

# MODELLING APPROACHES TO ASSESS THE EFFECTIVENESS OF MACRO-PRUDENTIAL POLICY

*Radu CUHAL*<sup>40</sup>

*Ludmila STARIȚÎNA*<sup>41</sup>

*Diana SADOVEANU*<sup>42</sup>

## Abstract

In this paper was approached the problem of the effectiveness of the macro-prudential policy, which became an actual subject in scientific literature. We made a literature review of the applied methods to diagnose the effectiveness of the macro-prudential policy toolkit; explored the possible methodologies and frameworks which can be used to investigate the effectiveness of the implemented macro-prudential policies (Alpanda et al. (2014), CGFS (2012)); showed their advantages and drawbacks and proposed an empirical method. By this paper we aimed to develop a proper framework for policy-makers to follow for sustainable implementation of the macro-prudential policy and assessment of its effectiveness.

**Keywords:** macro-prudential policy, effectiveness, DSGE model, empirical models

**JEL classification:** E5, G21, G28

## 1. Introduction

The crisis has demonstrated the need to renew our approach to financial system regulation and notably to complement it with a macro-prudential perspective. There is no single definition of what constitutes “macro-prudential” policy. There is, however, some consensus over its broad outlines.

First, it involves adding a macroeconomic perspective to the supervision of the financial system, which up till now has only really been addressed from a “micro” standpoint. As the crisis has shown, financial stability does not depend solely on the soundness of the individual components that make up the financial system; it also depends on complex interactions and interdependencies between these components. Moreover, the term “macro” refers to the interactions between the real world and the financial world, to the extent that a risk only becomes “systemic” once the imbalances or shocks affecting the financial system pose a significant threat to economic activity.

The second characteristic of macro-prudential policy is that it is preventive. Its aim is precisely to prevent the formation of financial imbalances, pro-cyclical phenomena or systemic risks by limiting excessive growth in credit and in economic agents’ debt levels, and increasing the shock-absorbing capacity of financial institutions or structures *ex ante*. Therefore, macro-prudential policy is not designed to manage financial crises directly once they have erupted, but rather to prevent them from happening in the first place. The implementation of macro-prudential policy poses a number of major challenges, particularly as many countries have only just put in place the necessary operational frameworks. Experience and analysis have shown that the successful implementation of macro-prudential policy depends on three key factors: the governance of that policy; the identification of market failures and the; selection of tools to combat them; a proper understanding of the channels of transmission and of the way these tools interact with other economic policies, notably monetary, fiscal and micro-prudential policies.

In recent years, many central banks mainly made use of the macro-prudential policy toolkit to address the financial stability issues. But besides the fact that the macro-prudential policy framework become relative popular, the evidence about the effectiveness of macro-prudential policy and its transmission mechanism is still limited. In this study we aim to explore the most used

---

<sup>40</sup> National Bank of Moldova, Chişinău, Republic of Moldova, radu.cuhal@bnm.md

<sup>41</sup> National Bank of Moldova, Chişinău, Republic of Moldova, ludmila.starritina@bnm.md

<sup>42</sup> National Bank of Moldova, Chişinău, Republic of Moldova, diana.sadoveanu@bnm.md

methods to assess the effectiveness of the macro-prudential policies and determine the transmission mechanism of its toolkit.

The paper was structured as follows: in the second section we made a literature review of the applied methods to diagnose the effectiveness of the macro-prudential policy toolkit. In the third section we explored the possible methodologies and frameworks which can be used to investigate the effectiveness of the implemented macro-prudential policies, we showed their advantages and drawbacks and we proposed an empirical method to follow for policy makers, the last section concludes.

## 2. Literature review

Besides the fact that the macro-prudential policy framework has become relatively popular, the evidence about the effectiveness of macro-prudential policy and its transmission mechanism is still limited. Most studies performed on this subject are cross-country analyses which were focused on the cyclical aspects on the credit and housing markets or on the systemic risk issues.

Many empirical works relied on the Lim et al. (2011) study, which found that several different macro-prudential tools reduce the procyclicality of credit growth by reducing the correlation between credit growth and GDP growth. Cerutti et al. (2015) showed that the usage of the macro-prudential policy instruments is generally associated with lower growth in credit and their effects are less in financially more developed and open economies. Also, they found that macro-prudential policies can help manage financial cycles, but they work less well in busts.

Dell'Ariccia et al. (2012) also found that macro-prudential policies can reduce the incidence of credit booms and temperate the negative effects of the bubbles. They stressed the fact that macro-prudential policies reduce the risk of bust, reducing by that simultaneously how the rest of the economy is affected by troubles in the financial system.

A large research work on the macro-prudential policy use and effectiveness was performed by the International Monetary Fund. The IMF defined the macro-prudential policy framework and categorized its toolkit. (IMF, 2011a); proposed indicators to measure the systemic risk (IMF, 2011b). Besides the IMF investigated the externalities effects, such as evasion effects and spillovers to other countries, urging the policy-makers to pay more attention to the multilateral effects of the macro-prudential policies. (IMF, 2011c)

As we showed the most worked performed by now, analyzed the effects of the macro-prudential policy instruments on various segments of the financial sector and found them effective in reducing the effects of the systemic risk. But, unfortunately were neglected the externalities and the aggregate outcome of use of the macro-prudential policy toolkit.

Beirne and Friedrich (2014) went more specific. They assessed the effectiveness and associated externalities that arise when macro-prudential policies are used to manage international capital flows and showed that the structure of the domestic banking system matters for the effectiveness of these policies. They found that a high share of non-resident bank loans in the MPP-implementing country reduces the domestic effectiveness of most MPPs, while a high return on assets in the domestic banking system has the opposite effect.

The most papers which addressed the issue of effectiveness of the macro-prudential policies had a theoretical or an empirical nature.

Some studies focused on the theoretical framework explored the welfare-enhancing side of the macro-prudential policies, in the context of existence of aggregate external financing shock. By introducing financial frictions, was showed that different agents of the financial sector can boost the systemic risk, by undertaking large exposures. Were investigated the financial frictions such as limited commitment in financial contracts (Lorenzoni, 2008), limited access of banks to productive capital in times of crisis (Federic, 2011) or collateral constraints. (Korinek, 2010)

Other theoretical researches explored the implications of the Dynamic Stochastic General Equilibrium (DSGE) framework.

Bianchi (2011) performed a quantitative analysis of the systemic credit externality in a two-sector DGSE-model of a small open economy. He showed that raising the cost of borrowing during tranquil times restores constrained efficiency and significantly reduces the incidence and severity of financial crises

The empirical literature on the macro-prudential policy framework highlighted a significant impact on the systemic risk.

Lim et al. (2011) examined the effectiveness of macro-prudential policy instruments by performing an analysis over a group of 49 countries and showed that many of the most frequently used instruments are effective in reducing pro-cyclicality, but the effectiveness is sensitive to the type of shock facing the financial sector. Based on their findings, we identified conditions under which macroprudential policy is most likely to be effective, as well as conditions under which it may have little impact.

Our paper is intended to be a small contribution to the existing literature on the proper implementation of the macro-prudential policy framework. We aim to propose a theoretical framework for properly introducing and assessing macro-prudential policy toolkit.

### **3. Testing the effectiveness of the macro-prudential policies. Understanding the interaction between the financial system and the macroeconomy**

The most crucial point in the process of development of the macro-prudential policy framework is understanding of the interaction between the financial system and the macroeconomy and proper assessment of the effectiveness of the developed macro-prudential policy toolkit.

In scientific literature does not exist a single approach to investigate the transmission mechanism and respectively, effectiveness of the macro-prudential policies in EMEs countries. Given the fact that each approach carries a series of drawbacks, in order to study the effectiveness of the macro-prudential policies in CIS countries is advisable to apply a set of different approaches, such as: analysis of historical experiences, theoretical approaches (DGSE model), empirical analysis and some alternative methods proposed by the Committee on the Global Financial System. Each approach allows not only to derive the effectiveness of the macro-prudential policy, but also its interaction with monetary policy and potential implications.

#### **I. General equilibrium approaches**

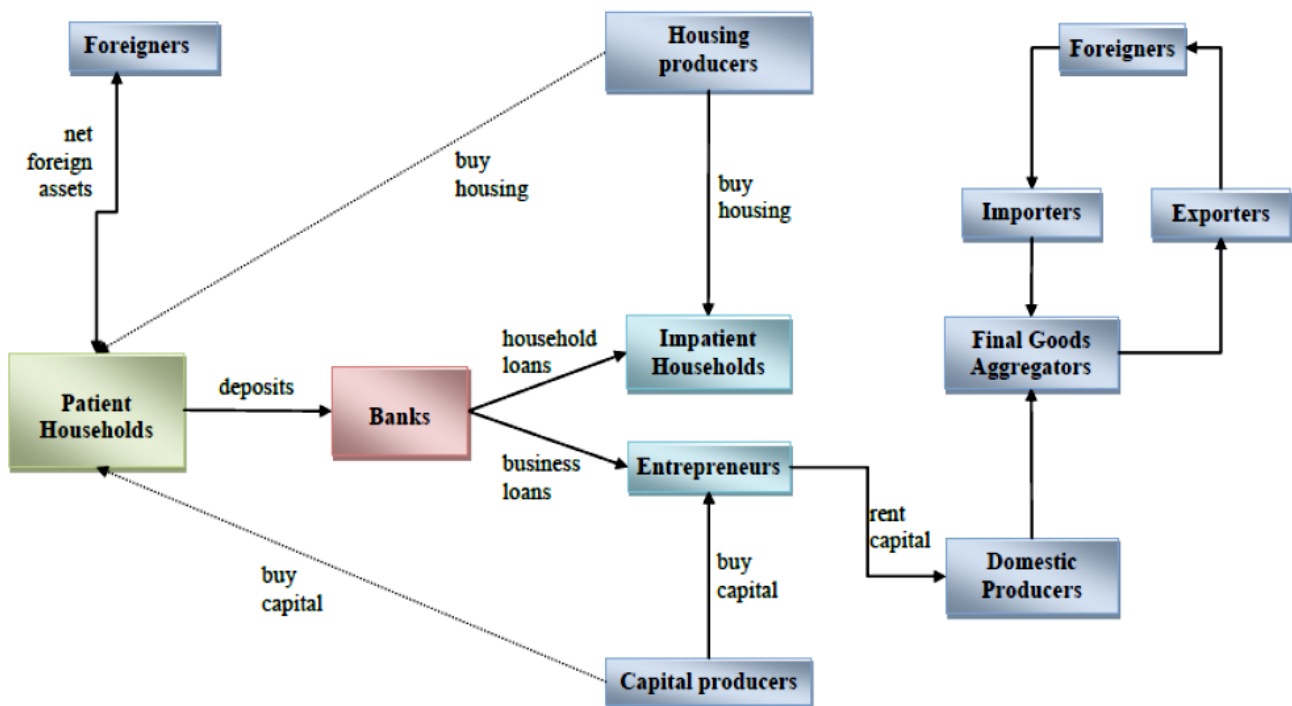
The DSGE models augmented with financial frictions, which build on the financial accelerator mechanism of Bernanke et al. (1999), have the potential to investigate the effects of macro-prudential tools that focus on the time dimension of systemic risk. Their general equilibrium nature makes them attractive for policy analysis.

The general equilibrium approaches used for assessment of the effectiveness of the macro-prudential policies can be grouped into three categories of models: banking models, dynamic stochastic general equilibrium macro model (DSGE) and infinite horizon general equilibrium macro model. (Galati, Moessner, 2014)

The main advantage of the *banking models* is the possibility to analyze risk-taking behavior of heterogeneous agents in an economy that is vulnerable to systemic risk. They capture the cross-sectional dimension of the systemic risk by exploring the interlinkages between assets and contracts and assuming that the financial shock can propagate through the financial system through informational and balance sheet linkages. (Perotti, Suarez, 2011)

*Dynamic stochastic general equilibrium macro model (DSGE)* is the most comprehensive model used by central banks to assess the effectiveness of the macro-prudential policy. The main contribution of this model lies in explaining the interlinkages between real and financial factors and how these interactions can contribute to the systemic risk amplification.

We considered that a representative DSGE model, which could be used for small-open economies is the approach, developed by Alpanda et al. (2014). The model incorporates four categories of agents: savers, bank who intermediate between savers and borrowers, lenders from private sector (households and firms).



**Fig.1. Model agents and key flows of funds, inputs and goods**

Source: Alpanda, S; Cateau, G.; Meh, C. (2014) A policy model to analyze macroprudential regulations and monetary policy, BIS Working Paper, no. 461, p. 42.

The model is structured in block equations and is featured for monetary, fiscal and macro-prudential policy. The rationale behind is the following: on the production side the domestic producers lend capital and labor to produce domestic goods, which aggregated with imported goods end in consumption, business investments, residential investment, government expenditure and exports. To capture the exchange rate pass-through were introduced the importers and exporters as separate agents.

Besides, uncontested advantages, the DSGE approaches have two important drawbacks to consider: these models neglect the role of time and business cycle, which makes it more difficult to study macroprudential tools geared towards the procyclicality of the financial system. Second, they are mostly partial equilibrium models, and recent research suggests that the effect of macroprudential tools is different in a general equilibrium setting (Al-Darwish et al., 2011; Galati, Moessner, 2014)

The strengths of the DSGE models are: modelling in a unified framework the interrelations between the balance sheets of the households, companies and banks; take account for the risk-taking channel and the long-term debt channel. Besides they provides a framework for a more deeper investigation of the transmission mechanism of the macro-prudential policy instruments, potential interrelations with monetary policy. Moreover, they are particularly suitable for simulations, which make them useful to study the impact of new policy instruments, and investigation of the effectiveness of various policies in simultaneously achieving macroeconomic and financial stability.

In order to highlight the main transmission channels of the macro-prudential policy tools and interaction with monetary policy, many emerging countries apply the simplified version of the DSGE models, mainly they resort on the Quarterly Projection model, applied first by the Canadian central bank and adjusted with financial frictions. We consider that is more appropriate not to use a general version of the model, but to adapt its equation by determining the specific structure of the model by applying the panel data method for a group of countries with the same conditions as the considered economy and then to adapt the estimated model to the specific conditions of each country. The main econometric methods used for analysis are estimation and calibration techniques.

Infinite horizon macroeconomic DSGE models are attractive for policy analysis, due to the fact that explore the time dimension of the systemic risk and allow simulations in order to investigate the

effects of the macro-prudential policy instruments. Compared to standard DSGE models, they are a more elaborate amplification mechanism and imply multiple equilibria, making them suitable for in-depth investigation of the effectiveness of the macro-prudential policies which can be used in order to reduce the negative effects of the crisis. (Boissay et al., 2013) But, the important drawbacks from which suffered these models are: exclude the possibility of defaults, do not take account for effects of changes in regulations

## **II. Alternative approaches (stylized maps)**

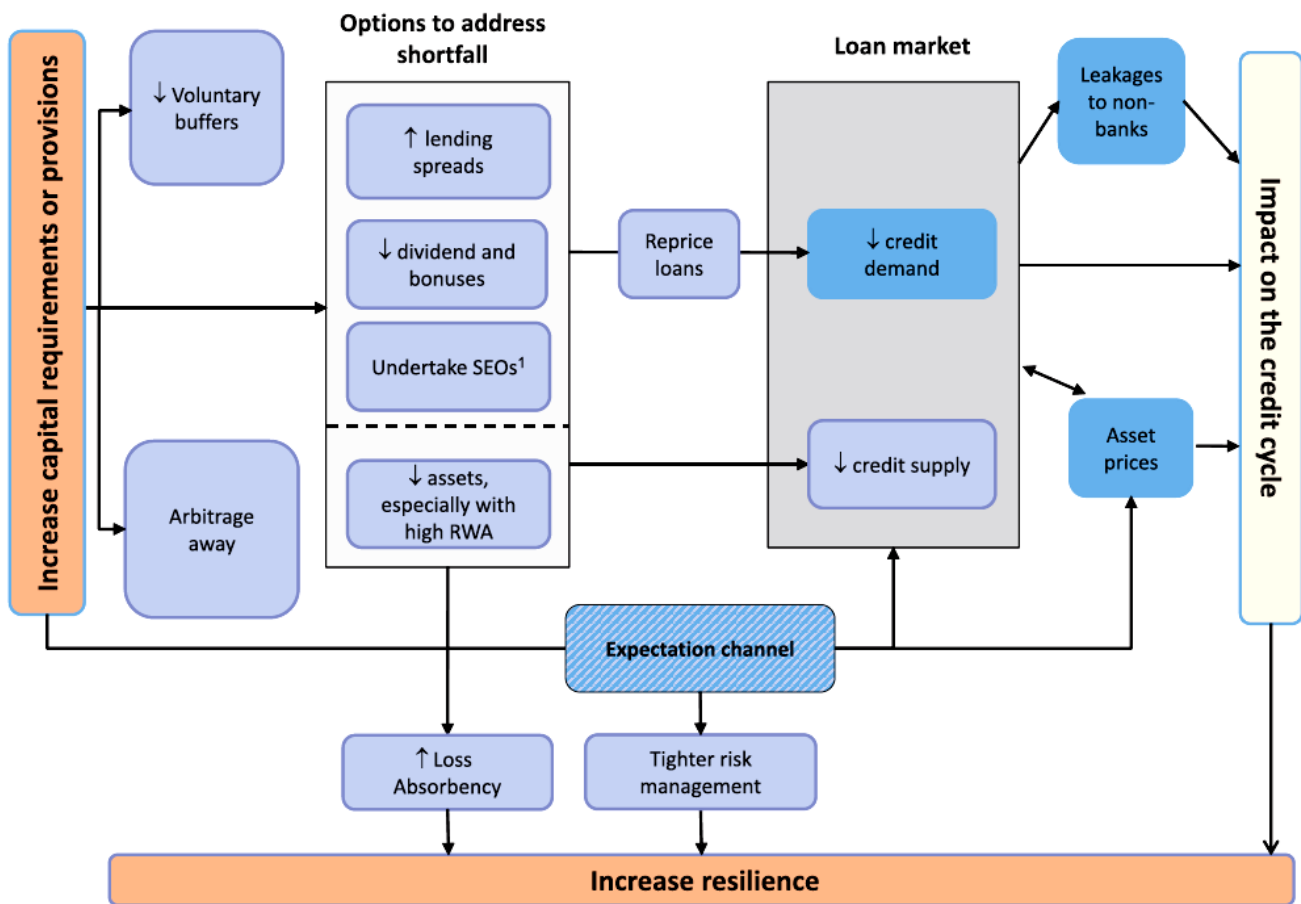
In recent years, several studies have followed an alternative, narrative approach to studying the transmission mechanism and effectiveness of macro-prudential tools.

An influential report elaborated by the CGFS (2012) provides a conceptual framework to illustrate how the effectiveness of the macro-prudential policy instruments can be judged in practice. (CGFS, 2012)

CGFS framework comprise a stylized presentations, named „transmission maps”, which can be used as practical tool to study how the changes in individual instruments of macro-prudential policy annihilate the identified vulnerabilities, and how they interact with other policies. The approach allow to study the impact of instruments on the credit cycle in different phases and the resilience of the financial sector to the stress tests. The tools used are capital or provisioning requirements, sectoral capital requirements, liquidity requirements and asset-side instruments

One of these transmission maps is presented in the figure below. As we can observe, this map is a narrative approach and provides only a rationale for judgement for policy-makers, related to the transmission mechanism and effectiveness of macro-prudential policy. Investigation econometric methods used are: narrative analysis, descriptive statistics, correlations.

This type of analyze is used to annihilate the potential drawbacks of the general equilibrium and empirical models. It provides several important results. First, in terms of monitoring the build-up of financial imbalances and predicting crisis, CGFS (2012a) documents how the credit-to-GDP gap, the debt service ratio, the growth in residential property prices and their gap turn out to have been useful indicators in signaling past crises. They are more recommended for emerging economies with low quality of statistical data. They offer a comprehensive scheme for judgement and is simple to use. Besides, are representative and are capable to capture the most important channel through which the policy makers may attain their objectives, due to the simplicity of the interlinkages on the financial market.



**Fig. 2. Transmission map of raising capital or provisioning requirements**

Source: Committee on the Global Financial System (2012) Operationalising the selection and application of macroprudential instruments, CGFS Papers, no. 48, p. 20

But besides the listed advantages, the alternative approaches have also many important drawbacks. First, the effects of individual instruments are often uncertain. The „transmission map” may describe a limited number of channels through which a macro-prudential policy instrument can work. Furthermore, some instrument may have only temporary effects, or may be determined by other exogeneous factors, which can be captured by the „transmission map”. Second, these approaches are not supported by the empirical evidence and the results depends on the expert experience and judgement.

### III. Empirical models

In some cases empirical analysis does not provide reliable results. This can be explained by the low quality of statistical data, lack of macroeconomic models to capture the mechanics of economy and financial system and their interlinkages and so on.

For policy-makers, the main problem in empirical analysis is to identify the causality and impact of macro-prudential policy on the financial and economic fundamentals. The results provided by the empirical tests can be very ambiguous. As a consequence, frequently are used several approaches at once, in order to deal with this issue. Some of these approaches are:

- event studies; assessments of authorities or outside observers;
- reduced-form regression analysis, typically conducted using cross-country panel regressions;
- macro stress tests;
- counterfactual analysis;
- analysis based on micro data.

As a econometric methods, policy-makers resort mainly on panel data methods. Panel data are used to overcome the problem with the quality and lack of the statistical data and better capture the impact of macro-prudential policy instruments. They are applied for specific group of countries.

Below is proposed a model, suitable for assessment of the macro-prudential policy effectiveness, from our point of view. First is presented the theoretical model, then a econometric base of the recommended approach.

#### a) Theoretical model

This section will lay out the empirical model used in the analysis and presents estimates of the policies' effects on total domestic credit.

The empirical reduced-form regression model used in the analysis is as follows:

$$C_{i,t} = \eta_i + \rho C_{i,t-1} + \beta VIX_t + \sum_{k=1}^p \theta_k X_{i,t-k} + \delta MAPP_{i,t-1} + \epsilon_{i,t} \quad (1)$$

As depended variables we recommend the VIX index (the global risk aversion variable), X – macroeconomic stance index, represented by a vector of two variables – real GDP growth and rate of change of the monetary policy nominal interest rate, and MAPP – macro-prudential policy index, constructed as a sum of individual instruments of macro-prudential policy, weighted equally: loan-to-valut (LTV), debt-to-income ratio (DTI), limits on credit growth (DC), limits on foreign lending (FC), reserve requirements (RR), dynamic provisioning (DP), countercyclical requirements (CTC), limits on profit redistribution (PRD).

We chose to use cumulative measures in the panel data analysis because macroprudential measures can affect credit and house price growth not just in the quarter of implementation but in subsequent quarters as well. Some of these policies may be delayed in their effect: though we record the date the measure was put in place, it could be that these measures do not bind until years later. For all these reasons we choose to use the country's overall macroprudential stance as our variable of interest.

$\eta_i$  is a fixed effect,  $i$  denotes countries,  $t$  indicates time period. The purpose of introducing country specific dummies, which correspond to the  $\eta_i$  is a fixed effect, is to estimate the country specific intercept term for each country in the sample.

For this type of analysis is recommended to apply the dynamic panel data regression model with country fixed effects.

#### b) Econometric model

The prototypical equation for the fixed effect model with strictly exogenous regressors to include lags of the dependent variable, allowing for error serial correlation of unknown form, takes the form:

$$y_{it} = \alpha y_{i(t-1)} + x'_{it} \beta + \eta_i + v_{it} \quad (2)$$

together with the assumption

$$E(v_{it} | x_{i1}, \dots, x_{iT}, \eta_i) = 0 \quad (t = 1, \dots, T) \quad (3)$$

An equation of this type might also contain lags of  $x$  and/or additional lags of  $y$ , but (1) captures the essential feature of the model that we wish to discuss. Namely, a dynamic effect of  $x$  on  $y$  for which the speed of adjustment is governed by the coefficient of lagged  $y$ .

Assumption (2) implies that  $x$  is uncorrelated to past, present and future values of  $v$ , and hence it is a strictly exogenous variable. It does not rule out correlation between  $x$  and the individual effect  $\eta$ . Lagged  $y$  will be correlated by construction with  $\eta$  and with lagged  $v$ , but it may also be correlated with contemporaneous  $v$  if  $v$  is serially correlated, which is not ruled out by (2). Thus, lagged  $y$  is effectively an endogenous explanatory variable in equation (1) with respect to both  $\eta$  and  $v$ . Examples include partial adjustment models of firm investment or labour demand, and household

consumption or labour supply models with habits. In these applications the coefficient  $\alpha$  captures the magnitude of adjustment costs or the extent of habits. It therefore has a structural significance. Moreover, there are often reasons to expect serial correlation in the transitory errors  $v$  of the economic model. In those cases lagged  $y$  must be treated as an endogenous explanatory variable.

Assumption (2) implies that for all  $t$  and  $s$

$$E [x_{is} (\Delta y_{it} - \alpha \Delta y_{i(t-1)} - \Delta x'_{it} \beta)] = 0 \quad (4)$$

Thus, the model generates internal moment conditions that, subject to a rank condition, will ensure identification in spite of serial correlation of unspecified form and the endogeneity of lagged  $y$ . Essentially, we are exploiting the strict exogeneity of  $x$  in order to use lags and leads of  $x$  that do not have a direct effect on  $\Delta y_{it}$  as instruments for  $\Delta y_{i(t-1)}$ .

For example, if the model contains the contemporaneous and first lag of a scalar variable  $x$  and  $T = 3$ , we have three instruments  $x_1$ ,  $x_2$  and  $x_3$  for the single equation in first differences

$$y_3 - y_2 = \alpha (y_2 - y_1) + \beta_0 (x_3 - x_2) + \beta_1 (x_2 - x_1) + (v_3 - v_2) \quad (5)$$

so that the coefficients  $\alpha$ ,  $\beta_0$ ,  $\beta_1$  are potentially just-identifiable from the moment conditions  $E (x_{is} \Delta v_{i3}) = 0$ , ( $s = 1, 2, 3$ ).

The models in this section should not be regarded as an extension of the pure autoregressive model. The purpose of AR models is to capture time series dependence, so that it is natural to start with serially uncorrelated errors. Here, however, lagged  $y$  appears in a structural role, and we consider models where its effect is identified regardless of serial correlation.

## 4. Conclusions

The most crucial point in the process of development of the macro-prudential policy framework is understanding of the interaction between the financial system and the macroeconomy and proper assessment of the effectiveness of the developed macro-prudential policy toolkit.

In scientific literature does not exist a single approach to investigate the transmission mechanism and respectively, effectiveness of the macro-prudential policies in EMEs countries. In this paper we aimed to develop a comprehensive framework for policy-makers, which would comprise the most representative approaches used to diagnose the effectiveness of the macro-prudential policy. First we presented the core structure of the DSGE model and showed the potential drawbacks which can be faced, when highlighted how the alternative methods can be used to annihilate these drawbacks. It was showed that, even that the alternative approaches are simpler and are more narrative, combined with DSGE model can be obtained a better rationale for assessment. Finally, we propose an empirical model to follow. We presented a general structure of the model, namely its core equation and main variables which can be adapted further giving the specific features of each economy.

## Bibliography

1. Al-Darwish, A., Hafeman, M., Impavido, G., Kemp, M. and P. O'Malley (2011) „Possible Unintended Consequences of Basel III and Solvency II”. IMF Working Paper WP/11/187.
2. Alpanda, S; Cateau, G.; Meh, C. (2014) „A policy model to analyze macroprudential regulations and monetary policy”, BIS Working Paper, no. 461.
3. Beirne, J.; Friedrich, Ch. (2014) „Capital Flows and Macroprudential Policies – A Multilateral Assessment of effectiveness and Externalities”, Bank of Canada Working Paper, no. 31.
4. Bernanke, B., Gertler, M. and Gilchrist, S. (1999) „The financial accelerator in a quantitative business cycle framework”. In J. Taylor and M. Woodford (eds) Handbook of Macroeconomics (Vol. 1, Part C, pp.1341–1393). North Holland: Elsevier.
5. Bianchi, J. (2011) „Overborrowing and Systemic Externalities in the Business Cycle”, American Economic Review, 101(7), pp. 3400-3426.



6. Cerutti, E.; Claessens, S.; Laeven, L. (2015) „The Use and Effectiveness of Macroprudential Policies: New Evidence”, IMF Working Paper, no. WP/15/61.
7. Committee on the Global Financial System (2012) „Operationalising the selection and application of macroprudential instruments”, CGFS Papers, no. 48.
8. Dell’Ariccia, G., Igan, D., Laeven, L., Tong, H. Bakker, B., Vandenbussche, J. (2012), “Policies for Macrofinancial Stability: How to Deal with Credit Booms,” IMF Staff Discussion Note 12/06.
9. Galati, G. and R. Moessner (2013) „Macroprudential policy – a literature review”, Journal of Economic Surveys, Vol. 27, No. 5, pp. 846–878.
10. IMF, (2010) „The Fund’s Role Regarding Cross-Border Capital Flows”, International Monetary Fund, Washington D.C., United States.
11. IMF, (2011a) „Towards Operationalizing Macroprudential Policies: When to Act?”, Chapter 3 in Global Financial Stability Report, September.
12. IMF, (2011b) „Recent Experiences in Managing Capital Inflows – Cross-Cutting Themes and Possible Policy Framework”, International Monetary Fund, Washington D.C., United States.
13. IMF, (2011c) „The Multilateral Aspects of Policies Affecting Capital Flows”, International Monetary Fund, Washington D.C., United States.
14. Korinek, A. (2010) „Regulating Capital Flows to Emerging Markets: An Externality View”, mimeo.
15. Lim, C., F. Columba, A. Costa, P. Kongsamut, A. Otani, M. Saiyid, T. Wezel, and X. Wu (2011) „Macroprudential Policy: What Instruments and How to Use Them, Lessons from Country Experiences”, IMF Working Paper 11/238.
16. Lorenzoni, G. (2008) „Inefficient Credit Booms”, Review of Economic Studies 75(3), pp. 809- 833.
17. Qureshi, M. S., Ostry, J.D., Ghosh, A.R., Chamon, M. (2012) „Tools for managing financial-stability risks from capital inflows”, Journal of International Economics, 88(2), pp. 407-421.