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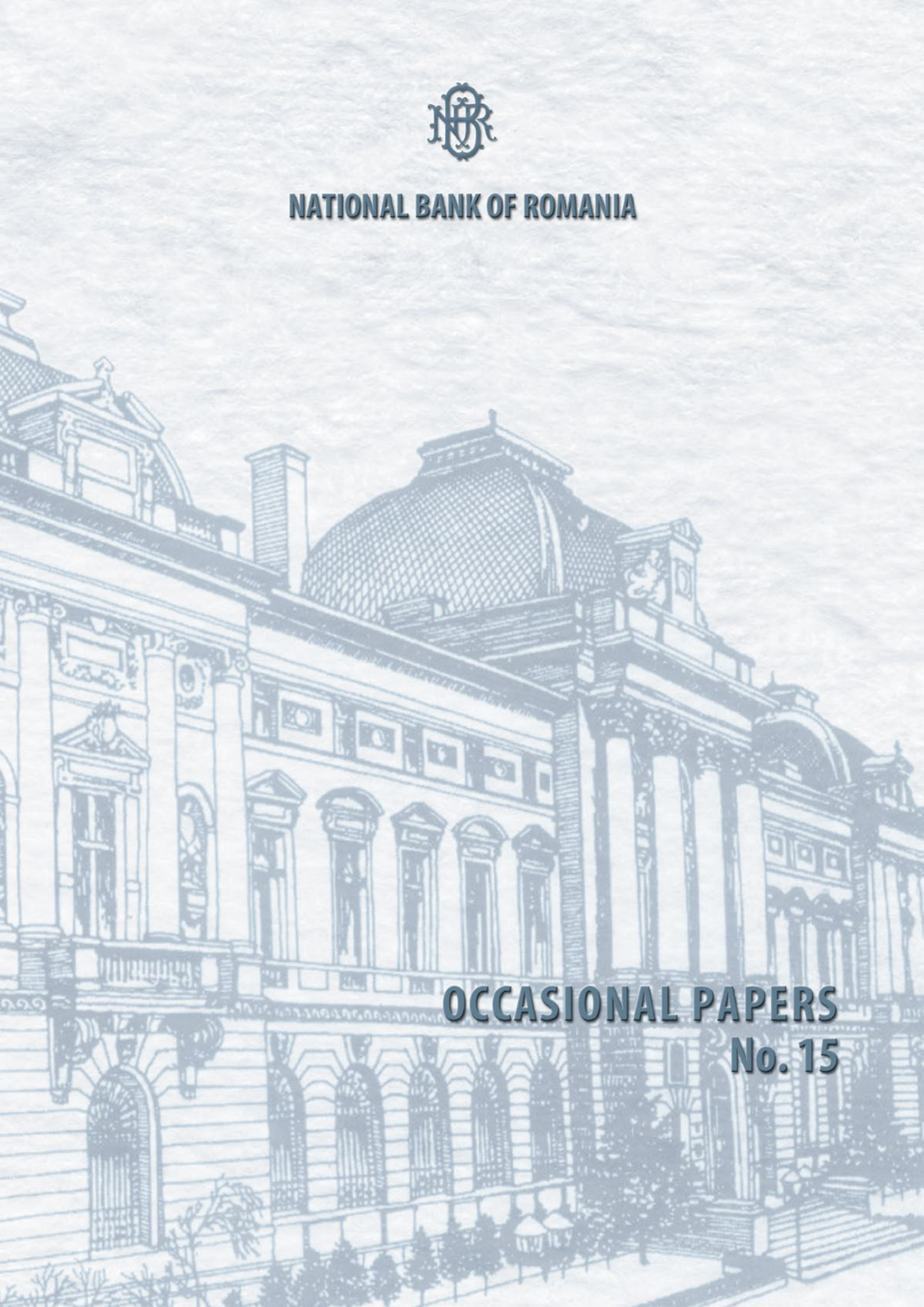

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IMPLEMENTING LOAN-TO-VALUE AND DEBT SERVICE-TO-INCOME MEASURES: A DECADE OF ROMANIAN EXPERIENCE[1]

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Contents

Abstract

We describe an example of designing, implementing and calibrating two macroprudential instruments – loan-to-value (LTV) and debt service-to-income (DSTI) – based on a decade of Romanian experience with these tools. We investigate LTV and DSTI effectiveness in trimming down excessive credit growth and in preserving the quality of banks' loan portfolios. We find strong links between DSTI levels and the debtors' capacity to repay their debt, underpinning the usefulness of caps for this instrument. We find that an approach based to a large extent on banks' self-regulation produces suboptimal results, exacerbating the pro-cyclicality in the system. A one-size-fits-all approach is less effective than tailoring the DSTI and LTV measures based on debtors' disposable income, the currency of indebtedness and the destination of the loan.

Keywords: financial stability, macroprudential instruments, house prices, credit growth, debt service-to-income (DSTI), loan-to-value (LTV), Romania

JEL classification codes: E44, E58, G21, G28

Executive Summary

A decade of Romanian experience with debt service-to-income (DSTI) and loan-to-value (LTV) instruments shows that they are relatively effective in: (i) curbing high credit growth and (ii) ensuring that both debtors and creditors are able to cope with possible adverse shocks in real estate prices, domestic currency depreciation or interest rate hikes. The second point explains why the DSTI and LTV caps should be used both in the upswing and in the downswing of the credit cycle.

We find strong negative correlation between the level of indebtedness and the ability to repay the debt. Moreover, debtors with lower income and high DSTI post a higher NPL ratio, irrespective of the purpose of lending (consumer or mortgage lending). There are links between the LTV level and debtors' capacity to repay their debt: the higher the LTV, the higher the non-performing loan (NPL) ratio. These arguments underpin the usefulness of using DSTI and LTV caps to foster debtors' capacity to repay their loans.

We find that banks' self-regulation on DSTI and LTV caps, without specific guidance from the authorities, delivers sub-optimal results. The Romanian banks behaved in a deeply pro-cyclical manner when an approach based to a large extent on self-regulation was implemented. We also find that the one-size-fits-all approach is not very effective. It is more useful to tailor the DSTI and LTV measures according to the specific patterns of possible risks. The caps for these instruments should be differentiated based on debtors' disposable income (low, medium and high), the currency of indebtedness (domestic or foreign) and the destination of the loan (mortgage or consumer loans).

The empirical evidence shows that the effectiveness of DSTI and LTV instruments in trimming down the rapid credit growth is higher than that of monetary policy instruments or other prudential measures. The Romanian specificities during the last decade largely point to this outcome; these include a high level of euroization, full capital account liberalization, a material share of FX loans, and significant foreign capital inflows.

There are three main policy messages for improving the effectiveness in using DSTI and LTV instruments. First, there is a need to strengthen the cooperation between the domestic macroprudential authority and other domestic and foreign-related authorities in order to preserve the ability of these instruments to deal with risks. Second, it is more prudent to monitor the total level of household and corporate sector indebtedness, instead of total domestic credit developments. The differences indicated by these two approaches are material. Focusing on the latter might delay the authorities' decisions on DSTI and LTV implementation or calibration, yielding sub-optimal outcomes in managing systemic risks. Third, higher transparency is needed from the authorities regarding their macroprudential intermediate objectives and, if possible, the instruments tailored to fulfill these objectives.

I. Introduction

Tentative lists of macroprudential instruments are already available at the international level (e.g. ESRB, 2013; IMF, 2013). The next step is to learn about the design, implementation, calibration and effectiveness of these instruments. Empirical findings on these aspects are relatively scarce, because, prior to the crisis, many such instruments were considered to distort the free markets, and so countries were encouraged not to use them. Debt service-to-income (DSTI) or loan-to-value (LTV) caps are among the instruments that, within a few years, changed their status from administrative to macroprudential instruments. Jacome and Mitra (2015) managed to collect details on the experience of six emerging economies that used DSTI and LTV both before and after the crisis, and have provided extremely useful findings.

Our paper falls within the stream of literature that searches for answers about operationalizing macroprudential instruments. Some papers (e.g. Aikman *et al.*, 2013; ESRB, 2014) focus on operationalizing the macroprudential regime, as a whole. Detken *et al.* (2014) target the countercyclical capital buffer operationalization. We concentrate on the operationalization of another two macroprudential instruments: debt service-to-income (DSTI) and loan-to-value (LTV). We provide inputs about their design, implementation and calibration, using the Romanian bank-level database as a case study. We also investigate their effectiveness in supporting the macroprudential intermediate objective of mitigating excessive credit growth and leverage. Our paper complements Neagu *et al.* (2015), where optimum levels for DSTI and loan-to-income caps are computed.

Romania is among the small open economies that was forced to resort to unorthodox measures in order to cope with challenges related to capital account liberalization, the euroization of the economy, credit boom developments, etc. (details in Annex 1). Some of these unorthodox measures are now considered "the new normal" (e.g. the use of DSTI and LTV caps). After analyzing a decade of Romanian experience with these instruments, we conclude that DSTI and LTV instruments are relatively effective in curbing high credit growth and ensuring that both debtors and creditors are better equipped to withstand possible adverse shocks. However, we find that the instruments' effectiveness in curbing house price growth is relatively poor in Romania, the result being in line with other studies (e.g. Lau and Rau, 2015 for Malaysia). On the other hand, Arregui *et al.* (2013) consider that the DSTI/LTV measures have an important impact on house price dynamics. Kim (2015) reaches the same conclusion for Korea, highlighting that the prudential measures were reinforced by fiscal ones.

We find that, in the absence of specific guidelines from the macroprudential authority, banks' self-regulation on DSTI and LTV yields sub-optimal results. Romanian banks behaved in a deeply pro-cyclical manner when an approach based more on self-regulation was implemented. However, self-regulation might work in the downward phase of the financial cycle, when banks are more risk averse. This is the conclusion we might grasp from the Brazil (Afanasieff *et al.*, 2015) and Poland (Bierut *et al.*, 2015) experiences. We also find that it is useful to tailor the DSTI and LTV measures according to the specific patterns of possible risks. The caps for these instruments should be differentiated based on debtors' disposable income (low, medium and high), the currency of indebtedness (domestic or foreign) and the destination of the loan (mortgage or consumer loan).

The first step in implementing DSTI or LTV caps is to know which systemic risks are more likely to be addressed by using these instruments. High indebtedness of households is one example of a risk that might impair financial stability, and the level of debt-to-service is a good leading indicator for banking crises (Drehmann and Juselius, 2013). Macroeconomic variables and bank specific factors are also leading indicators for repayment behavior (Klein, 2013). Real estate negative developments represent another risk that might trigger a financial crisis; and Davis *et al.* (2011) provide a survey of the literature from this perspective. The main systemic risks monitored in Romania when taking policy decisions regarding DSTI or LTV caps relate to: (i) borrowers' indebtedness (or excessive credit growth – from a lender's perspective), (ii) the sectoral concentration in real estate assets, and (iii) the macroeconomic imbalances. To this end, the National Bank of Romania has developed a framework to monitor the challenges stemming mainly from the household and corporate sectors.

The rest of the paper is structured in three parts. Section II highlights the Romanian framework for DSTI and LTV: how these instruments are used (calibration, enforcement and communication processes) and how decisions are taken (institutions involved and dealing with "leakages"). The effectiveness of the instruments from the perspective of credit, house price and non-performing loan dynamics is presented in Section III. The last section concludes with a summary of the lessons to be learned from the Romanian experience.

II. Using the instruments

A. Monitoring systemic risk

In Romania, the identification of potential systemic risks is based on both quantitative and qualitative tools. The main systemic risks that might trigger activation of the DSTI or LTV caps are: the high level of borrowers' indebtedness (or excessive credit growth – from a lender's perspective), sectoral concentration in real estate assets and macroeconomic imbalances.

At the early age of DSTI and LTV usage, the key indicators monitored by the authorities when deciding upon the introduction/calibration of these instruments were: credit growth dynamics (especially in FX), external equilibrium (current account deficit) and the inflation rate. This monitoring framework evolved in line with the macroprudential analysis agenda. More emphasis is now put on indicators flagging potential systemic risks stemming from developments in the real estate market and borrowers' (household and corporate sector) vulnerabilities, as a complement to a banking sector analysis.

The household sector is monitored largely by (i) the structure and dynamics of indebtedness and (ii) the ability to service the debt. The overall level of indebtedness is quantified by a series of indicators: the level of debt service-to-disposable income, debt-to-assets, debt-to-net wealth and debt-to-GDP. The indebtedness is also monitored from a structural perspective: by currency (the share of FX loans in total loans granted to households), by destination (the share of mortgage and consumer loans, respectively, in total loans), by categories of disposable income (e.g. the borrowers with lower than average disposable income display a higher level of indebtedness and a higher

non-performing ratio), and by tenure (short, medium, and long-term lending). Households' ability to service the debt is assessed by computing the non-performing loan ratio (total, by currency, income, destination, vintages, etc., see Table A4.1, Annex 4) and by the sensitivity analyses of the NPL response to potential shocks on interest or exchange rates. The monitoring framework is based on micro-data from the Central Credit Register (within the central bank) and Credit Bureau (private entity) databases. The analysis of these indicators points to the following conclusions: (i) lending in foreign currencies is riskier than lending in domestic currency, (ii) consumer lending should not exceed 5 years (the level above which the NPL ratio would significantly increase); and (iii) there is a threshold of indebtedness above which the ability of the borrowers to repay their debts decreases considerably (Chart A4.1, Annex 4). This threshold differs from one cohort to another (cohorts are grouped by disposable income), but an aggregate 45 percent yardstick is informally monitored. This value is in line with Neagu *et al.* (2015), who find a considerable upsurge in the probability of unsustainable lending if this threshold is crossed.

The corporate sector is monitored from several perspectives. First, the leverage ratio (debt/capital) is computed for the overall economy, by main economic sectors, and by firm size (micro, small and medium enterprises). The yardstick for this ratio is 2, above which a closer monitoring is performed. Second, the structure and dynamics of loans granted to firms by banks and non-bank financial institutions (both domestic and foreign lenders) are examined. The focus is on the share of the FX loans granted to unhedged borrowers. Third, in order to assess the credit risk, the following indicators are quantified (i) the one-year probability of default for the corporate sector and (ii) the NPL ratio (total, by currency, economic sector, firm size, destination of the loans, etc.). Fourth, the main soundness indicators of the corporate sector (ROE, EBIT/interest expenses, etc.) are investigated. A stress-test exercise of the corporate sector is performed to assess its ability to cope with negative macro and financial developments.

The banking sector is assessed mainly through its capacity to adequately cover the expected and unexpected losses (through provisions and capital) and its ability to shield against the risks stemming from the concentration in real estate assets (the overall exposures to construction and real estate sectors, as well as the volume of real estate collateral from banks' books are computed).

The DSTI/LTV ratios are examined through several databases. First, the quarterly bank lending survey is used, where explicit questions about the DSTI and LTV levels are listed[1] (Chart A4.4, Annex 4). Second, DSTI and LTV at credit level can be computed since 2012 respectively, by merging the databases provided by the Central Credit Register, the Ministry of Finance, and the National Institute of Statistics. Third, one-off questionnaires help collect further information on DSTI and LTV on banks' portfolios.

[1] The questionnaire is submitted to the largest 10 banks in the system. The figures for LTV and DSTI ratios have been collected since Q4/2007: (i) for both the existing stock and the new lending activity, and (ii) for the lowest and the highest limit of LTV and DSTI, as stipulated in the banks' internal norms.

B. Taking decisions

1. Institutional considerations

All the decisions regarding DSTI and LTV are taken and implemented by the central bank. The National Bank of Romania (NBR) has monetary policy and microprudential responsibilities, and, starting in 2004, was also given the task of preserving financial stability. These tasks have proved complementary so far. The inflationary pressures called for measures to tackle high credit growth. The high level of indebtedness in FX, as well as the rapid transmission of the domestic currency depreciation into inflation expectations, benefited from measures to reduce volatility and sudden changes in the exchange rate.

The proposals regarding DSTI and LTV are discussed in the Supervisory Committee and submitted to the NBR Board for final decision. The NBR Board is made up of 9 members: 4 executives (a governor, a first-deputy governor, and two deputy governors) and 5 non-executives. *De facto,* the Supervisory Committee has a semi-hard to hard decision-making power, as a consequence of its responsibilities to discuss and endorse prudential measures and of its organization (all the executive members of the NBR Board are acting in the Supervision Committee). Such institutional arrangement facilitates the swift implementation of measures like DSTI and LTV caps.

There was strong coordination between the Supervisory Committee and the Monetary Policy Committee in implementing DSTI and LTV measures to manage capital flows. The capital account liberalization (KAL)[2] process was pro-cyclical in nature, because it overlapped with strong external inflows. The DSTI and LTV measures introduced in 2003 acted as a counterbalancing stance for the KAL, complementing the prudent stance of the monetary policy.

2. Application and enforcement

The NBR rules on DSTI and LTV usually enter into force 30 days after their publication in the *Official Gazette*. Nevertheless, the measures on DSTI and LTV adopted in the last few years allow for a 60-day period for enforcement. The reason is the increasing complexity of the process of setting up the caps, which are differentiated based on the risk profile of the debtors and the bank products (i.e. mortgage or consumer loans).

In order to limit the unintended consequences of the macroprudential measures, several actions have been implemented. First, restructured loans have been exempted from DSTI and LTV caps, with a view to not imposing further limitations on these already constrained debtors that would affect the servicing of their debt. Second, loans granted within the *Prima Casă* ("First Home") government social program are not subject to LTV caps in order to maintain access to the program for low-income debtors. The government collateral provides a guarantee for banks that such exposures will be recovered in case the debtors are unable to repay the loan. Third, starting 2009, DSTI caps for mortgage loans have not been subject to stress testing requirements (regarding

[2] An important part of the capital account liberalization process took place during 2003–2006, and was a prerequisite for Romania's accession to the EU in 2007.

income, exchange rate and interest rate shocks), as this portfolio exhibits a lower risk profile and residential real estate would be further affected by additional pro-cyclical measures.

3. Communication

The measures implementing DSTI and LTV caps follow the standard procedures applicable to those regulations that might materially impact the financial system: a preliminary draft regulation is discussed with the Romanian Banking Association; the final draft is posted on the central bank website for further comments from other stakeholders; the approved version of the regulation is published in the *Official Gazette*.

The Financial Stability Report is a useful communication tool for the NBR's views regarding the risks associated with the lending activity and the needed policy actions. The report (released once a year) provides separate analyses of developments in the household, corporate, and real estate sectors, including possible measures that the central bank might implement to tackle the identified systemic risks.

The NBR experience with DSTI and LTV implementation highlights the need for further transparency of the authorities' macroprudential intermediate objectives. Such transparency would enhance the communication between the central bank and market participants, by explaining the main drivers of the authorities' actions.

C. Calibration and dealing with "leakages"

1. Calibration

The DSTI and LTV caps have undergone several changes since their first implementation in early 2004. The calibration of these instruments is based on a hybrid approach that combines qualitative and quantitative analyses. The qualitative assessment looks at potential upside and downside risks associated with such measures. The quantitative analysis relies on a set of key indicators: (i) risk indicators (non-performing loan ratios by type of loans, currency and maturity), (ii) the share of exposures per sub-portfolio and associated growth rates, and (iii) real estate market developments.

The calibration includes both the value of the caps and their applicability across financial institutions. From their implementation in early 2004, these prudential measures have been applicable to all credit institutions (Romanian legal entities) and branches[3] of the foreign credit institutions present in Romania. In 2006, the measures were extended to the main non-bank financial institutions, while in 2011 payment institutions and electronic money institutions with a significant level of lending were brought under the umbrella of the DSTI and LTV requirements.

[3] Nevertheless, between 2007 and 2011, branches were exempted from these measures, as a consequence of the implementation of the EU banking rules. In 2011, branches were asked to meet the DSTI and LTV requirements, for financial stability reasons.

The instruments require changes in order to better contain the systemic risks and to drive away the circumvention phenomenon. In 2003, caps on DSTI differentiated between two types of loans: 30 percent for consumer loans and 35 percent for mortgage loans. The LTV cap was set at 75 percent for both consumer loans for the acquisition of goods and mortgage loans. In 2006, a maximum indebtedness limit of 40 percent of the net income of a debtor and his/her family was imposed, and, for computing the DSTI, the minimum daily living costs[4] were deducted from the disposable income. In 2007 (Romania joined the EU), the NBR moved from a regulatory framework considered to be administrative (i.e. caps on DSTI and LTV) to an approach based rather on market self-regulation. The explicit caps on DSTI and LTV were eliminated. In return, lenders were requested to set up their own rules for establishing maximum indebtedness' levels, differentiated by classes of risk for borrowers[5]. Such change resulted in the pro-cyclical behavior of credit institutions in establishing adequate prudential values for DSTI caps.

In order to preserve the prudent regulatory stance, the central bank changed its attitude in 2008. The NBR introduced a new approach based on the mandatory assessment of debtors' capacity to repay their debt in a stress scenario and the requirement for lenders to calibrate the DSTI level (at origination) in such a way that debtors should not exceed the maximum indebtedness level over the entire life of the loan. The new approach complemented the self-regulation approach, but with the NBR providing guidelines to ensure that risk was adequately captured in the lenders' internal norms. In 2009, loans granted under the newly implemented *Prima Casă* national program were exempted from the DSTI requirement.

The European Systemic Risk Board recommendation on foreign currency lending[6] found the NBR well advanced in implementing DSTI and LTV measures. For full compliance, the central bank tailored the LTV caps[7] based on the type of borrower (hedged/unhedged) and by currency: 75 percent for consumer loans denominated in foreign currency or indexed to a foreign currency rate, 85 percent for mortgage loans denominated in local currency, 80 percent for mortgage loans to hedged borrowers denominated in foreign currency, 75 percent for mortgage loans to unhedged borrowers denominated in euro and 60 percent for mortgage loans to unhedged borrowers denominated in a foreign currency other than euro. The limits were applied to the new loans, with the exception of those granted through the *Prima Casă* national program. For setting the DSTI caps, lenders were required to also take into account the income risk (in addition to interest rate and currency risks). In 2012, the DSTI rules were extended to non-financial companies.

[4] This measure was part of a prudential package that also included the introduction of a limit on credit institutions' exposure in FX loans to unhedged borrowers (individuals or firms) of 300 percent of their own funds, and the extension of the DSTI and LTV requirements to loans granted by non-bank financial institutions.

[5] These changes provided more flexibility to lenders, but a 40 percent cap on total DSTI was still mandatory until the new internal norms, incorporating the changes introduced by the new regulation, were validated by the NBR.

[6] The European Systemic Risk Board Recommendation 2011/1 from 21 September 2011 on lending in foreign currencies.

[7] The figures were established based on a three-year adverse scenario, where the value of the collateral should remain sufficient to cover potential losses. The distinction among currencies is done according to the risks associated with each portfolio of loans and the developments in the real estate markets at the time of implementation of the measure.

2. Dealing with policy "leakages"

The Romanian experience with the macroprudential measures reveals that DSTI and LTV caps may be circumvented (Georgescu, 2011), similar to the experience of other countries (Jacome and Mitra, 2015). First, there is the standard circumvention method of using non-regulated entities to deliver loans. In order to evade the macroprudential measures introduced in 2003, banks started to transfer their credit activity to non-bank financial institutions (entities within the same financial group). In response, in 2006 the NBR brought under its regulatory and supervisory umbrella the non-bank financial institutions with significant lending activity and extended the DSTI/LTV prudential measures to these institutions.

Second, banks apply promotional interest rates in the first period of the loan in order for the debtors to fulfill the DSTI requirements at the origination of the credit. At the end of the promotional period, the level of indebtedness may rise considerably. In 2008, NBR asked the lenders to ensure that debtors would fulfill the DSTI conditions during the entire life of the loan.

Third, banks lengthen the maturity of credits in order to decrease the monthly debt service payment of the borrowers in order for the indebtedness level to stay within the DSTI caps. As a response, in 2011, NBR limited the maximum tenure of consumer loans to 5 years.

Fourth, loans from the *Prima Casă* government program are granted an LTV cap of 95 percent and are not subject to the stress testing conditions in computing the DSTI. These loans have a government guarantee, and therefore the credit risk in banks' balance sheets is curbed to a large extent.[8] The non-performing loan ratio for the *Prima Casă* portfolio is significantly lower compared with the overall mortgage portfolio. Possible changes might be needed in the event of a new house price boom and if the volume of *Prima Casă* transactions remains a significant component of the total new mortgage loans provided by banks.

III. Evaluating effectiveness

We evaluate the effectiveness[9] of the DSTI and LTV caps from the perspective of their ability to: (1) trim down high credit growth, (2) prevent a housing price bubble, and (3) foster debtors' capacity to repay the loans.

A. Credit dynamics

We focus on the evolution of household credit, divided into its main components: consumer loans and mortgage loans[10]. We employ a bank lending channel model to estimate the effects of the DSTI and LTV caps on household credit dynamics. This approach, introduced by Bernanke and Blinder

[8] For loans granted from 2009 to 2011, the government provided a 100 percent guarantee, while for loans granted as of 2011, the guarantee has been reduced to 50 percent.

[9] We have the same understanding about the effectiveness of a macroprudential instrument as the ESRB (2013): "<effectiveness of the instrument> means the degree to which the instrument can address market failures and achieve the ultimate and intermediate objectives".

[10] DSTI and LTV caps for lending to companies were introduced in December 2012. It is too early to grasp pertinent conclusions from the evolution of credit delivered to companies.

(1988) and Kashyap and Stein (1994), considers that a monetary policy shock that is transmitted to the supply of credit through interest rate and also influences banks' willingness to lend due to frictions in switching between different forms of funding. We are interested in assessing the impact of the prudential regulation on credit developments, and therefore we add in the bank lending channel model a variable to identify this effect.

The general form of the equation for the lending channel model is:

$$\Delta \ln L_{i,t} = \alpha \, \Delta ln \; L_{i,t-1} + \beta_{MP} \sum_{k=1}^{4} \Delta \, r_{MP,t-k} + \beta_{MRR} \, \Delta \, r_{MRR,t-1} + \beta_y \, y_{t-1} + \beta_{infl} \, \pi_{t-1} + \delta \, X_{i,t-1} * r_{MP,t-1} + \mu \, D_{t-1} + \varepsilon_{i,t}$$

where i = 1,N banks, t =1,T quarters, r_{MP} = monetary policy rate, r_{MRR} = the minimum required reserves ratio, π = the inflation rate, y = the real annual GDP growth rate, X = variables for various bank characteristics variables (the solvency ratio and the loan-to-deposit ratio, LTD, which measures banks' structural liquidity position).

D represents the regulation dummy variable and is defined as taking the value 1 when prudential measures on DSTI and/or LTV are introduced (and/or modified) and zero otherwise (the measures are detailed in Table A.1, part A and Chart A4.1, Annex 1).

We estimate the model using the GMM dynamic panel data technique[11] following the specifications used by Ehrmann *et al.* (2001) and Gambacorta *et al.* (2004, 2011). The model is estimated for the first 14 banks of the Romanian banking sector[12] (cumulating 80 percent of total outstanding loans) for the period 2004 – 2012, using credit-by-credit information.

For the dependent variable, we use the total loans granted to households (also separated into its two components: mortgage loans and consumer loans). The growth rate of loans is corrected for adjustments in the portfolio due to credit sales (externalized loans). A set of data statistics for the variables employed in the model is presented in Table A2.1, Annex 2.

The coefficient μ from the above equation captures the response of credit to the prudential measures regarding DSTI and LTV. The identification is not perfect and the results should be interpreted with care, as we cannot totally separate the effects of the DSTI/LTV measures from other regulations that are in place during the same period, the most important of which is the NBR norm that limits foreign currency exposure from credit activity (Table A.1, part B, Annex 1). Also, it is difficult to disentangle the consequences of the DSTI measures from the LTV measures, as most of the time these prudential regulations are introduced at the same time.

The period scrutinized (2004 – 2013) covers almost an entire credit cycle. The level of banking intermediation increases from around 5 percent of GDP to 20 percent at the end of the expansionary phase (Chart A2.1, Annex 2). Analyzing the impact of the prudential measures only for the

[11] Using an OLS method with fixed effects for banks, even in the absence of the autocorrelation in errors due to the lagged dependent variable, would have most likely produced biased estimators (Nickell, 1981).

[12] We select the banks by putting a materiality threshold on their lending portfolio of 1 percent in total aggregate credit to households and firms.

expansionary phase of the cycle (2004 – 2008) is very important, for at least two reasons: (i) the estimations are not affected by adjustments during the contraction phase of the credit cycle and (ii) they give an assessment of the measures' efficiency in the short run, which should help the macroprudential authorities calibrate their instruments. These measures are set to produce two types of effects – the first one, in the short run, directly observable, reducing the excessive credit growth, and, the second one, in the long run, keeping the credit activity within the prudential limits and, therefore curbing the credit cycle.

Before setting any econometric models, we employ a simple event study for two key moments: (i) 2004 Q1, when the DSTI/LTV regulation was implemented (Chart A2.2, Annex 2), and (ii) 2008 Q3, when the prudential regulation was tightened by introducing specific guidelines in setting DSTI limits, thus making the shift from a "self-regulation" framework to a guided "self-regulation" framework (Chart A2.3, Annex 2). The results indicate that: (i) the macroprudential measures appeared to have successfully contributed to the reduction of the credit growth rate, and (ii) the direct impact lasts only for one year, after which the effect on credit growth decreases to near zero.

We estimate the marginal effect of the DSTI/LTV measures on credit to lie between 4.6 and 8.8 percentage points in the first quarter after the measures are introduced (the highest level being for consumer loans). The incremental impact of the prudential measures is significantly reduced after one year, and it is close to zero after two years (Chart A3.1, Annex 3). If we look only at the expansionary phase of the credit cycle, the impact is stronger (around 10 percentage points) and significantly higher compared to the response of credit to the monetary policy shock (around 6 percentage points).

To test the robustness of our estimations, we add other variables to the specification described above, in line with other findings (e.g. Barajas *et al.*, 2003): the change in banks' external funding and the change in imports as a percentage of GDP. The results are fairly stable across regression specifications. We also test the model by replacing the monetary policy rate with the interbank interest rate, following Angeloni *et al.* (2003). These last estimations are not included in the paper, as the results are very similar.

The analysis of total household credit dynamics (Table A3.1, Annex 3) indicates that: (i) the prudential regulations play an important role, as they exhibit a strong anti-cyclical effect (the impact doubles in the pre-crisis period, 2004 Q4 – 2008 Q4). The average impact in the first quarter varies between a 4.9 to 5.6 percentage points decrease in lending and is around 10 percentage points during the expansionary phase of the cycle; and (ii) the banks' external funding is also a major determinant factor.

The mortgage credit growth analysis (Table A3.2, Annex 3) shows that: (i) the regulation variable enters the regression with a lag of two quarters (a possible explanation is that banks adjust their lending to households more slowly for housing purchases compared to consumer loans); (ii) the overall result does not change when controlling for the period during which the *Prima Casă* government program is in place (the program was introduced during the downturn phase of the credit cycle, in 2009 Q3); and (iii) the housing price has an important effect on credit growth (4 percentage points), but its size and statistical significance are reduced when controlling for other variables like banks' external funding.

For consumer credit (Table A3.3, Annex 3) the results indicate that: (i) prudential regulations play a major role, higher than in the case of mortgage loans (the marginal effect of DSTI/LTV measures on credit lies between 7.5 and 8.8 percentage points for the entire period and at 10.5 percentage points for the first phase of the cycle); (ii) the demand factor is material (the coefficient for the real GDP growth rate varies between 0.9 and 1.1) and (iii) banks' external funding and the change in imports as a percentage of GDP are important drivers of the consumer credit growth. The results for the consumer credit growth should be considered with additional care, as the consumer credit indicator is constructed based on the credit-by-credit information from the Central Credit Register, which does not record exposures per debtor below RON 20,000 (approx. EUR 4,500).

B. Housing price dynamics

We expect no material effects of DSTI/LTV caps on housing prices in Romania, as data indicates a low recourse to bank credit for funding real estate transactions during the expansionary phase of the credit cycle. The number of new mortgage-backed loans was considerably lower compared with the number of total new transactions in the housing market during the expansionary phase of the credit cycle (less than 20 percent were credit-based transactions, 2005 – 2008). Moreover, during the downward trend of the cycle, the number of new mortgage-backed loans decreased more sharply than the number of real estate transactions.

The dynamics of the housing price index support the same conclusion (Chart A3.2, Annex 3), as there was no meaningful change in the index during the periods when the DSTI/LTV measures were in place. In order to test the link between real estate prices and bank credit, we apply a Granger causality test. The result is shown in Table A3.4, Annex 3. According to this test, the change in real estate prices precedes (Granger cause) the change in mortgage credit, while the null hypothesis of no Granger causality is accepted for the inverse relationship.

C. Non-performing loan (NPL) dynamics

We assess the effectiveness of DSTI/LTV regulations in maintaining the quality of the banks' portfolio. We analyze the results where DSTI/LTV caps are explicitly provided in the prudential norms or guided self-regulation is in place versus the periods when an approach based to a large extent on banks' self-regulation is implemented.

We apply a GMM dynamic panel data model for the evolution of non-performing loan (NPL) ratios[13] by vintages[14]. We look at the NPL ratio for the portfolio of loans granted each quarter

[13] The NPL ratio is defined as the share of non-performing loans in the total outstanding amount for each vintage. A loan is considered non-performing (in default), if it is more than 90 days overdue, at least once since its origination. We use only the exposures per debtor larger than RON 20,000 available in the Central Credit Register.

[14] The vintages are defined as the flow of new loans granted quarterly during 2004 – 2010. We compute the time series of non-performing ratios for each vintage until the end of 2013. The last vintage is 2010 Q4, in order to have a comfortable outlook period for analyzing its performance. This approach allows for both time and cross-sectional dimension in our work and for controlling the persistence in the default state. The rescheduled or refinanced loans are excluded from the analysis.

between 2004 and 2010 and assess the driving factors using variables found in the literature. Additionally, we run similar regression equations on household portfolios with different types of loans to test for variations in debtors' repayment behavior.

We use the following categories of explanatory variables, based on findings in the literature (e.g. Klein, 2013): (i) macroeconomic variables[15] (disposable income growth rate, exchange rate, unemployment rate, real estate price index, etc.), (ii) financial stance indicators[16] (banks' return on assets, solvency ratio, leverage ratio, etc.) and (iii) prudential regulation.

We construct a dummy variable for the self-regulation period, as following[17]:

$$Self-regulation\ dummy\ = \begin{cases} 1, & from\ 2007\ Q1\ until\ 2008\ Q3 \\ 0, & otherwise \end{cases}$$

The equation for the developments of the NPL ratio is the following:

$$NPL_{i,t} = \alpha\, NPL_{i,t-1} + \beta_1\, \Delta X_{t-l} + \beta_2\, \Delta\, Y_{t-l} + \mu\, D_{t-2} + \varepsilon_{i,t}$$

where i = 1, N vintages, and t = 1, T quarters, l = number of lags, X_{t-l} stands for macroeconomic variables, Y_{t-l} for the financial stance indicators and D represents the regulation tightening or self-regulation dummy variable (defined above). We use the evolution of the NPL ratio for each vintage as a dependent variable.

Like in the case of credit dynamics, we cannot disentangle between measures targeting DSTI, on the one hand, and LTV, on the other hand, as the regulations overlap for almost the entire period analyzed. The impact of prudential regulation is tested separately and also in interaction with macroeconomic variables (e.g. unemployment rate, index for real estate developments, etc.) or loan characteristics (interest rate, exchange rate, etc.).

The analysis of the NPL ratio for the household' portfolio as a whole reveals the following main results. First, the approach based on banks' self-regulation led to an increase in the NPL ratio (see Eq.1, Table A5.1 and Chart A5.1, Annex 5) and also to a higher sensitivity of the indebted households to macroeconomic developments (such as unemployment rate[18]) (Table A5.2, Annex 5). The results are in line with the empirical findings, which indicate that the easing

[15] More than 90 percent of respondents from a European Commission study (*The over-indebtedness of European households: updated mapping of the situation, nature and causes, effects and initiatives for alleviating its impact*, 2013) indicate macroeconomic factors as being the main determinants of over-indebtedness. Among these factors, unemployment is the most significant, followed by wages, fluctuations in the interest rate and movements in the exchange rate.

[16] The variables reflecting the financial stance of the banking sector are only tested to control for the sensitivity of the non-performing loan dynamics to banks' strategies. The leverage ratio delivers the most stable results.

[17] For a robustness check, we also test the impact of regulation tightening. The estimations confirm the results, in the sense that a tightening of regulations contributes to diminishing NPL ratios for the entire household portfolio, and also for the sub-portfolios.

[18] Other macroeconomic variables were also tested, but the results were inconclusive and they are not presented in the paper.

of the lending standards by credit institutions in a pro-cyclical manner (2007 Q1 – 2008 Q3) is associated with a higher non-performance of both mortgage and consumer loans (Chart A4.2 and Table A4.2, Annex 4).

Second, we discover that the real estate price dynamics have an impact on all debtors, regardless of whether they took a loan in the self-regulation period or not[19]. The correction of real estate prices is transferred into higher NPL ratios (see Eq.1, Table A5.1, Annex 5), in line with the empirical findings that show a link between the LTV level and debtors' capacity to repay their debt. The riskiest mortgage loans in terms of NPLs are those granted in the period of excessive credit growth (2007 – 2008) and that currently have the highest LTV values (90 percent in 2007 and over 110 percent in 2008, Chart A4.3 and Table A4.2, Annex 4). This portfolio accounts for almost 75 percent of the total volume of mortgage NPLs (as of December 2013).

For the mortgage loan analysis, we account for the loans granted through the *Prima Casă*[20] government program. In this sense, we use a dummy variable that takes the value 1 for all loans granted between 2009 Q3 and 2010 Q4. The results show that these loans contribute to a decrease in the NPL ratio, compared to other vintages (see Eq.2 from Tables A5.1 and A5.2, Annex 5). Nevertheless, the dummy variable cannot be specifically applied to the *Prima Casă* loans, but to all loans granted during this period. The results should be interpreted with caution, because its effect might also include other factors such as tighter lending standards, adverse real estate price developments, etc.

We find that non-mortgage backed consumer loans[21] are the most affected by the self-regulation approach. The sensitivity to macroeconomic factors (the unemployment rate) of loans granted in this period is the highest (Eq. 3, Table A5.2, Annex 5) and the impact on the NPL ratio is the largest (Eq. 3, Table A5.1, Annex 5).

IV. Conclusions

We describe an example of designing, implementing and calibrating two macroprudential instruments: loan-to-value (LTV) and debt service-to-income (DSTI). We also investigate LTV and DSTI effectiveness in slowing down excessive credit growth and in preserving the quality of banks' loan portfolios. Our work is based on the Romanian experience with the use of these instruments from 2004 onwards. During this period, Romania witnessed both sides of the credit and business cycles, and encountered challenges related to full capital account liberalization, the euroization of the economy, credit boom developments, etc. Some unorthodox measures

[19] We also tested the real estate price variable with an interaction, but the sensitivity does not differ substantially.

[20] The programme has a significant contribution to the mortgage loan flows and accounts for almost 45 percent of the total mortgage loan stock (June 2014).

[21] The results should be viewed with caution as the NPL ratio for non-mortgage backed consumer credit was, due to the lack of historical data, constructed based on the information from the Central Credit Register which does not record loans with values lower than approximately EUR 5,000. This portfolio is among the riskiest category of loans granted to households (Table A.4.1, Annex 4).

implemented a decade ago to cope with these challenges are now among "the new normal" (e.g. the use of DSTI and LTV caps).

The first step in implementing DSTI or LTV caps is to know which systemic risks are more likely to be addressed by using these instruments. The main systemic risks monitored in Romania when taking policy decisions regarding DSTI or LTV relate to: the level of borrowers' indebtedness (or excessive credit growth – the lender perspective), the sectoral concentration in real estate assets and the macroeconomic imbalances. To this end, the NBR has developed a framework to monitor the challenges stemming mainly from the household and corporate sectors.

We find that the DSTI and LTV caps have been relatively effective in: (i) curbing high lending activity and (ii) ensuring that both debtors and creditors are able to cope with possible adverse shocks in real estate prices, domestic currency depreciation, or interest rate hikes. The latter point explains why the LTV and DSTI caps should be used both in the upswing and the downswing of the credit cycle.

We learn that a one-size-fits-all approach is not very effective. It is more useful to tailor the DSTI and LTV measures according to the specific patterns of possible risks. The caps for these instruments should be differentiated according to the debtors' disposable income (low, medium and high), the currency of indebtedness (domestic or FX loans) and the destination of the loan (mortgage or consumer).

We apply an extension of the Bernanke and Blinder (1989) lending channel model using a GMM dynamic panel technique to assess the impact of DSTI/LTV measures on lending dynamics and NPL developments. We use bank-level information and credit-by-credit databases to grasp the consequences of the DSTI and LTV caps on lenders' and debtors' behavior. We find that these macroprudential instruments have a strong anti-cyclical effect. We find that banks' self-regulation on DSTI and LTV caps, without any specific guidance from the authorities, would deliver sub-optimal results. The Romanian banks behaved in a deeply pro-cyclical manner when an approach based to a large extent on self-regulation was implemented.

We find strong negative correlation between the level of indebtedness and the ability to repay the debt. Moreover, debtors with lower income income and high DSTI post a higher NPL ratio, irrespective of the purpose of lending (consumer or mortgage lending). There are links between the LTV level and debtors' capacity to repay their debt: the higher the LTV, the higher the non-performing loan ratio. These arguments underpin the relevance of using DSTI and LTV caps to foster debtors' repayment capacity.

The effectiveness of these macroprudential instruments in slowing down the rapid credit growth seems to have been higher than that of the monetary policy or microprudential instruments. The main explanations for this outcome are: (i) the high level of euroization, full capital account liberalization and the material share of FX lending affect monetary policy transmission, (ii) substantial foreign capital inflows prior to the crisis and significant returns in the banking sector limit the scope of microprudential instruments; and (iii) in periods of high euphoria among market participants, the price costs channel (like interest rates) seems to work less effectively than the quantity costs channel (like

DSTI and LTV caps) in altering players' behavior. The econometric analysis supports this conclusion that the DSTI and LTV measures played an important role in dampening the growth in credit.

We find that DSTI and LTV effectiveness in curbing house price growth is relatively poor in Romania, the result being in line with other studies. Data indicates a low recourse to bank credit for funding real estate transactions. The number of new mortgage-backed loans is considerably lower than that of total new transactions.

The Romanian experience with the macroprudential measures reveals that DSTI and LTV caps may be circumvented. The experience is similar in other countries (Jacome and Mitra, 2015). First, there is the standard circumvention method of using the non-regulated entities to extend loans in order for banks to escape the macroprudential requirements. In response, the NBR has brought under its umbrella the main non-bank financial institutions and extended the scope of DSTI/LTV prudential measures so as to cover these institutions as well. Second, the NBR asked the lenders to ensure that debtors would fulfill DSTI conditions during the entire life of the loan, not only at the origination of the credit. Third, the NBR limited the maximum tenure of consumer loans to 5 years, as banks lengthened the loan maturity to decrease borrowers' monthly debt service in order for the indebtedness level to fit the DSTI caps.

There are three main lessons to be drawn from the Romanian experience in using DSTI and LTV caps. First, there is a need for strong cooperation between domestic and foreign authorities in order to preserve the effectiveness of these instruments. The risk of arbitrage remains, although these measures are harder to be circumvented compared with others, especially when used in combination. On the domestic front, the key issue is to ensure that other types of lenders (like non-bank financial institutions or some components of shadow banking) fulfill the same lending conditions as banks. The NBR has addressed this challenge by bringing under its regulatory and supervisory umbrella the non-bank financial institutions with significant lending activity. On the external front, the establishment of the European Systemic Risk Board has created the framework to deal with a large part of the arbitraging activity that becomes manifest within the EU borders.

The second lesson highlights the need for a change in the macroprudential authorities' perspective, by moving from the lender to the debtor side. Monitoring mainly developments in the monetary surveys (i.e. loans extended by domestic banks), might deliver a substantially incomplete picture to policymakers, and their decisions would be sub-optimal. In the borrowers' portfolio there is a lot of additional debt stemming from: (i) domestic financial institutions other than banks, (ii) non-resident financial lenders, (iii) loans originally provided by domestic banks, but currently externalized to third parties, and (iv) financial loans extended directly by the parent company. A debtor perspective would focus on the total level of borrowers' indebtedness, irrespective of the sources (from domestic or abroad, from banks or non-banks, etc.). A creditor perspective would concentrate on the challenges to the banks' portfolio, and the crisis has taught us that such an approach might deeply underestimate the risks.

The third lesson relates to the importance of higher transparency on the part of the authorities regarding their macroprudential intermediate objectives. Markets should be informed about these

objectives, and, if possible, the instruments should be tailored to fulfill them. Such an approach would enhance the communication between the macroprudential authority and the financial markets, and would decrease the resistance from the private sector when such instruments are implemented. The authorities should build internal risk-monitoring procedures to address the possible impairment of macroprudential intermediate objectives, including early warning thresholds, and instruments to be used in case a threshold is breached.

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Annex 1 – Regulatory measures taken by the National Bank of Romania

Table A.1. Regulatory measures taken by the NBR

Period	A. Prudential measures with an impact on lending	Credit cycle phases
February 2004	A maximum indebtedness level* of 30% for consumer loans, 35% for mortgage loans. In the case of consumer loans for purchasing goods the down payment was set at 25%, but for consumer loans for other purposes the guarantees should cover 100% of the loan. The maximum LTV level for mortgage loans was set at 75%. The requirements are applied to both lei- and foreign-denominated loans.	**Early developments on the domestic credit market: 2003 – 2004** The macroeconomic environment is characterized by strong economic growth (with GDP growth rates of 5.1% to 5.7% in 2001 – 2003 and 8.5% in 2004) and a steady decline in the inflation rate. Economic growth is spurred by a significant increase in domestic demand, especially household consumption (fuelled by the hike in the minimum wage and optimistic expectations about future income). The relative improvements in the fiscal position and a slight deterioration of the external balance (backed by strong foreign direct investment) add to the overall enhancement of the macroeconomic context. The banking sector undergoes major restructuring and reform measures that end up in several banks being closed down and a new banking law being enacted. At the end of 2003, financial assets represent 30% of GDP, of which more than 90% come from the banking sector. Financial liberalization is the defining element of this period. The large foreign capital inflows create a liquidity surplus in the banking sector and the National Bank of Romania (NBR) strives to sterilize it (the minimum reserve requirements for foreign currency liabilities are raised to 30% in the second half of 2004). The rapid acceleration of domestic bank credit (the total stock of non-government credit increases by 48% in 2003 and 26.2% in 2004, while loans to households jump by 214% in 2003 and 44.8% in 2004, real terms figures), in the context of large capital inflows into the banking sector, raises concerns for the central bank as regards lending sustainability. Measures to ensure adequate risk management for banks are envisaged. In this environment, DSTI and LTV caps are implemented at the end of 2003.**

* The indebtedness level is calculated as the monthly debt service value (principal, income expenses and, since 2006, fees and other credit expenses) divided by the debtor's net monthly income (and, since 2006, the income includes only permanent sources of income and excludes encumbered resources).

** During the 1970's and 1980's, several similar measures to rationalize credit were in place, including a sort of DSTI (where the maturity and the interest rates were set by the law) and LTV. The measures on DSTI and LTV discussed in this paper refer to those implemented in post-communist Romania. Such measures were approved by the National Bank of Romania Board in December 2003 and entered into force in February 2004.

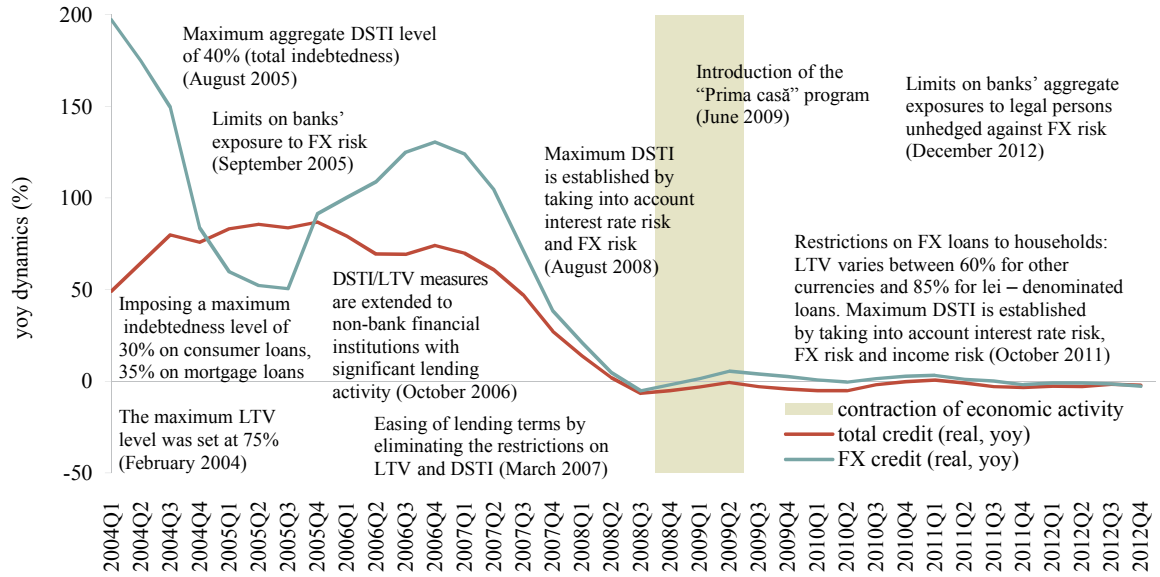
Period	A. Prudential measures with an impact on lending	Credit cycle phases
August 2005	A maximum indebtedness level for all debts (bank credit, leasing, NFI credit) of 40% of the debtor's net income or, when appropriate, of his/her family's is introduced. The requirement is applied to both lei- and foreign-denominated loans.	**The first phase of the excessive credit growth period: 2005 – 2006** Economic growth remains elevated and above potential output, fuelled by domestic demand. Household consumption is the main driver, with domestic investment rapidly picking up. The external balance deteriorates further, although it is largely by foreign direct investment. The strong non-government credit growth resumes in 2006, after a slight setback in 2005, with the household sector remaining the driving force of credit dynamics (out of which consumer credit posts the fastest rise). According to Georgescu (2011), after the implementation of 2005 measures, a clear shift is observed in terms of credit dynamics. The main challenges for the NBR are: (i) to cope with the inflationary pressures exerted by demand factors; the NBR used additional, less traditional instruments, to achieve its objectives (the MRR ratio for foreign-denominated liabilities was raised to 40% in March 2006), (ii) to improve the transmission mechanism of the policy rate in the context of a new monetary policy regime (inflation targeting was adopted in August 2005) and of large foreign capital inflows (in the context of completion of the capital account liberalization ahead of EU accession in January 2007) and (iii) to weather the rapidly increasing household indebtedness.
October 2006	The regulation is extended so as to cover non-bank financial institutions with significant lending activity. The fees and other costs are included in the calculation of the indebtedness level. The requirement is applied to both lei- and foreign-denominated loans.	
March 2007	The regulation is changed from explicitly defined caps on DSTI/LTV to a more banks' self-regulation approach. Credit institutions are requested to define in their internal norms the maximum levels for caps, according to their risk profile, differentiated by the borrower's risk class.	**The late phase of the excessive credit growth period: 2007 – 2008** In 2007 and the first three quarters of 2008, the macro-financial conditions continue to be buoyant. Economic growth is strong (6.3% in 2007 and 7.3% in 2008) and the unemployment rate is on a downward trend (to 6.1% in 2007 and further to 5.8% in 2008). Non-government credit continues to expand (by 50.5% in real terms in 2007). Foreign-currency denominated loans become the main component of the credit stock (54.3% in 2007, growing by 72.6% in real terms).
August 2008	The regulation is amended by requiring banks to evaluate debtors' capacity to repay in a stress scenario, taking into account the foreign currency risk and the interest rate risk. Banks are required to introduce different ceilings on indebtedness ratios for different currency denominated loans.	

Period	A. Prudential measures with an impact on lending	Credit cycle phases
October 2011	▪ Introduction of explicit limits for LTV: – For mortgage loans, the LTV limits are: 85% for loans denominated in local currency, 80% for loans denominated in foreign currency to hedged borrowers, 75% for loans denominated in euro to unhedged borrowers and 60% for loans denominated in other foreign currencies than the euro granted to unhedged borrowers. LTV limits are not applied to the *Prima Casă* loans. – For consumer credit in foreign currency, the value of purchased goods shall not exceed 133%. Consumer credit is limited to 5 years. ▪ Maintaining the requirement for banks to calculate the maximum level of indebtedness in a stress scenario by taking into account foreign currency, interest rate and income risks. In the case of consumer loans, the shock values for the risk factors are explicitly specified: (i) a depreciation of the local currency against the EUR (by 35.5%), against the CHF (by 52.6%) and against the USD (by 40.9%), (ii) 0.6 percentage points increase for interest rate risk and (iii) a 6% shock for income risk.	**The credit contraction phase or post-crisis period: 2009 – present** The intensification of the international financial crisis in September 2008 entails a severe shift in investors' risk tolerance for emerging market assets. Material changes occur in the domestic macro-financial conditions: economic activity contracts by 6.6% and unemployment increases to 7.5% in 2009. The changes at the macro-level impacted the credit market mainly through the income, foreign currency (representing the majority of the credit stock) and wealth (housing prices adjust significantly) channels. Economic growth returns into positive territory in 2011, after two years of contractions, while the unemployment rate stands above 7%. Consumer demand remains subdued, owing to a further decline in real disposable income, increasing uncertainty regarding the future financial stance, decreasing real estate prices and high household indebtedness. The unfavorable international macroeconomic and financial environment also add to the negative developments.
December 2012	Expansion of the measures to non-financial companies unhedged to currency risk by requiring lenders to apply tighter conditions on foreign currency-denominated loans.	

Period	B. Other measures with an impact on lending
September 2005	Overall exposure limits for credit institutions (Romanian legal entities) regarding foreign currency-denominated loans to households and companies equal to at most 300 percent of their own funds (after deducting credit risk provisions).
October 2005	Credit institutions may include the borrowers who do not earn steady income in the currency in which their loan is denominated in the 'B' financial performance category at most.
February 2006	The regulation and supervision of non-bank financial institutions by the central bank.
March 2008	The October 2005 restriction regarding the possibility to classify an unhedged borrower in the 'B' financial performance category at most is eliminated. Additionally, a new requirement regarding distinct provisioning coefficients for loans in foreign currency or linked to another currency exchange rate granted to unhedged borrowers, as compared to hedged borrowers is introduced.
April 2009	Improvements in the provisioning reporting and allowing for a maximum 25% deduction of provisions for the principal amounts of property-backed loans.
June 2009	Launch of the *Prima Casă* government program.

Period	C. Changes in the minimum reserve requirements ratios (MRR)
August 2004	MRR ratio on foreign currency-denominated liabilities: increase from 25% to 30%
August 2005	MRR ratio on lei-denominated liabilities: decrease from 18% to 16%
January 2006	MRR ratio on foreign currency-denominated liabilities: increase from 30% to 35%
March 2006	MRR ratio on foreign currency-denominated liabilities: increase from 35% to 40%
July 2006	MRR ratio on lei-denominated liabilities: increase from 16% to 20%
November 2008	MRR ratio on lei-denominated liabilities: decrease from 20% to 18%
July 2009	MRR ratio on foreign currency-denominated liabilities: decrease from 40% to 35% MRR ratio on lei-denominated liabilities: decrease from 18% to 15%
August 2009	MRR ratio on foreign currency-denominated liabilities: decrease from 35% to 30%
November 2009	MRR ratio on foreign currency-denominated liabilities: decrease from 30% to 25%
April 2011	MRR ratio on foreign currency-denominated liabilities: decrease from 25% to 20%
January 2014	MRR ratio on foreign currency-denominated liabilities: decrease from 20% to 18% MRR ratio on lei-denominated liabilities: decrease from 15% to 12%

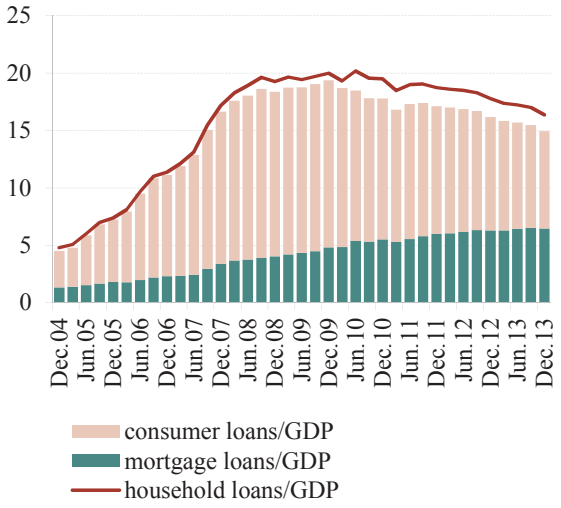
Chart A1.1 Macroprudential measures in Romania relative to the household loan dynamics



Source: NBR, NBR calculations

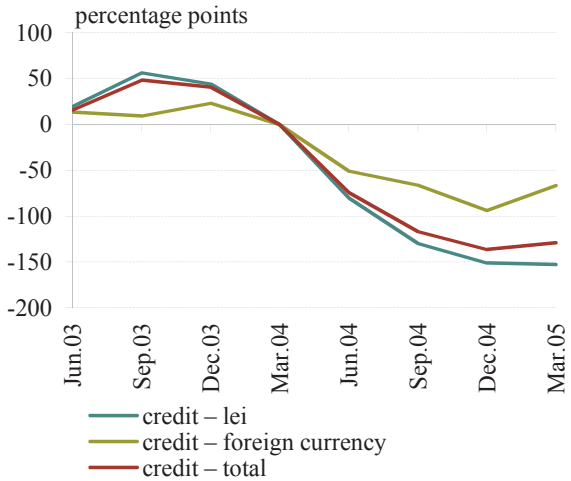
Annex 2 – Credit dynamics

Chart A2.1 The evolution of household loans as a share in GDP during 2004 – 2013



Source: NBR, NIS, own calculations

Chart A2.2 The change in household loan dynamics (real annual growth rate) before and after 2004* prudential regulations

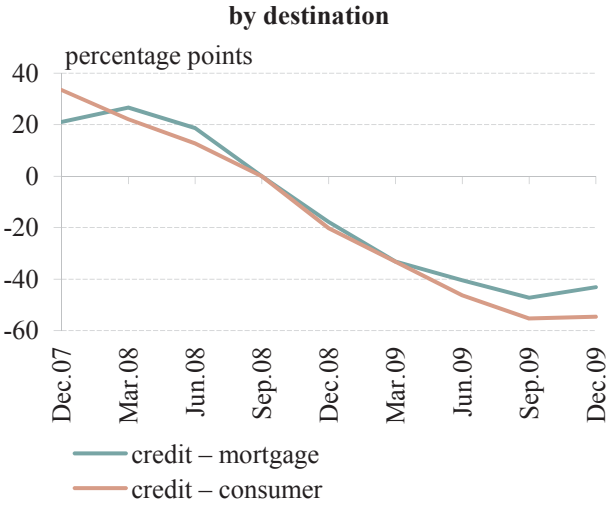


Note: Rates are normalised at 2004 Q1.

Source: NBR, own calculations

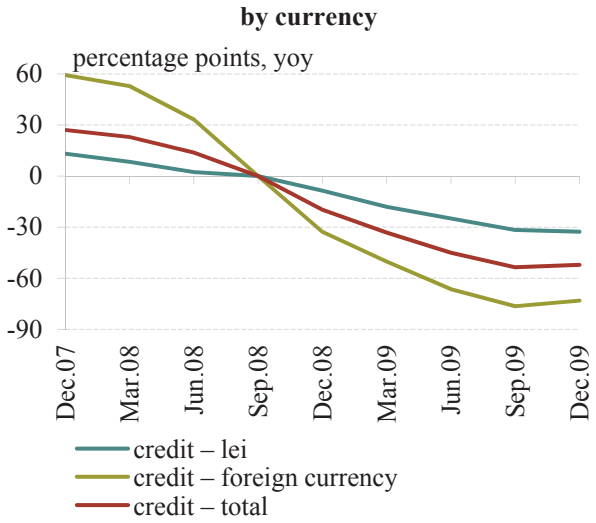
* Due to data availability issues, the impact of the prudential measures on credit dynamics by loan destination, i.e. mortgage and consumer loans, could not be calculated for the measures introduced in 2004.

Chart A2.3 The change in household loan dynamics (real annual growth rate) before and after 2008 prudential regulations



Note: Rates are normalised at 2008 Q3.

Source: NBR, own calculations



Note: Rates are normalised at 2008 Q3.

Source: NBR, own calculations

Table A2.1 Summary statistics

Variable	Observations	Mean	Std.	Min	Max
Growth rate of credit, (total)	490	11.0	19.9	-39.9	151.2
Growth rate of credit, (mortgage)	475	9.5	17.2	-36.3	177.1
Growth rate of credit, (consumer)	487	13.4	25.3	-43.9	151.6
Change in monetary policy rate	490	-0.4	1.1	-5.0	2.0
Change in interbank market rate	490	-0.4	2.2	-5.6	5.6
Change in the minimum reserve requirements rate (MRR, lei)	490	-0.1	1.0	-3.0	4.0
Change in the minimum reserve requirements rate (MRR, FX)	490	-0.3	2.7	-10.0	10.0
Loan-to-deposits	490	141.0	97.9	15.2	592.1
Solvency ratio	490	16.3	6.4	8.3	49.2
Real GDP growth rate	490	2.8	4.8	-7.9	9.8
Bank external debt	490	2.6	0.3	1.7	2.9
Imports/GDP	490	3.6	0.1	3.4	3.8
Growth rate of real estate price	490	4.5	0.3	3.7	5.0

Annex 3 – Results of the econometric models on credit growth

Table A3.1 Total loans to households

	Eq. 1	Eq. 2	Eq. 3	Eq. 4
	2004 Q4 – 2012 Q4			2004 Q4 – 2008 Q4
Growth rate of credit, total (t-1)	0.532*** (0.00)	0.519*** (0.00)	0.535*** (0.00)	0.411*** (0.00)
Real GDP growth rate (t-1)	0.688** (0.03)	0.619*** (0.01)	0.719*** (0.00)	1.410*** (0.00)
Change in monetary policy rate (t-1)	0.924 (0.79)	1.214 (0.73)	1.245 (0.72)	-0.812 (0.84)
Change in monetary policy rate (t-2)	0.365 (0.73)	0.602 (0.48)	0.099 (0.90)	-0.105 (0.92)
Change in monetary policy rate (t-3)	-3.608*** (0.00)	-3.793*** (0.00)	-3.590*** (0.00)	-3.645*** (0.00)
Change in monetary policy rate (t-4)	-0.171 (0.79)	0.051 (0.93)	-0.157 (0.79)	-0.420 (0.59)
Regulation Dummy (t-1)	-5.497* (0.05)	-4.867* (0.06)	-5.612** (0.03)	-10.003*** (0.00)
LTD (t-1)* change in monetary policy rate (t-1)	0.008 (0.40)	0.007 (0.44)	0.007 (0.44)	0.010 (0.32)
Solvency ratio (t-1)* change in monetary policy rate (t-1)	-0.193 (0.16)	-0.183 (0.19)	-0.186 (0.17)	-0.167 (0.24)
Change in minimum reserve requirements rate, RON (t-1)	0.665 (0.41)			
Change in minimum reserve requirements rate, FX (t-1)	0.183 (0.68)			
Inflation (t-1)	-0.316 (0.14)			
Change in bank external debt (t-2)		19.704* (0.09)		
Change in imports/GDP (t-1)			5.475* (0.09)	
Observations	406	406	406	182
Instruments	18	16	16	17
Hansen t-stat	7.148	9.835	9.430	9.801
Hansen p-val	0.307	0.132	0.151	0.279
AR(1)	0.079	0.078	0.076	0.069
AR(2)	0.990	0.955	0.976	0.886

The estimation method is Arellano and Bover (1995). We use the Windmeijer (2005) correction. The small number of groups limits the number of instrumental variables (Hansen probability increases to very high values). The endogenous variables used are the lagged dependent variable and the real economic growth. The instrumental variables are entered into the regression with two to five lags. The p-values are displayed in parentheses, where * p<0.10, ** p<0.05, *** p<0.01.

Table A3.2 Mortgage credit portfolio

	Eq. 1	Eq. 2	Eq. 3	Eq. 4
	2004 Q4 – 2012 Q4			2004 Q4 – 2008 Q4
Growth rate of credit, mortgage (t-1)	0.390*** (0.00)	0.327*** (0.00)	0.351*** (0.00)	0.290*** (0.00)
Real GDP growth rate (t-1)	0.887*** (0.00)	0.893*** (0.00)	0.944** (0.01)	1.233** (0.02)
Change in monetary policy rate (t-1)	-4.331 (0.47)	-4.877** (0.02)	-4.870** (0.04)	-5.249** (0.04)
Change in monetary policy rate (t-2)	1.086 (0.22)	0.840 (0.39)	0.807 (0.42)	0.002 (1.00)
Change in monetary policy rate (t-3)	-3.275*** (0.00)	-2.948*** (0.00)	-2.864*** (0.00)	-3.031*** (0.00)
LTD (t-1)* change in monetary policy rate (t-1)	0.012 (0.21)			
Solvency ratio (t-1)* change in monetary policy rate (t-1)	-0.121 (0.71)			
Regulation Dummy (t-1)	0.488 (0.76)			
Regulation Dummy (t-2)	-4.820* (0.05)	-5.109* (0.06)	-5.123** (0.04)	-10.922** (0.04)
Change in minimum reserve requirements rate, FX (t-1)	-0.032 (0.84)			
Inflation (t-1)	-0.159 (0.62)			
Growth rate of real estate price (t-1)	4.099 (0.10)	2.919 (0.45)	3.490 (0.16)	1.050 (0.85)
Change in bank external debt (t-2)			9.167 (0.21)	
Prima Casă Dummy		-1.826 (0.44)		
Observations	408	408	408	184
Instruments	18	16	16	15
Hansen t-stat	1.446	11.896	12.841	6.252
Hansen p-val	0.963	0.156	0.117	0.619
AR(1)	0.018	0.019	0.024	0.020
AR(2)	0.911	0.873	0.870	0.772

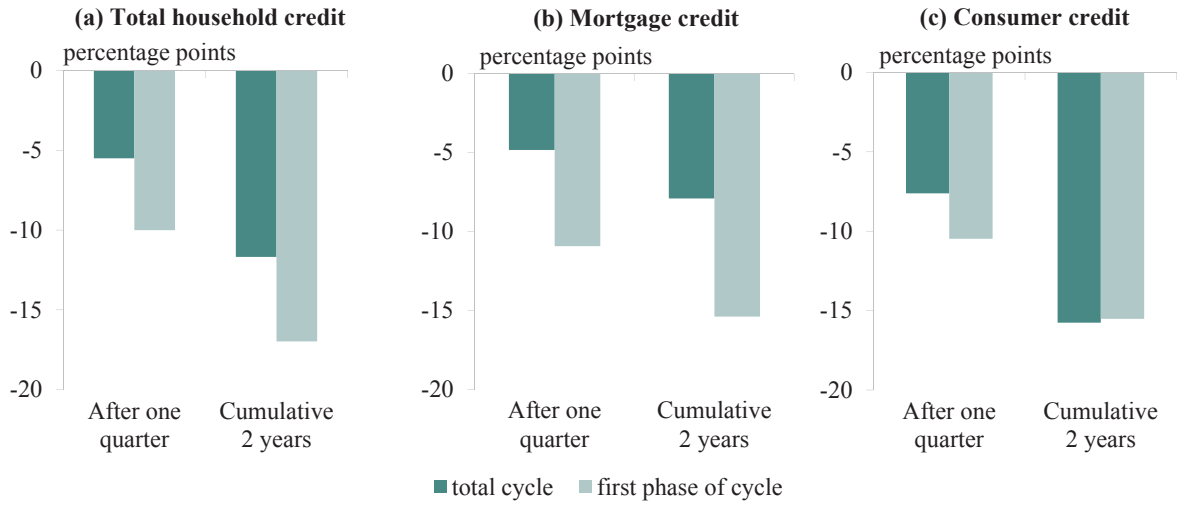
The estimation method is Arellano and Bover (1995). We use the Windmeijer (2005) correction. The small number of groups limits the number of instrumental variables (Hansen probability increases to very high values). The endogenous variables used are the lagged dependent variable and the real economic growth. The instrumental variables are entered into the regression with two to six lags. The p-values are displayed in parentheses, where * p<0.10, ** p<0.05, *** p<0.01.

Table A3.3 Consumer credit portfolio

	Eq. 1	Eq. 2	Eq. 3	Eq. 4
	2004 Q4 – 2012 Q4			2004 Q4 – 2008 Q4
Growth rate of credit, consumer (t-1)	0.520*** (0.00)	0.488*** (0.00)	0.513*** (0.00)	0.325*** (0.01)
Real GDP growth rate (t-1)	0.930*** (0.00)	1.035*** (0.00)	1.134*** (0.00)	2.068*** (0.00)
Change in monetary policy rate (t-1)	-1.396 (0.23)	-1.269 (0.25)	-1.249 (0.26)	-2.509** (0.04)
Change in monetary policy rate (t-2)	0.332 (0.77)	0.858 (0.40)	0.143 (0.88)	-0.018 (0.99)
Change in monetary policy rate (t-3)	-4.562*** (0.00)	-5.754*** (0.00)	-5.455*** (0.00)	-5.779*** (0.01)
Change in monetary policy rate (t-4)	0.454 (0.62)	0.665 (0.42)	0.475 (0.57)	-0.641 (0.52)
Regulation Dummy (t-1)	-7.603** (0.02)	-7.510** (0.03)	-8.847** (0.01)	-10.472** (0.05)
Change in minimum reserve requirements rate, RON (t-1)	-0.462 (0.54)			
Change in minimum reserve requirements rate, FX (t-1)	0.683 (0.11)			
Inflation (t-1)	-0.034 (0.91)			
Change in bank external debt (t-2)		21.842 (0.13)		
Change in imports/GDP (t-1)			9.430*** (0.01)	
Observations	406	406	406	182
Instruments	16	16	16	15
Hansen t-stat	8.587	11.772	11.037	11.251
Hansen p-val	0.198	0.162	0.200	0.188
AR(1)	0.021	0.019	0.017	0.035
AR(2)	0.652	0.739	0.604	0.863

The estimation method is Arellano and Bover (1995). We use the Windmeijer (2005) correction. The small number of groups limits the number of instrumental variables (Hansen probability increases to very high values). The endogenous variables used are the lagged dependent variable and the real economic growth. The instrumental variables are entered into the regression with two to six lags. The p-values are displayed in parentheses, where * p<0.10, ** p<0.05, *** p<0.01.

Chart A3.1 The impact of DSTI/LTV regulation on credit growth rate



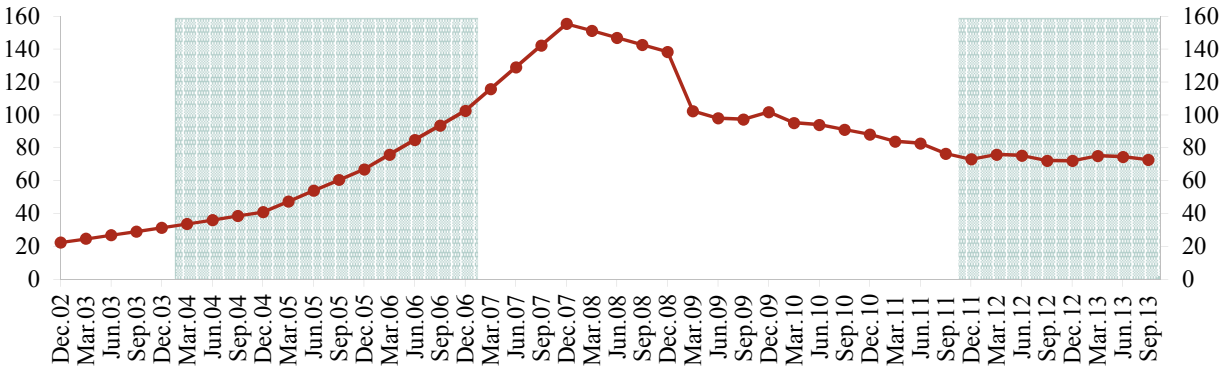
Note: The results are derived from regression equations 1 and 4 in Tables A3.1, A3.2 and A3.3.

Table A3.4 Granger causality test

Null Hypothesis:	Observations	F Statistics	Probability
Changes in Mortgage Credit do not Granger Cause changes in Real Estate Price Index	31	1.37	0.28
Changes in Real Estate Price Index do not Granger Cause changes in Mortgage Credit	31	3.71	0.02

Note: The number of lags used is 4 and was set based on Akaike information criterion (AIC) and on Hannan-Quinn information criterion (HQ). The sample used is 2002 Q4 – 2013 Q4.

Chart A3.2 The impact of DSTI/LTV regulation on real estate prices



Note: The line represents the real estate price index, the red area represents the periods when the most important regulations on DSTI/LTV were in place. For the real estate price data, we use two different indexes. For the period 2002-2008, the index is calculated based on a hypothetical value for residential real estate prices (the methodology is described in the Financial Stability Report, 2006) and for 2009 onwards, we use the National Institute of Statistics (NIS) index. The gap between December 2008 and March 2009 is due to the differences in the data sources used by the two methods employed. The NIS index measures changes in prices for apartment buildings, individual buildings and residential property overall.

Source: NIS, NBR, own calculations

Annex 4 – Non-performing loan dynamics

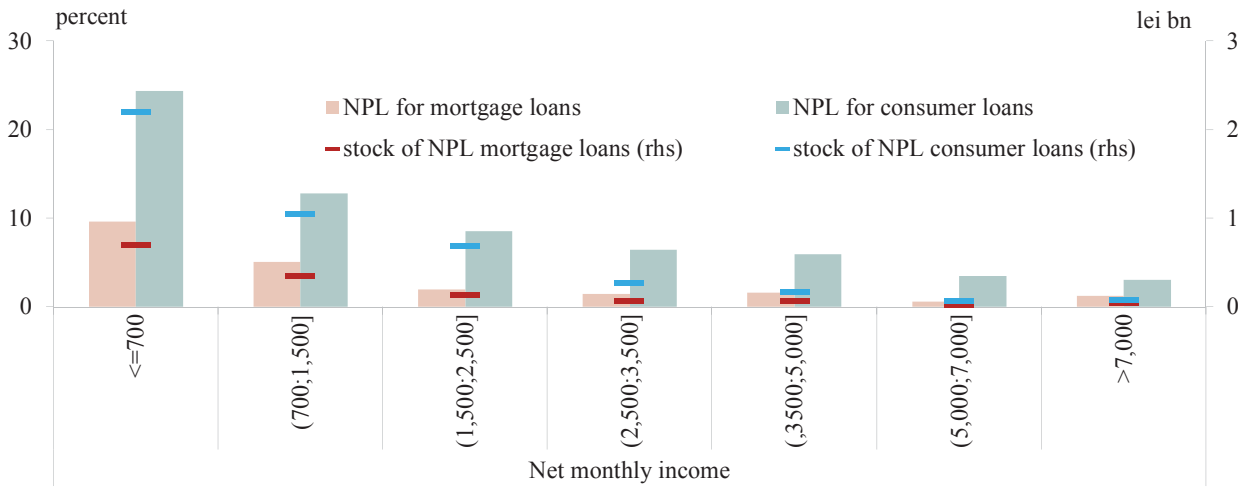
Table A4.1 Developments of NPL* ratio by type of loan and by currency for the households' portfolio

Date	NPL ratio* *(percent)*				
	Mortgage loans	Mortgage backed consumer loans	Non-mortgage consumer loans	Local currency loans	FX loans
Sep.08	0.69	0.60	3.57	3.07	1.45
Dec.08	1.07	1.02	4.34	3.66	1.97
Mar.09	1.92	1.84	5.62	4.58	3.03
Jun.09	2.37	2.45	6.99	5.63	3.83
Sep.09	2.90	3.66	8.53	7.05	4.83
Dec.09	3.06	4.58	9.88	8.29	5.45
Mar.10	2.97	5.13	10.07	8.45	5.65
Jun.10	3.35	6.27	10.95	8.87	6.53
Sep.10	3.68	7.19	11.89	9.33	7.29
Dec.10	3.90	7.84	11.08	8.70	7.54
Mar.11	4.18	8.45	10.77	8.50	7.87
Jun.11	4.41	9.19	10.13	7.68	8.10
Sep.11	4.51	9.67	10.70	7.95	8.43
Dec.11	4.53	10.36	10.08	7.28	8.62
Mar.12	5.18	10.99	11.54	7.97	9.45
Jun.12	5.69	12.07	12.11	8.15	10.11
Sep.12	5.87	12.56	11.49	7.80	10.12
Dec.12	5.96	12.73	12.01	7.77	10.32
Mar.13	5.99	13.26	13.01	8.80	10.69
Jun.13	6.05	14.03	13.62	8.89	11.12
Sep.13	5.80	13.89	13.53	8.75	11.01
Dec.13	5.70	13.31	13.17	8.95	10.83
Mar.14	5.85	14.36	13.36	8.65	11.39
Jun.14	5.73	14.83	12.06	7.36	11.46

* The NPL ratio is calculated as the share of non-performing loans (more than 90 days overdue) to outstanding loans.

Source: Central Credit Register, Credit Bureau, MPF, NBR calculations

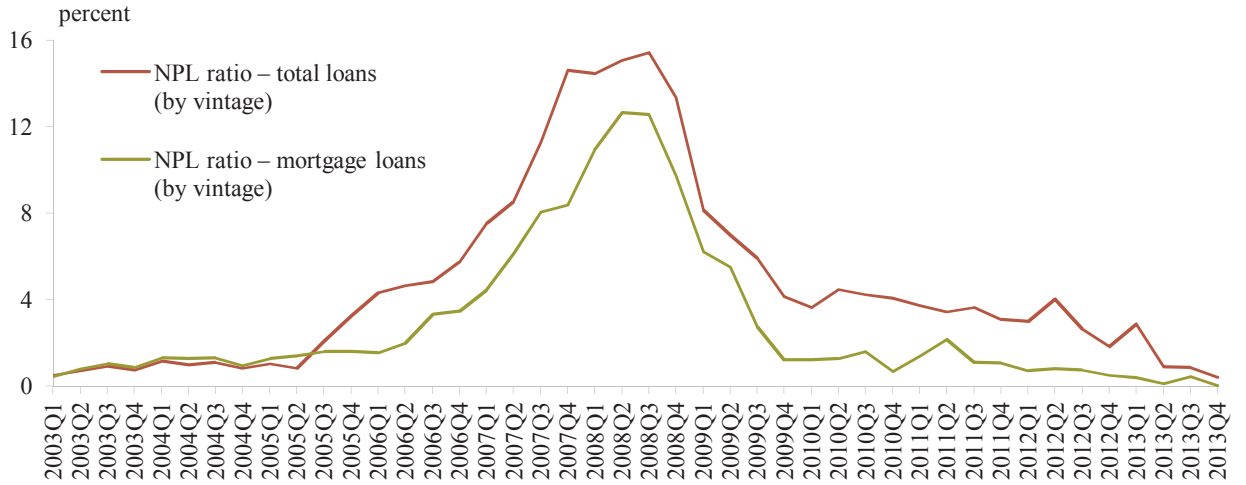
Chart A4.1 Developments of NPL ratio by monthly net income (June 2014)



Note: The information includes only households with bank loans and the net monthly income does not include co-borrowers. The data on income is of December 2013, and on credit exposures of June 2014. The coverage ratio is around 75 percent of total exposures and 60 percent of non-performing loans (in June 2014).

Source: Central Credit Register, Credit Bureau, MPF, NBR calculations

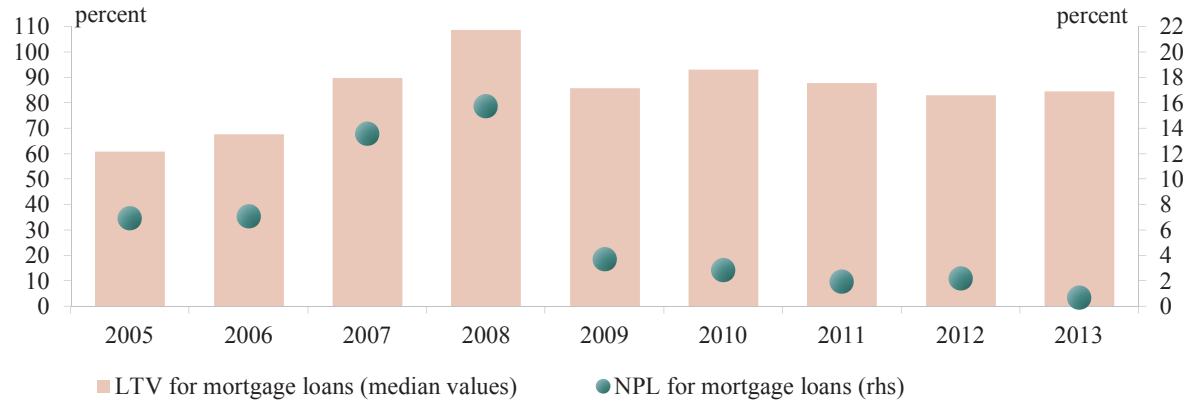
Chart A4.2 Developments of NPL ratio for credit vintages (cut-off date: June 2014)



Note: The NPL ratio reflects the share of non-performing loans to total loans and is calculated for each quarterly vintage (starting 2003 Q1). For comparability among vintages, a loan is considered non-performing if the borrower defaulted on its loans at least once in a 3-year period since the origination. Nevertheless, starting June 2011 the interval of analysis has decreased, with the NPL ratio reflecting the developments until June 2014 (the cut-off point). The data have been corrected for rescheduled loans starting March 2005, when the identification became available. The dummy for the prudential regulation refers only to measures related to LTV and DSTI.

Source: Central Credit Register, NBR calculations

Graph A4.3 LTV and NPL values for vintages of mortgage loans (June 2014)



Note: LTV values are calculated as of June 2014 (for all annual vintages) and therefore reflect the current collateral values.

Source: Central Credit Register, NBR calculations

Table A4.2 NPL* ratio by vintage and loan characteristics for households' portfolio

Date	NPL ratio for all loans	NPL ratio for mortgage loans	NPL ratio for consumer loans	DSTI* (median value for all loans)	LTV** (median value for mortgage loans)
2005	1.93	1.48	2.15	27.43	65.36
2006	4.93	2.79	5.60	29.57	51.96
2007	11.30	7.30	12.43	32.11	58.53
2008	14.81	11.72	15.75	41.66	75.27
2009	5.93	2.84	7.90	30.93	58.12
2010	4.14	1.22	6.43	32.88	62.37
2011	3.46	1.40	4.64	33.05	75.06
2012	2.87	0.68	5.67	30.45	64.07
2013	1.16	0.27	2.40	24.88	72.89

Note: The NPL ratio is calculated for each annual vintage and reflects the share of non-performing loans to total loans. A loan is considered non-performing if the borrower defaulted (more than 90 days overdue) at least once in a 3-year period since the origination. Nevertheless, starting June 2011 the interval of analysis has decreased, with the NPL ratio reflecting the developments until June 2014 (the cut-off point). These figures are available for exposures higher than RON 20,000 alone. The data are corrected for rescheduled loans.

* *DSTI represents the median value calculated for all loans originated every year between 2005 – 2013.* It is calculated based on the assumption of constant annuities, with outliers being excluded from the database.

$$\mathrm{DSTI}_{loan} = 100 * \frac{\left(\frac{\frac{r}{12} * P}{1-\left(1+\frac{r}{12}\right)^{-n}}\right)}{I} \qquad (1)$$

where r is the annual interest rate; P is the credit value at origination; n is the original maturity of the loan (number of months), I is the average monthly net income per debtor.

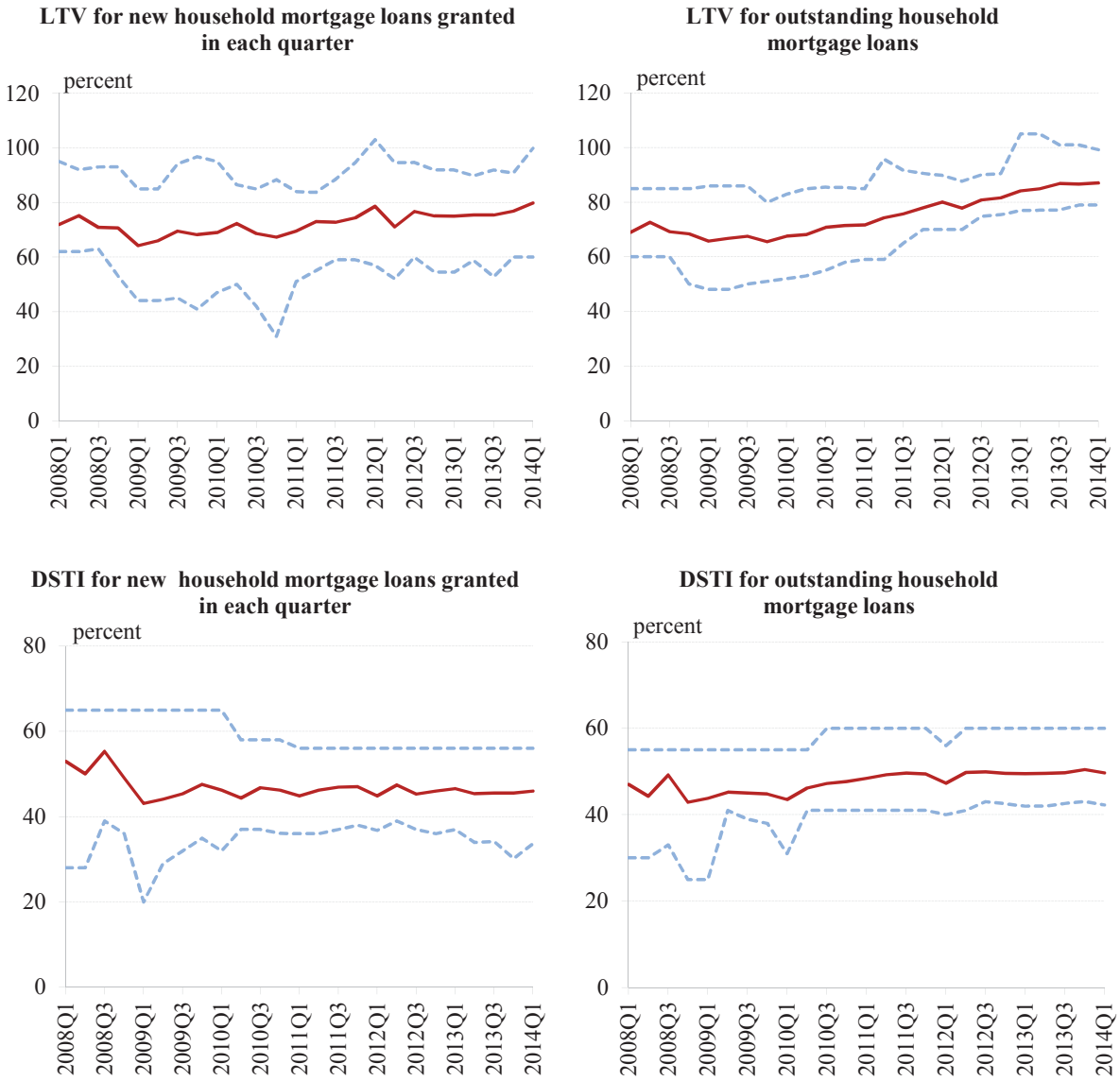
** *LTV (loan-to-value) represents the median value calculated for all loans originated every year between 2005 – 2013 (Eq.2).* Due to data limitation[1], we use the collateral values from 2013 and correct them going back to the origination, using the residential real estate price index. We assume that December 2013 figures represent the market value and all collateral values behave in a similar way to the market (the same correction of real estate prices is applied to all loans):

$$\mathrm{LTV}_{loan} = 100 * \frac{\text{Outstanding loan amount}}{\text{Adjusted collateral value}} \qquad (2)$$

Source: Central Credit Register, MPF, NIS, NBR calculations

[1] The collateral data have been available in the Central Credit Register starting 2012.

Chart A4.4 LTV and DSTI from banks' mortgage loans to households



Note: The figures represent the DSTI and LTV values from banks' portfolios (and not the caps from the regulations). The red line represents the average value of the indicators and blue lines represent the interval band (min, max) of variation.

Source: National Bank of Romania (Bank Lending Surveys)

Annex 5 – Results of the econometric models on non-performing loan ratios

Table A5.1 Developments in the non-performing loan ratio for the households' portfolio and for sub-portfolios: the impact of self-regulation

Aggregate NPL	(Eq. 1) Aggregate NPL ratio	(Eq. 2) NPL for mortgage loans	(Eq. 3) NPL for non-mortgage backed consumer loans
NPL ratio (t-1)	0.987*** (0.00)	1.011*** (0.00)	0.927*** (0.00)
Growth rate of unemployment (t-2)	1.504*** (0.00)	0.601*** (0.01)	8.123*** (0.00)
Growth rate of real estate index (t-2)	-1.958*** (0.00)	-0.879** (0.02)	
Financial expectations over the next year (t-4)	-0.008*** (0.00)		-0.049*** (0.00)
Change in local currency interest rate (t-2)[1]	0.517*** (0.00)		5.081*** (0.00)
Change in FX interest rate (t-2)	0.042 (0.80)	0.075 (0.76)	
Leverage ratio (t-4)	0.047*** (0.00)	0.029*** (0.00)	0.142*** (0.00)
Self-regulation dummy[2]	0.359*** (0.01)	0.279*** (0.00)	0.765*** (0.00)
Dummy for *Prima Casă* loans[3]		-0.080*** (0.01)	
Observations	658	658	658
Instruments	44	43	42
Hansen t-stat	25.650	24.279	26.350
Hansen dof	36.000	36.000	36.000
Hansen p-val	0.900	0.932	0.881
AR(1)	0.000	0.001	0.000
AR(2)	0.903	0.099	0.054

The estimation method is Blundell and Bond (1998) in a difference GMM approach. The endogenous variables used are the lagged dependent variable and banks' characteristic variable, together with the macroeconomic variables. No restriction is imposed on the number of lags for the instrumental variables introduced into the regression. The p-values are displayed in parentheses, where * p<0.10, ** p<0.05, *** p<0.01.

[1] The impact stemming from the interest rate on loans denominated in local currency reflects also the increase in margins associated with the period at the outbreak of the crisis. This variable does not influence the overall results.

[2] The *self-regulation dummy* accounts for the changes in the prudential regulation that the NBR introduced in March 2007, moving from explicit limits on DSTI and LTV to self-regulation (March 2007 - September 2008).

[3] The dummy for *Prima Casă* loans accounts for the different risk profile of this category as compared to other real estate loans. It takes a value of 1 for all mortgage loans granted since 2009 Q2.

Table A5.2 Developments in the non-performing loan ratio for the households' portfolio and for sub-portfolios: the impact of self-regulation and of its interaction with macroeconomic variables

	(Eq. 1) Aggregate NPL ratio	(Eq. 2) NPL for mortgage loans	(Eq. 3) NPL for non-mortgage backed consumer loans
NPL ratio (t-1)	0.990*** (0.00)	1.011*** (0.00)	0.928*** (0.00)
Interaction between unemployment rate and lack of self-regulation in 2007 (t-2)	1.187*** (0.00)	0.535** (0.01)	7.672*** (0.00)
Interaction between unemployment rate and self-regulation in 2007 (t-2)	2.786*** (0.00)	0.846*** (0.01)	9.910*** (0.00)
Growth rate of real estate index (t-2)	-1.894*** (0.00)	-0.871** (0.02)	
Change in local currency interest rate (t-2)[1]	0.524*** (0.00)		5.076*** (0.00)
Change in FX interest rate (t-2)	0.059 (0.72)	0.077 (0.75)	
Financial expectations over the next year (t-4)	-0.008*** (0.00)		-0.049*** (0.00)
Leverage ratio (t-4)	0.045*** (0.00)	0.029*** (0.00)	0.140*** (0.00)
Self-regulation dummy[2]	0.338*** (0.01)	0.276*** (0.00)	0.744*** (0.00)
Dummy for *Prima Casă* loans[3]		-0.081*** (0.01)	
Observations	658	658	658
Instruments	45	44	43
Hansen t-stat	23.374	23.757	25.951
Hansen dof	36	36	36
Hansen p-val	0.948	0.942	0.892
AR(1)	0.000	0.001	0.000
AR(2)	0.968	0.092	0.054

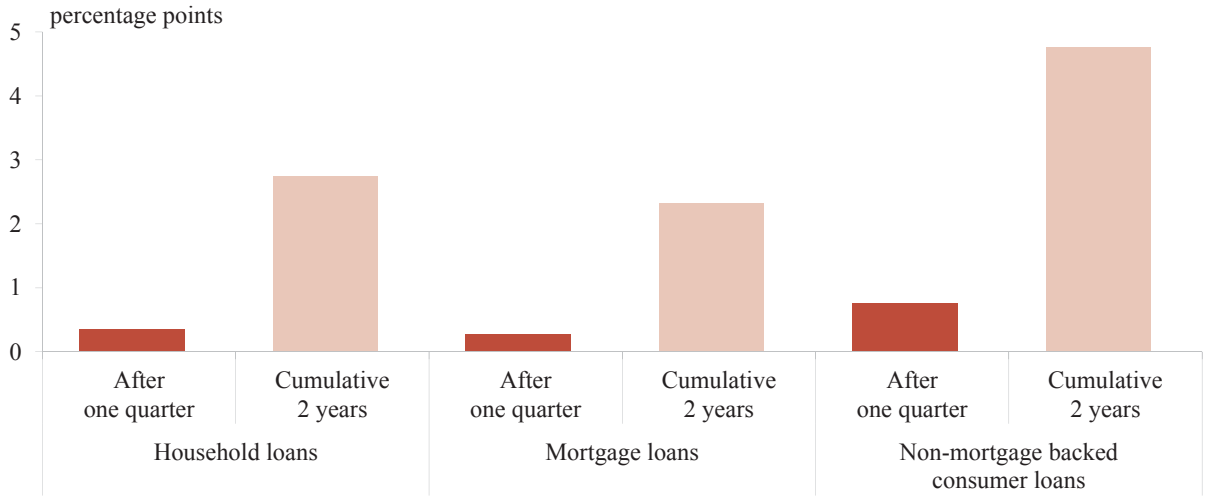
We use the Blundell and Bond methodology (1998) in a difference GMM approach. The endogenous variables used are the lagged dependent variable and banks' characteristic variable together with the macroeconomic variables. No restriction is imposed on the number of lags for the instrumental variables introduced into the regression. The p-values are displayed in parentheses, where * p<0.10, ** p<0.05, *** p<0.01.

[1] The impact stemming from the interest rate on loans denominated in local currency reflects also the increase in margins associated with the period at the outbreak of the crisis. This variable does not influence the overall results.

[2] The *self-regulation dummy* accounts for the changes in the prudential regulation that the NBR introduced in March 2007, moving from explicit limits on DSTI and LTV to self-regulation (March 2007 – September 2008).

[3] The dummy for *Prima Casă* loans accounts for the different risk profile of this category as compared to other real estate loans. It takes a value of 1 for all mortgage loans granted since 2009 Q2.

Chart A5.1 The impact of self-regulation (of DSTI/LTV) on the NPL ratio for different types of loans



Note: The values are calculated based on the regression equation in Table A5.1. The results are similar to those calculated based on figures in Table A5.2.