Cristian-Florin DĂNĂNĂU,
The National Bank of Romania and the University of Economic Studies, Bucharest

Case studies

A DISEQUILIBRIUM MODEL FOR LEI-DENOMINATED NON-GOVERNMENTAL CREDIT IN ROMANIA

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Abstract

We empirically investigate through an econometric approach the Romanian credit market, namely the lei-denominated part of it, and the factors that interact with it. The main goal is to assess whether a credit crunch ocurred in Romania during the economic crisis. To this end we employ the disequilibrium model framework, set up in economic literature some 40 years ago. Our investigation takes into consideration the main macroeconomic determinants of this market, that interact with demand and supply. Our approach has in view the macroeconomic variables such as output, interest rates and foreign currency credit. The demand and supply function are estimated through the maximization of a certain maximum likelihood function. The final conclusion is that, based on the estimated model, one cannot detect a credit crunch in the after-crisis period.
This paper's results show that empirically-constructed disequilibrium models can be used to properly describe the behavior of the lei-denominated credit market, by taking necessary precautions.

Introduction

This article focuses on the evolution of non-governmental lei-denominated credit in Romania, during a thirteen years period, 2000-2012. This interval includes the membership period of the country to the European Union, that contributed to the economic development, in general, and to massive inflows of banking capital, in particular. Disequilibrium method established by **(Maddala and Forrest, 1974)** is used in order to assess the trends of this type of credit. Specifically, we assess whether a credit crunch (a situation in which "the supply of credit is restricted below the range usually identified with prevailing interest rates and the profitability of investment projects" **(Pazarbasioglu, 1997)**) ocurred within Romanian economy during the crisis period. As a consequence, an estimation and validation of a disequilibrium model for the Romanian lei-denominated credit market is done for the first time in literature.

The article has the following structure: in the first part we deliver an overview of the literature in the field of assessing credit markets through disequilibrium models. The second part comprises a short description of the theoretical model. A third part is dedicated to explaining the rationale behind our choice of explanatory variables for credit supply and demand.

The model's estimation, together with its macroeconomic interpretation is done in the fourth part of the article. A general conclusion of the main findings and future research area is at the end of the paper.

1. Literature review

The disequilibrium models were extensively used by various authors for analyzing certain national credit markets, with a view of assessing credit crunch: **(Barajas and Steiner, 2002)** for Colombia, Peru and Mexico, **(Ghosh and Ghosh, 1999)** for Korea, Indonesia and Thailand, **(Hurlin and Kierzenkowski, 2007)** for Poland, **(Nenovsky et al., 2003)** for Bulgaria, **(Baek, 2005)** for Korea, **(Pazarbasioglu, 1997)** for Finland, **(Pruteanu, 2004)** and **(Vodova, 2008)** for the Czech Republic. We will present briefly the results of these studies.

(Baek, 2005) uses the following vectors of independent variables for the Korean credit market: for the supply: loans granted in the previous period, the interest differential between the interest rate for credits and the coupons of corporate bonds, bank deposits from the previous period, compulsory reserve rate and the industrial production index; for the demand: the value of credits in the previous period, the interest differential between the interest rate for credits and the performance of certificates of deposit and the industrial production index.

(Barajas and Steiner, 2002) assess the slowing down of bank credits to the non-governmental sector in three countries in Latin America. The functions of aggregate supply and demand include the following variables: i) the industrial production; ii) the gross domestic product; iii) the GDP gap; iv) the expected inflation rate; v) the stock market index. In addition to elements presented in previous studies, two specific variables are included for the supply function: the percentage of non-performing loans from the total volume of credits, as well as the percentage of specific credit risk provisions from the total volume of non-performing loans.

(Ghosh and Ghosh, 1999) use a disequilibrium model to investigate a potential credit crisis in three Asian countries: Indonesia, Korea and Thailand during the period 1997-1998. The authors assume that the real supply of credits depends on the following variables: i) the real interest rate compared to the cost of resources (the latter is estimated according to the rates for deposits); ii) the current output as a measure of the companies' reimbursing capacity; iii) the commercial banks' real capacity to grant loans. In its turn, the real demand for credits is determined by the following variables: i) the real interest rate; ii) the current output, in order to evaluate both the demand for working capital and as an indicator of future output (calculated as an average in the periods t-2, t-1 and t in order to reduce endogeneity-related issues); iii) the production gap, measured as a deviation of the current industrial production from its long-term trend; iv) stock market prices (as a proxy for expected output); v) inflation, as a general indicator of the macroeconomic environment.

(Hurlin and Kierzenkowski, 2007) apply the standard ML methods and obtain counter-intuitive results as regards the identification of regimes. The explanation stems from using non-stationary time series. Observed variables are non-stationary and are not co-integrated in the linear model. In fact, it is impossible to test co-integration in demand and supply equations since their actual quantities are simply unobservable. In order to avoid this difficulty, the authors estimate the disequilibrium models in first differences, and use the min condition on annual growth rates as a first approximation. This modification of the model leads to a very precise identification of both regimes on the Polish credit market.

(Nenovsky et al., 2003) uses of a variety of factors to explain credit supply, respectively credit demand. The influencing factors can be grouped in the following categories: i) traditional factors (the size of the companies, the profit, bank resources), which also include internal regulations, as well as the structure of the banks and the companies; ii) the legal and institutional framework, mainly the restrictions resulting from the implementation of the monetary council regime; iii) corruption, influence exercised by the state; iv) property structure, control over the companies and the

banks. Data regarding companies was gathered from a database which includes 118 large companies listed on the stock market in Bulgaria, and the covered period is between 1998 and 2001. Data about banks was obtained mainly through a questionnaire that all the 35 commercial banks in America completed, and other necessary information was gathered from the banks' balance sheets and profit and loss accounts.

(Pazarbasioglu, 1997) analyzes the empirical evidence of a credit crunch in Finland, following the banking crisis. The paper uses monthly data on financial indicators, and the results suggest that the market reduction in bank lending during 1990s was a reaction to a cyclical decline of credit demand. Another finding is that banking industry become less willing to provide credit during periods associated with weak asset quality. Evidence is found as to the fact that banks increased collateral requirements during 1994, increasing non-price terms of loans. Other studies suggest that this process stopped and consequently the percentage of firms that have difficulties in accessing loans declined to less than 10 percent.

(Pruteanu, 2004) explores whether Czech companies are credit rationed on the market for newly granted loans denominated in Czech koruna. This is the sole research in which a domestic currency credit market (which is „mixed up" to a foreign currency market) is investigated. The author uses foreign-currency-denominated loans as explanatory variable in both demand and supply equations. Finally, two periods of the studied interval are characterized by a state of excess supply, and for the rest of the time, the author finds evidence of moderate excess demand. One must stress the fact that we similarly use the foreign currency loans in Romania's case, due to the fact that for the whole period 2000-2013 a great share, 58,3%, of the non-governmental credit has been denominated in foreign currencies.

(Vodova, 2008) has in view the credit market in Czech Republic, and takes into consideration for credit demand: i) the interest rate; ii) the gross domestic product, with a lag of 3 three-month periods; and iii) the inflation rate. For credit supply two independent variables are used: i) the banks' capacity to grant loan, and ii) the gross domestic product, as a measure of the debtors' ability to pay their debts. The following is worth mentioning: positive signs would are expected for GDP in both equations, but after estimation the GDP coefficient is negative in supply equation, which illustrates the existence of an inverse relation between this parameter and the credit supply. According to the author, this can be explained by referring to the banks' potential anti-cyclic behavior: if they expect a decline in the economic growth in the future, they can reduce their current credit supply.

2. Theoretical framework of the model

A disequilibrium model involves the estimation of two functions, one related to the demand, the other to the supply. The two sets of regressors have to be distinct and to include variables that determine supply and demand from an economic perspective. The disequilibrium hypothesis considers that the minimum of the two quantities at a certain moment represents the equilibrium on the market. The theoretical framework of this group of models was introduced for the first time in the seminal article of **(Maddala and Forrest, 1974)**. In order to formalize the described method, the following linear regression equations are given:

$$D_t = X_{1t}' \beta_1 + u_{1t}$$

$$S_t = X_{2t}' \beta_2 + u_{2t}$$

where D_t, S_t represent the demand, respectively the supply in period t, the vectors X_1, X_2 represent the exogenous variables that influence the demand, respectively the supply of credits, and u_1, u_2 represent the residuals, which are independently and normally distributed (white noise). Then, the level of equilibrium of the market at a given moment t is established by:

$$Q_t = \min(D_t, S_t)$$

This assumption is reasonable, as if demand is higher than the supply, then the excess demand remains unsatisfied (supply regime), and in the opposing situation when supply is higher than the demand, the excess supply remains uncovered (demand regime). In brief, disequilibrium hypothesis means that the short side of the market prevails at some moment in time, and the price of the quantities involved (in our case the lending interest rate) does not adjust itself to an equilibrium level. If both residuals are independent and normally distributed, then one can calculate the vector of structural parameters. The method of maximum likelihood (ML) estimation is used for the likelihood function of the model, deduced by **(Hurlin and Kierzenkowski, 2007)**. Also, one can compute the estimated probabilities of each regime.

3. Empirical model's specification

In the sequel, we shortly describe the variables included within the empirical model, together with their motivation for our choice. The estimation results are also presented, and some comments on their relevance from an economic viewpoint are made. Finally, we drawn some practical considerations on the lei-denominated loans market evolution and we indicate some future research directions related to the empirical disequilibrium model.

In order to estimate and subsequently validate the disequilibrium model in Romania's case, first we have to establish the regressors, that must be

macroeconomic variables that have a great impact on either demand-side or supply-side of lei-denominated loans market. To this end, for credit demand and supply we take into consideration the following linear regressions:

$$cngr^d = \alpha_0 + \alpha_1 * cngvr_{t-1} + \alpha_2 * pib_{t-3} + \alpha_3 * dobc_{t-3} + \alpha_4 * infl_{t-1} + \alpha_5 * bet_{t-1}$$

$$cngr^s = \beta_0 + \beta_1 * cngvr_{t-1} + \beta_2 * pib_{t-1} + \beta_3 * depr_{t-1} + \beta_4 * markup_{t-1}$$

where:

- ***cngvr*** is the real foreign-currency-denominated credit granted by banks to firms and households (excluding public administration). In demand equation the sign could be either positive – if the firms and households consider splitting the reimbursement and other risks between national and foreign currency, and negative – if they see foreign currency loans as an alternative to lei loans – which is likely to happen, for example, if the interest rate differential decreases. In supply equation the expected sign is negative, as banks have limited financing resources, that must be "splitted" between lei and foreign currency;
- ***pib*** is the gross domestic product in constant prices, seasonally adjusted, with three lags in demand equation, as a *proxy* for the general economic climate; the expected sign is positive in both equations as both sides of the credit market generally tend to act procyclically. i.e to boost demand and supply in case of economic growth. Since this variable is not originally available in monthly values, we used linearly interpolated the original values in order to get the monthly values of the series;
- ***dobc*** is the nominal lending rate, with three lags - due to the time needed to process the credit applications; the expected sign is negative, as the firms and household look at it as a major indicator of the cost of financing;
- ***infl*** is the inflation rate expressed by consumer price index. The expected sign is negative, as a higher inflation indicates a worse general economic environment, that shoud result in a decrease of the demand;
- ***bet*** is the index of the Bucharest stock exchange; the expected sign is positive if the macro effect prevails, i. e. an increase of the stock exchange activity accounts for better economic perspectives, and negative if the substitution effect is in place;
- ***depr*** represent the real domestic term deposits (including public deposits), which is used as a *proxy* for lending capacity of the banking system as regards lei-denominated loans. Obviously, the expected sign is positive;
- ***markup*** is the risk premium that banks charge their clients and it is calculated as the difference between the nominal lending rate and the nominal money market rate ROBID at three months. The higher the risk premium, the lesser is the banks' willingness to grant credits due to incertainty associated with such credits, therefore its expected sign is negative.

The dependent variable is the real lei-denominated credit granted by banks to firms and households, ***cngr***.

All time series are from the National Bank pf Romania, except for ***pib***, which is from the National Institute of Statistics. To avoid endogeneity problems we considered all the regressors with various lags, in order to get the best statistical results. The initial series are in monthly values and cover the period 2000m01:2012m12. Nominal values for were deflated by using the inflation rate, expressed by the consumer price index. All series, except for ***dobc***, ***infl*** and ***markup,*** expressed in percents, are expressed in natural logarithms.

Although the time series exhibit unit roots, i.e. they are non-stationary, we perform our estimation in levels, as opposite to **(Hurlin and Kierzenkowski, 2007)**, due to the following reasons:

- using differentiated series results in less useful information, in the sense that one cannot draw appropriate conclusions if the differences of demand and supply are used instead of actual levels;
- the series representing lei-denominated credit tends to be integrated of order 2, according to ADF test, that would imply taking second difference, with further loss of generality.

4. Estimation's results and main findings

In order to use the ML method we have to get the initial values of structural parameters (the coefficients in demand and supply equations, as well as the two standard errors). To this end we used the method proposed in **(Hurlin and Kierzenkowski, 2007)**.

The errors in both the initial OLS demand and supply equations are normally distributed, according to Jarque-Bera tests (*computatins performed with statistical software Eviews 7.0*) (see annex 1).

Therefore, the basic assumption of errors normality is verified by our model. We get the following ML estimates of the parameters (*computations were performed using the software developed by professor Christophe Hurlin, freely available on www.execandshare.org*) (t-statistics below each equation):

$$cngr^d = -44.2365 + 1.6907 * cngvr_{t-1} + 4.0524 * pib_{t-3} - 0.0077 * dobc_{t-3} + 0.0220 * infl_{t-1} - 0.3913 * bet_{t-1} \quad (1)$$

$$-2.9277 \quad 4.9306 \quad 2.4425 \quad -2.6026 \quad -2.1678 \quad 3.5264$$

$$cngr^s = -21.7312 - 0.2894 * cngvr_{t-1} + 2.2273 * pib_{t-1} + 1.0925 * depr_{t-1} - 0.0275 * markup_{t-1} \quad (2)$$

$$-6.6451 \quad -3.0320 \quad 5.5468 \quad -5.2586 \quad 6.1392$$

All coefficients are statistically significant in (1) and (2), and have the expected signs, except for inflation rate, which proves a good fitness of our model to the data. In this way the empirical assumptions we have made on the determinants of credit market are practically confirmed.

The positive elasticity of foreign-currency-denominated credit in demand equation reflects, according to **(Pruteanu, 2004)**, the process of country's European Union integration process, especially form a financial viewpoint. In this context, firms and households consider euro loans as an equal opportunity currency in which they can borrow funds, thus splitting the incurring risks of the debtors by diversifying between domestic and foreign currency. The same variable has a negative effect on supply, as expected (although lesser in absolute value), and indicates the presence of a substitution effect: an increase of 1% of foreign-currency-denominated loans determines a decrease of about 0.29% of lei-denominated loans.

General economic development, proxied by the level of gross domestic product, has the most important effects on boths sides of the market; however, the elasticity is greater (almost twice) on the demand side. This situation can be explained by the fact that the real sector of the economy has a greater positive influence on the real sector of the economy (as the source of demand) than on the financial one (as the source of supply). One can shortly state that: the greater the level of past economic development, the greater the contemporaneous demand for credit.

The nominal interest rate has a negative semi-elasticity of -0.0077, so that a one percent increase of nominal lending rates determines a 0,7% reduction of the credit demand. This fact confirms the fact that economic operators tend to take into account the nominal rates when they are making decisions about credit applications, and this can be associated with the need for funds is generally "counter-balanced" by the existing lending rates.

The inflation rate has a relatively low positive semi-elasticity of 0.0220, and this fact indicates that a low inflation should lead to a decrease in lei loans demand. In other words, borrowers do not take into consideration the price level as signalling the "quality" of economic environment. In fact, the period of low inflation rates (2006-2012) partially coincide with low level of credit (2009-2012).

The elasticity of ***bet*** is negative and shows that an increase of 1% of the index results in a decrease of 0.4% of the credit demand. This confirms the fact that the Bucharest Stock Exchange plays a role as an alternative source of financing to banking credit.

The domestic deposits have an elasticity of 1.10 (closer to 1), which is highly significant. This fact shows that our initial assumption to proxy the lending capacity by this variable was correct. On the other hand, the size of the coefficient suggests that generally banks appeal to other resources than domestic deposits to increase their lending capacity.

The risk premium semi-elasticity has the expected negative sign and shows that an increase in markup of one percent diminishes the credit supply by 2.75%.

In order to further check the validity of our model we have to test whether there are at least one co-integration relationship between the fitted values of demand and supply, as calculated from the ML estimation above, on the on hand, and the original, observed lei-denominated credit time series on the other hand. To this end, we performed two Johansen co-integration tests (trace tests) for the two pairs of time series, that show the existence of desired co-integration relationships. We only provide the test for fitted demand in annex 2, similar result is obtained for fitted supply.

Finally, we show in annex 3 the estimated probabilities of each regime. One can easily observe that for the most period the market was in a demand regime. However, at the beginning of the interval (2000m04-2004m12), the market was in a supply regime, which is in line with the relatively lack of bank capital, high markups associated with greater risks, and low levels of GDP, factors that restrained the credit supply. The appearance of demand regime coincided both with the major improvement in the international status of Romania, represented by the signing of European nUnion accession treaty (April 2005) and to a major change in monetary policy, namely inflation rate targetting, adopted by the central bank in August 2005. As a result, credit in foreign currency became a major alternative of financing as more and more Romanian economic operators connected to European Union economic environment (*in this way, the interest rate risk and exchange rate risk associated with lei denominated loans were removed, especially for importers*), and therefore the demand for lei-denominated credit decreased. Also, the inflows of foreign capital to the banks from their foreign mother-banks, thus resulting in greater lending capacity

5. Overall conclusions and future research areas

This paper investigates the lei-denominated Romanian credit market that appeared in the process of transition to the market economy, which includes a healthy banking system. First part deals with a comprehensive presentation of past results and findings in the field of disequilibrium models used in various national credit markets.

The other parts of this paper shortly present the theoretical model, as well as the main findings related to an empirical disequilibrium model for lei-denominated credit market of Romania. Using the maximum likelihood method, which is well-known in the literature, we estimate the structural

parameters of our model and make some useful insights into the inner structure of the lei-denominated credit market.

The estimation results show that there was no credit crunch on Romanian lei-denominated market. Moreover, according to the estimated coefficients, the demand regime prevailed in the period 2005-2012, that coincides with the *de jure* membership Romania to the European Union.

This paper's model uses lending capacity as a variable that discriminates between demand and supply. If we take into account the large number of possible factors that may affect credit supply, mentioned in literature, a future research area is the testing, calibration and validation of disequilibrium models that include those factors. Additionally, the present study may be improved by proposing alternative models and estimating them through maximum likelihood method, in order to get a better statistical quality and to better correlate the theoretical findings with the economic facts.

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Annexes

Annex 1. Normality of residuals in initial demand and supply equations

Series: Residuals	
Sample 2000M04 2012M12	
Observations 153	
Mean	1.29e 14
Median	-0.011277
Maximum	0.183085
Minimum	-0.253829
Std. Dev.	0.101619
Skewness	-0.064595
Kurtosis	2.332345
Jarque Bera	2.948142
Probability	0.228991

Series: Residuals	
Sample 2000M04 2012M12	
Observations 153	
Mean	1.62e 15
Median	-0.000656
Maximum	0.240564
Minimum	-0.205666
Std. Dev.	0.097228
Skewness	0.251634
Kurtosis	2.373672
Jarque Bera	4.115478
Probability	0.127742

Annex 2. Co-integration trace test of fitted demand with actual credit

Sample (adjusted): 2000M09 2012M12				
Included observations: 148 after adjustments				
Trend assumption: Linear deterministic trend				
Series: FIT_DEMAND LCNGLR				
Lags interval (in first differences): 1 to 4				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.090829	17.84381	15.49471	0.0217
At most 1	0.025026	3.750923	3.841466	0.0528
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Annex 3. Estimated probabilities of demand and supply regimes