a model where actual observed credit at time t lies on the supply curve (excess demand), or on the demand curve (excess supply), or on both (equilibrium):

$$q_t = \min\{D_t, S_t\},$$

$$S_t = \alpha X'_{1t} + u_{1t}, \quad (1)$$

$$D_t = \beta X'_{2t} + u_{2t},$$

where D_t and S_t represents demand for and supply of bank loans. These variables are not observed, only the transaction quantity q_t is observed. The vectors X'_{1t} and X'_{2t} contain exogenous variables and represent credit supply and demand functions. The error terms u_{1t} and u_{2t} are distributed with zero mean, variances σ_1^2 and σ_2^2 and covariance matrix $\Sigma = \{\sigma_{ij}\}$.

Thus, the model (1) indicates the probability of each observation belonging to either supplied or demand amounts. However, due to the non-stationarity of data at levels we applied the model proposed by Hurlin and Kierzenkowski (2007), where growth rates correspond to the transformed data by first order differences:

$$\Delta q_t = \min\{\Delta D_t, \Delta S_t\},$$

$$\Delta S_t = \alpha X'_{1t} + u_{1t}, \quad (2)$$

$$\Delta D_t = \beta X'_{02} + u_{2t}.$$

The interpretation of the results of the model specified by formula (2) is different from the model specified in formula (1). Therefore we cannot define the disequilibrium as an excess of supply or demand. We identify the disequilibrium as an excess of quantities of new loans supplied or demanded on the market at time t . The full-information maximum likelihood approach with a numerical maximization of the likelihood function is applied to estimate the disequilibrium model (Herrera *et al.*, 2013).

It is assumed that variance of error terms $u_{1t} - u_{2t}$ is normally distributed with variance $\sigma^2 = \sigma_1^2 + \sigma_2^2$. Hence the reduced variable $(u_{1t} - u_{2t})/\sigma$ is normally distributed as well. The probability that the observation belongs to supply regime (π_t^s) is given by:

$$\pi_t^s = P(D_t > S_t) = 1 - \phi(h_t) = 1 - \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{h_t} e^{-\frac{x^2}{2}} dx, \quad (3)$$

where ϕh_t represents the cumulative distribution function of the normal distribution $N(0, 1)$. Analogously, the probability that the observation belongs to demand regime (π_t^d) is estimated as follows:

$$\pi_t^d = P(D_t < S_t) = \phi(h_t) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{h_t} e^{-\frac{x^2}{2}} dx. \quad (4)$$

The estimation of the log-likelihood function and disequilibrium testing is based on the approach defined by Herrera *et al.* (2013). To identify money supply function we followed the model applied by Vodová (2009) in the empirical analysis of the Czech Republic. The estimation was performed in the following form:

$$S_t = \alpha_0 + \alpha_1 \text{CAR}_t + \alpha_2 \text{NPL}_t + \alpha_3 \text{DEP}_t + \alpha_4 \text{RER}_t + \alpha_5 \text{IR}_t + \alpha_6 \text{RES}_t + \alpha_7 D_t + u_{1t}, \quad (5)$$

where CAR represents Capital Adequacy Ratio, NPL is the amount of non-performing loans, DEP represents deposits, RER are minimum reserve requirements, IR is the discount rate of the Czech National Bank, RES are bank reserves and D represents the dummy variable related to two specific crises periods after the year 2007 (2008Q03–2009Q04 and 2011Q01–2013Q01).

The money demand function is based on the empirical analysis of Herrera *et al.* (2013) extended by the exchange rate (ER) which represents specific conditions of small open economies (Arlt *et al.*, 2001):

$$D_t = \beta_0 + \beta_1 I_t + \beta_2 \text{ER}_t + \beta_3 \text{IIP}_t + \beta_4 \text{DEBT}_t + \beta_5 \text{EQ}_t + \beta_6 \text{IR}_t + \beta_7 D_t + u_{2t}, \quad (6)$$

where I represents inflationary expectations, IIP is the industrial production index which represents economic activity, DEBT is the rate of household indebtedness and EQ is the PX stock exchange which represents equity index.

RESULTS

Because of the failure to meet conditions of normality, we excluded three variables: 1) capital adequacy ratio, 2) minimum reserve requirements and 3) household indebtedness. Results of maximum likelihood estimations of credit supply and demand functions are presented in Tab. I. These results represent equilibrium models of private credits in the Czech Republic during the period 1999–2013.

We identified 4 models which are reduced according to the significance of the parameters. The basic model (Model 1) was reduced by inflationary expectations in accordance t-test results. The direct impact of the interest rate (discount rate) was rejected due to the context with economic theory (keynesian liquidity preferences). In Model 2 there is no significant relationship between the exchange rate changes and credit demand at the 10% significance level. After the reduction we obtained Model 3 where we identified 3 factors of credit demand at the 1% significance level.

I: *Estimations of demand and supply function*

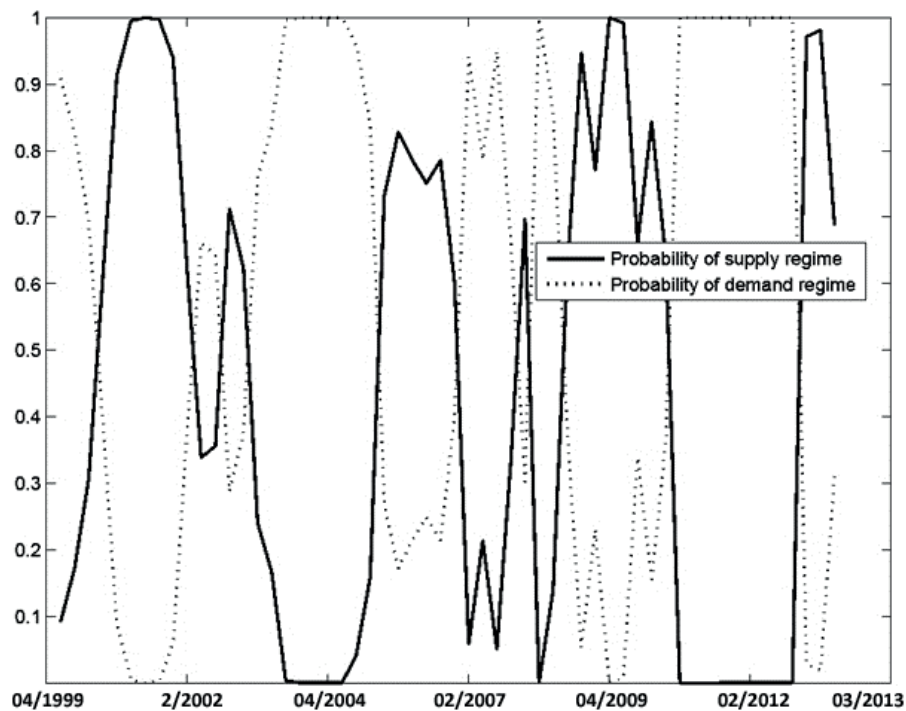
	Model 1	Model 2	Model 3	Model 4
Maximum Likelihood Estimates of Credit Supply				
Constant	0.1033*** (4.6997)	0.1058*** (4.8374)	0.1084*** (4.5797)	0.1146*** (4.6339)
Non-performing loans	0.3069*** (4.5088)	0.2981*** (4.5453)	0.3103*** (4.3984)	0.3039*** (4.4736)
Private deposits	0.6737*** (3.2604)	0.6508*** (3.1143)	0.6118*** (2.9406)	0.4547** (2.0956)
Discount rate	-0.0425* (-1.9715)	-0.0356* (-1.6960)	-0.0347 (-1.5254)	
Bank reserves	-0.3726*** (-4.4906)	-0.3376*** (-3.9253)	-0.3298*** (-3.5174)	-0.2204*** (-2.6551)
Dummy variable	-0.1040*** (-3.9594)	-0.1053*** (-4.0809)	-0.1070*** (-3.8821)	-0.1019*** (-3.6329)
Maximum Likelihood Estimates of Credit Demand				
Constant	0.0473 (0.7529)	-0.0379 (-0.8247)	-0.0623** (-2.2646)	-0.0665** (-2.4159)
Inflationary expectations	-0.1787 (-1.5158)			
Exchange rate	0.8824** (2.1283)	0.4829 (1.4389)		
Industrial production index	4.0602*** (3.2443)	5.7914*** (3.7267)	5.4543*** (4.8885)	5.5086*** (4.9151)
PX stock exchange	0.4077*** (4.5362)	0.3700*** (3.0841)	0.4215*** (4.1429)	0.4129*** (4.0528)
Discount rate	0.1763** (2.1900)			
Dummy variable	-0.4414*** (-3.8785)	-0.5277*** (-3.1214)	-0.5864*** (-4.9495)	-0.5888*** (-4.8828)
Log-likelihood	-103.9121	-98.3328	-96.1859	-94.5496
Adjusted R ²	0.7204	0.6455	0.6302	0.6314
Uncond. prob. of supply regime	0.3929	0.4464	0.4821	0.4821
Uncond. prob. of demand regime	0.6071	0.5536	0.5179	0.5179

The first cause of the credit demand changes is economic activity, especially industrial production index which follows the transaction motive of money demand. PX stock exchange changes have direct impact on aggregate demand, especially during crash times. Negative effects of the crises on the credit demand are shown by the dummy variable which represents the financial crisis after the year 2007 (period 2008Q03–2009Q04) and debt crisis which hit the Europe and the Czech Republic in the period 2011Q01–2013Q01.

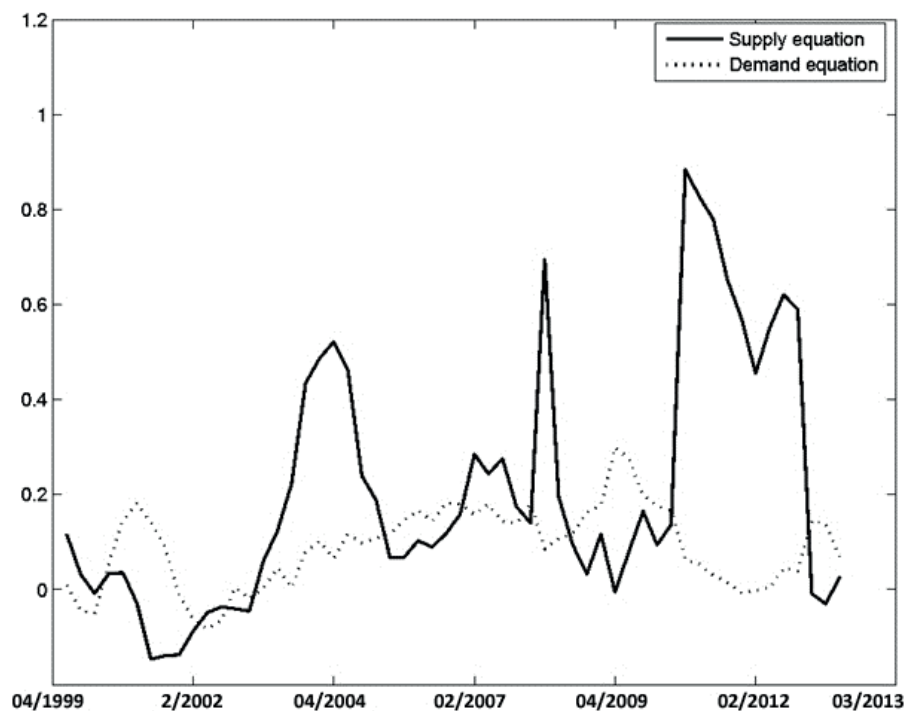
Changes in the supply of credits are explained by five variables in Model 3. There are significant effects of non-performing loans, deposits, bank reserves and dummy variable (which represents crisis periods). Impact of the interest rate was rejected at the 10% significance level which could be explained by the very low discount rates after the year 2007 which were continuously stable.

Therefore we removed the interest rate from the Model 3 and obtained Model 4.

In Model 4 we identified the positive effects of savings and the negative effect of bank reserves on the credit supply which is consistent with the theoretical background and other empirical studies (e.g. Herrera *et al.*, 2013). Negative effects of crises (dummy variable) could be explained by credit crunch effect due to tightening of the conditions required to obtain a loan from the banks. Obviously, there is also a positive effect of non-performing loans on the credit supply which suggests that banks may still increase their loans as the generation of non-performing loans. It is the natural result of lending when banks have very low level of non-performing loans. The Parameters of the credit demand function did not change substantially in Model 4.



1: Unconditional probability of supply and demand regime for Model 3

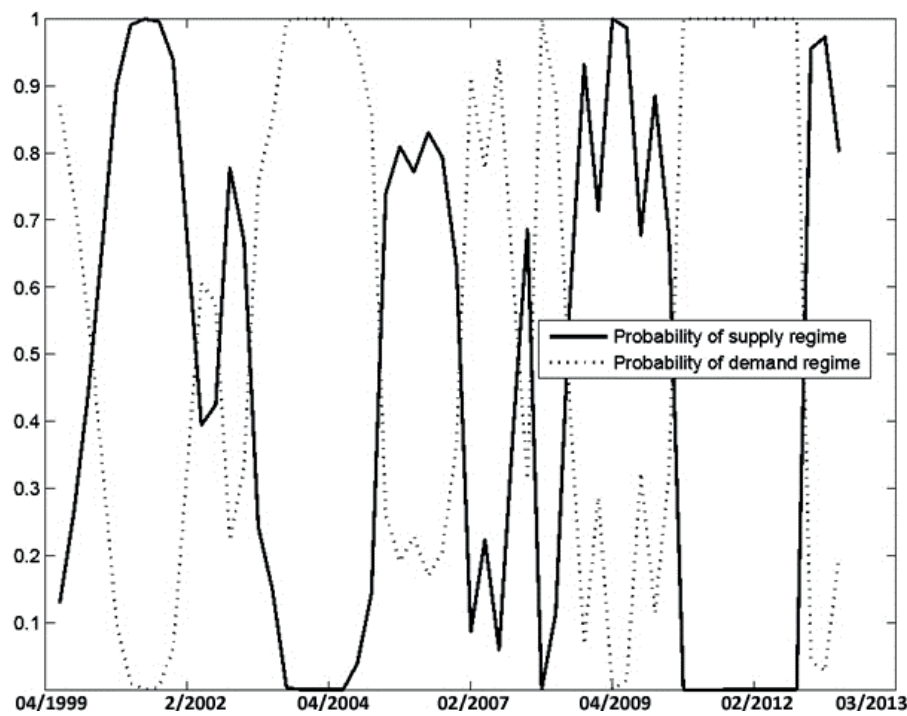


2: Estimated quantities in Supply and Demand regime for Model 3

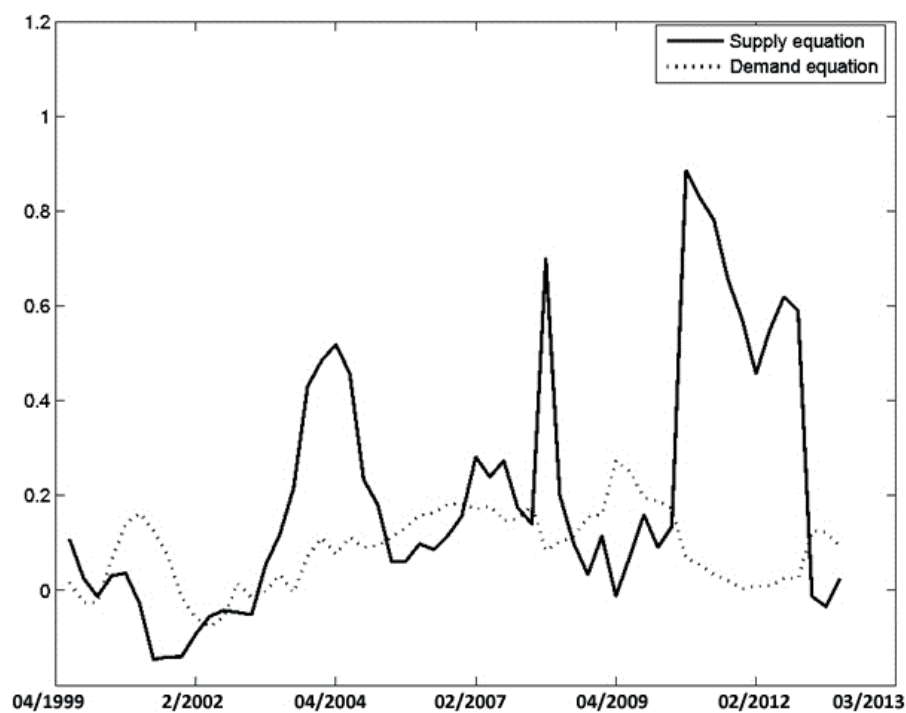
However, these two models (Model 3 and Model 4) are not substantially different in probability to distinguish between supply and demand regimes (Tab. I). The probability is also shown in Fig. 1 and Fig. 3. We assume credit crunch (excess of demand) when the estimated probability of the supply regime is higher than 0.5 (see formula 3). Simultaneously,

we assume excess of supply when the demand regime is higher than 0.5 (see formula 4).

For the final conclusions we follow Model 4 (Tab. I) which is presented in Figs. 3–4. We can identify eleven moments when credit supply and demand changed their prevalence between the years 1999 and 2013 (Fig. 3). To better understand



3: Unconditional probability of supply and demand regime for Model 4



4: Estimated quantities in Supply and Demand regime for Model 4

excess of demand or supply we show the estimated demand and supply for Model 3 (Fig. 2) and Model 4 (Fig. 4). Regardless of frequent changes in regimes during the observed period we identified only two periods when we can describe credit crunch. The first is during the years 2000 and 2001, the second

(shorter and less substantial) we can identify in the year 2009. On the contrary, excess of supply is confirmed during the years 2003–2004 and 2010–2012, as well as immediately after the financial crisis during the years 2007 and 2008.

DISCUSSION

It is important to mention that the European countries are more reliant on bank credits and bank intermediation of savings, than the United States and the rest of the world. Therefore the banking system plays a crucial role for sustained recovery in Europe after financial crises. We focused on the situation in the Czech Republic, which is characterized by a significant presence of foreign banks. Western European investors were attracted by prospects of rapid growth in the local market lacking initial capital, guaranteeing high returns. European banks have been increasingly active in this market, notably Austrian banks. This situation led to vulnerabilities that have accumulated during the pre-crisis period. The excessive consumption growth, associated with the lending boom, intensified the impact of the financial crisis in the emerging economies of Central and Eastern European countries.

Zdzienicka (2011) showed that countries that were characterized by a credit boom in the years 2002–2008 are also those countries that have those countries that have experienced the largest credit contractions after the financial crisis. These findings were confirmed especially in Bulgaria, the Czech Republic, Estonia, Latvia, Lithuania and Slovenia. This author argued with credit crunch but she analysed only the deviations of credits from its long-term trend. In comparison with Zdzienicka (2011) we

performed a more detailed analysis of credit market equilibrium and our results confirmed that credit decline after the crisis is primarily caused by decline on the demand side.

Our results are consistent with the empirical contribution of Hale and Arteta (2009). They showed that decline in credits is mostly caused by decline in contracting demand. They focused on the currency crises in 15 emerging markets in the period 1981–2004. Effects of the recent financial crisis were analysed by Nguyen and Qian (2014). They applied microeconomic datasets of World Bank in six Eastern European countries in the period 2008–2009 and concluded that decline in demand prevailed as the causes of credit fall. Their results also confirmed that impact of the crisis differs with different sectors in which these firms operate.

We can find the theoretical argumentation of our empirical findings in the Post-Keynesian theory of money endogeneity. According to these assumptions, money supply is determined by money demand. The process of money creation is caused by economic and investment activity which reduced after the financial crisis. Moreover, the Czech Republic is significantly linked with the banking system in the euro area where the upper limit of credit money creation disappears (Kapouněk, 2011). Therefore, the probability of a credit crunch in the Czech Republic is very low.

CONCLUSION

In this paper we tried to answer the question whether decline in credits in the Czech Republic after the financial crisis was caused by credit crunch or demand factors. At the first step we identified money supply and money demand functions. The variables of credit demand and supply were identified according to the empirical findings of Herrera *et al.* (2013). Both functions were adapted to the specific conditions in the Czech Republic. The credit supply function was modified according to the empirical analysis provided by Vodová (2009) and the demand function was extended by the exchange rate which represent the specific conditions of small open economies (Arlt *et al.*, 2001).

As the second step we employed the provided by Hurlin and Kierzenkowski (2007) to identify disequilibrium in the credit market, especially excess of demand (credit crunch) or supply of new amounts of credit at the time t . To estimate the disequilibrium model we applied the full-information maximum likelihood approach with a numerical maximization of the likelihood function. We created 4 models where Model 3 and Model 4 are background accepted for discussion of the results. The Model 4 is reduced by the discount rate as the independent variable of the credit supply function. The unconditional probability of the supply regime was estimated at 0.4821, the unconditional probability of the demand regime was estimated at 0.5179. However, the credit crunch (excess of demand over supply) was identified between the years 2000 and 2001 and during the year 2009. On the contrary, excess of supply was shown much more substantially in the periods 2003–2004, 2010–2012 and also in the period after the financial crisis during the years 2007 and 2008.

Finally, we concluded that decline in credits after the financial crisis was caused primarily by demand factors. Theoretical background for this conclusions was provided by the Post-Keynesian theory of money endogeneity. We argued that money supply is determined by money demand which is affected by investment and economic activity. The fall in investment activity and credit demand after the financial crisis were the main factors which impacted on the credit market. The effect is significant due to the link of the banking sector in the Czech Republic and the euro area, because the upper limit of credit money creation in the huge monetary unions has vanished.

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