

A study concerning macroeconomic correlations on the basis of ARIMA models

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Abstract: The global financial crisis has seriously affected economies in developing and Moldova was not an exception. Affected by political instability which left visible fingerprints on the country's macroeconomic trends, the national economy is in recession. A new economic crisis could lead the country to bankruptcy. Thus, it is necessary to identify an analytical tool that would allow the anticipation of new potential differences between needed of the financial resources for the economy to achieve the objectives and planned measures, including those to meet any additional needs arising in the process, on the one hand and the possibilities of purchasing them on the other.

Key words: financial imbalance, modeling financial imbalance, ARMADL regression

Financial intermediation plays a significant role in the economic development of a country. In fact, in the Republic of Moldova, financial intermediation is more influential than the capital market. For example, the financial intermediation measured by the ratio of money supply to GDP has shown a remarkable evolution from 28% in 2000 to 63% in 2014. Given the fact that Moldova's economy is in decline, it largely depends on additional sources to finance investment and consumption needs. Thus, there is an increased interest of financial institutions in crediting the economy.

According to the model of causality between the economic activity and crediting the economy described by Bernanke and Gertler (1995), there is a causal relationship and assets as credits are relevant when sending monetary shocks to the real economy. If a monetary policy is tighter, banks respond by limiting their supply of loans. So, according to this mechanism, commercial banks offer a limited number of credits during a crisis. In other words, a low crediting rate may indicate the beginning of a crisis which originates from tight monetary policies or a response to socio-political conditions in the respective region.

At the moment, we cannot outline a standardized forecasting technique to anticipate potential financial crises. But every year, this segment undergoes new empirical studies that attempt to identify the basic parameters of this phenomenon. The financial crises of 1994 -1998 in countries such as Russia, Mexico, Thailand, Indonesia, Malaysia, Brazil and South Korea and the US financial market collapse in 2008 which generated a global financial crisis have led to the emergence of a new modeling segment. Below you will find a brief description of the most valuable studies on this segment.

In econometric analyses, credit crises for demand and supply of "money" are estimated by most authors separately in order to identify periods of excess deposits or excess lending. The first empirical research to highlight the general market disequilibrium was conducted by Fair and Jaffee (1972), who applied the maximum likelihood estimation in their attempts to find the optimum balance between demand and supply of credit. This theory was developed in the works

of Fair and Kelejian (1974) and Maddala and Nelson (1974). Later, Quandt and Ramsey (1978) analyze the imbalance through the switching regression model where periods of excess credits and excess deposits represent two regimes with a certain probability of occurrence.

Pazarbasioglu (1996) uses modeling to identify the decisive factors for the credit crisis in Finland as a result of the banking crisis in 1991-1992. By analyzing monthly data, he shows that the decline in crediting was the result of a reduced demand for credits related to the high degree of borrowers' indebtedness. On the other hand, banks could not accept greater risks due to deteriorated quality of assets and a general decline in the banking system, thus it was needed to increase capital adequacy.

Other applications are made by Ghosh and Ghosh (1999) and Beng and Ying (2001). Ghosh and Ghosh (1999) analyzed the credit crisis in Eastern Asia during 1997-1998. They found little evidence that at the aggregate level there would be a link between demand and supply on the credit market, although, at the micro level, some firms would have lost access to credits. Beng and Ying (2001) use data for the banking system in Malaysia to determine the extent of the imbalance. They show that during the financial crisis there has been a sharp decrease of loans provided by the commercial banks.

In 1999 Kim performed a study to identify the causes of economic imbalance in Korea as a consequence of the economic crisis. He finds convincing evidence on the practical importance of the credit channel, following the Korean financial crisis. Furthermore, he presents clear evidence that a significant decrease in loans is mainly driven by a sharp decline in the supply of credits which largely occurs due to the strict regulations generalized in the field of the bank capital rather than a reduced demand for credits.

The study conducted by Kanoh and Pumpaisanchai (2006) define the credit crisis as a situation where the supply of credits is restricted by the market interest rates and the profitability of the investment projects. The study was based on the official statistics and the survey results provided by Japanese banks and companies which presented the views of the respondents that carried out credit activity and respectively benefited from credit terms. One of the basic advantages of this study is the use of qualitative information describing the interaction between banks and the productive sector that is not included in the official quantitative data, but which is very important when the market is inefficient. The logistic regression was used as a modeling technique to estimate credit supply and respectively credit demand. After that, the calculation of the credit market skewness relied on the difference between credit supply and the real credit demand and the discrepancies showed the inefficiency of the Japanese banking system.

Further to a research carried out by Sornette and Woodard (2009), they set the general framework that allows to identify the causes triggering the financial and economic crisis, namely the accumulation of financial bubbles and their interdependence that lead to the illusion of "a perpetual money machine" which enables financial institutions to enrich at the expense of the instability of the artificially created process. The diagnosis made determined the authors to conclude that many of the measures taken to address the crisis of liquidities and encourage excess consumption in USA were irrational and even dangerous, because the hedge funds were not collected during "the good times". They suggest anticipating crisis situations by using economic and financial modeling based on information that describes the multiaspectual macroeconomic situation in the country: the financial aspect, economic aspect, material resources availability, labor force, demographic processes, level of education. For quality results, the authors propose to establish a priori limits on modeling macroeconomic and political parameters or other

dimensions. There will be used long data series which will also include crisis statistics. Additionally, it should be taken into account the level of the country's development and the degree of influence on the world economy as a whole. In order to check how far-seeing the model is, the retrospective modeling will be applied and the given results will enable adjustments to the created instrument.

Below you will find the results of the research conducted on the basis of the statistics of the Republic of Moldova, January 2011 - July 2016 ¹ in order to estimate a dynamic econometric model capable to identify phases of the financial imbalances and the effects of the trend for the upcoming months.

The sites of the public institutions such as the National Bureau of Statistics and the National Bank of Moldova as well as the results of the study "The Global Competitiveness Index" were used as information sources for modeling.

Bernanke and Gertler mentioned in their work that there is a functional dependency between crediting the economy and the financial and economic crisis. Thus, based on this theory, the model proposes the variable of the financial imbalance to be expressed by considering the indicator *New loans granted, total in time, in the banking sector*².

In Sornette and Woodard's work to describe the overall economy, the model includes the following indicators to be defined as exogenous variables:

a) proxy variables that describe supply and demand of the financial and banking system:

- *weighted average interest rate on new loans;*
- *weighted average interest rate on new deposits ;*
- *new loans granted, total in time, in the banking sector.*

b) proxy variables that describe aspects of economic development as a whole³:

- *industrial output price index;*
- *consumer price index.*

c) a proxy variable describing the workforce:

- *the average monthly salary*⁴

d) a proxy variable describing the interaction with the world:

- *the net international investment position of the Republic of Moldova*⁵.

¹It was not possible to take into account a longer period of time in the absence of monthly trends for exogenous variables selected in the model;

² In national currency and in foreign currency. Transactions with non-residents, government loans / deposits and interbank loans / deposits are not included;

³ The basic indicator showing this measure, GDP, has not been used in the modeling due to the lack of monthly trends in the official statistics after 2010. Between 2010-2014 only annual data for this indicator is available;

⁴ Since January 2011, statistical data on salary gains are obtained based on new selective statistical survey: short-term statistical indicators implemented in the national statistics in line with the European standards. Information does not include data from the Dniester left bank districts and Bender municipality.

To overcome the limitations on information generated by the lack of updated official statistics for the areas of major interest for this study⁶, it was decided to take into account the effect of these variables indirectly by considering the Global Competitiveness Index (GCI) of the Republic of Moldova, which according to the WEF methodology is calculated on the basis of 110 indicators, divided into 12 groups, four of which are basic factors, six factors are to increase efficiency and two factors⁷ are innovational. Based on the GCI country ranking, it was calculated the position of the Republic of Moldova, assuming that the country with the highest GCI will have the share 1 and the one with the lowest GCI – approximately 0. The measures obtained were used to re-estimate the trends shown by the indicators: *Industrial output price index* and *The net international investment position of the Republic of Moldova*, thus taking into account the effect of the missing variables.

Due to the fact that the variables selected for modeling in the data sources are expressed in different units of measure, their unification called for the calculation of the dynamics indices expressed in coefficients.

Time series modeling puts forward a number of conditions on the initial data quality. To obtain no-convergent estimators of the structural parameters of the model, initial data series must be stationary, without a seasonal effect. Thus, all the selected series in the study were ADF tested. Non-stationary series turned out to be: Index of the dynamics of the weighted average interest rate on new loans, Index of the dynamics of the weighted average interest rate on new deposits. The first difference method ensured stationarity. Testing seasonality by means of the graphics *Means by Season* has revealed the presence of the seasonality effect in the following dynamic series: Industrial output price index, Index of the dynamics of the weighted average interest rate on new loans, Index of the dynamics of the weighted average interest rate on new deposits. To adjust the series there were used the statistical procedures: *Census X-12* for the first-order variables that made up the difference and referred to the index of the dynamics of the weighted average interest rate on new loans and respectively to the index of the dynamics of the weighted average interest rate on new deposits, but the industrial output price index was adjusted using the *Moving Average Methods* procedure.

In order to estimate the impact of the identified factors on the dynamics of new loans in the banking sector, the regression ARMADL (AutoRegressive Moving Average Distributed Lag) was applied. Some concepts of dynamic modeling will be presented below.

If we consider that Y_t is a variable that is to be modeled on the basis of X_{it} , which shows the vector of the explanatory variables, the set of optimal conditions are described by:

$$F_t = \sigma(x_t, x_{t-1}, \dots, y_{t-1}, y_{t-2}, \dots)$$

Assuming the linear dependence, the overall shape of the model is:

⁵ The data was recalculated in the national currency under the official average monthly exchange rate of the reference currency.

⁶ The evolution of GDP, the industrial output, labor force development, changes in net exports, monthly data for 2011-2016.

⁷ 2016 estimates are based on forecast levels of previous years.

$$Y_t = \delta' d_t + \beta_0' X_t + \beta_1' X_{t-1} + \dots + \beta_m' X_{t-m} + a_1 y_{t-1} + \dots + a_p y_{t-p} + u_t + \theta_1 u_{t-1} + \dots + \theta_1 u_{t-1}$$

where $E(u_t | F_t) = 0$. d_t - dummy variable (a free term, seasonality, etc.)

The ARMADL models are a developed form of the ARDL (Autoregressive Distributed Lag) patterns which are widely used in modeling time series as of the middle of the 60s. The advantage of these models is that they can be used both for stationary series and for a combination of stationary and non-stationary series, with a seasonal and a non-seasonal effect.

In the given model, Y_t stands for the index of the dynamics of the new loans in the banking sector (ICREDIT);

X_{it}' - m dimensional vector of regressors: index of the dynamics of the weighted average interest rate on new loans(DIR_CR_SA); index of the dynamics of the weighted average interest rate on new deposits(DIR_DP_SA); index of the dynamics of the new deposits, total in time, in the banking sector (IDEPOZIT); industrial output price index adjusted on the basis of the global competitiveness index, seasonally adjusted (IPI_CRSA); consumer price index (CPI), the average monthly salary index (ISAL, index of the net international investment position of the Republic of Moldova adjusted on the basis of the global competitiveness index (IPINV_CR);

u_t - error term.

In the present study, we identified an econometric model that simulates the interaction between the market of new loans granted to residents by the Moldovan banks and financial resources of the population presented through the net wage, price dynamics reflected in the consumer price index, the performance of the productive sector shown by the industrial output index; the interaction with the world economies was depicted by the net investment position in a difficult time both economically and politically, i.e. in 2011-2016. In this time range, there were liquidated three major banks on the local banking and financial market; moreover, the great financial fraud took place: embezzlement of heavy public funds. However, the simulation results are very close to the real trend of the estimated variable, meeting all the conditions imposed on similar econometric simulations, respectively the future trends benefitting from a higher degree of credibility. To improve the quality of model simulation, we consider it necessary to include new influence variables. The problem we faced is efficiency of supplying monthly or quarterly statistics by the competent authorities.

Bibliography:

1. Almon, S., The distributed lag between capital appropriations and net expenditures. *Econometrica*, 33, 1965, p. 178-196.
2. Bernanke, B. and M. Gertler, Inside the Black Box: The Credit Channel of Monetary Policy Transmission, *Journal of Economic Perspectives*, 9(4), 1995, p. 27-48.
3. Dhrymes, P. , *Distributed Lags: Problems of Estimation and Formulation*. Holden-Day, San Francisco, 1971.
4. Fair R. and Jaffee D. *Methods of Estimation for Markets in Disequilibrium*, *Econometrica* 45(7), 1972, p. 1723-7.

5. Fair R. and Kelejian, H., Methods of Estimation for Markets in Disequilibrium: A Further Study, *Econometrica* 42(7), 1974, p. 177-99.
6. Frances, P., R. van Oest. On the econometrics of the Koyck model. Report 2004-07, Econometric Institute, Erasmus University, Rotterdam.
7. Giles, D. E. A.,. A polynomial approximation for distributed lags. *New Zealand Statistician*, 10, 1975, p.22-26.
8. Giles, D. E. A.,. Current payments for New Zealand's imports: A Bayesian analysis. *Applied Economics*, 9, 1977, p.185-201.
9. Kanoh S. and Pumpaisanchai C., Listening to the Market: Estimating Credit Demand and Supply from Survey Data, *Hi-Stat, Discussion Paper Series, No. 137*, February 2006.
10. Maddala, G. and F. Nelson, Maximum Likelihood Methods for Markets in Disequilibrium, *Econometrica*, 42, 1974, p. 1013-1040
11. Pazarbasioglu, C., "A Credit Crunch: A Case Study of Finland the Aftermath of the Banking Crisis," *IMF Working Paper WP/96/135*, 1996.
12. Quandt R. and Ramsey J. , Estimation Mixtures of Normal Distributions and Switching Regres-sions. *Journal of the American Statistical Association* 73, 1978, p. 730-752.
13. Schmidt, P. & R. N. Waud,. The Almon lag technique and the monetary versus fiscal policy debate. *Journal of the American Statistical Association*, 68, 1973, p.1-19.
- Shiller, R. J.,. A distributed lag estimator derived from smoothness priors. *Econometrica*, 41, 1973, p.775-788.
14. Somette D., Woodard R., Financial Bubbles, Real Estate bubbles, Derivative Bubbles, and the Financial and Economic Crisis, *APFA7 Conference*