Do macroprudential borrower-based measures influence inequality? A structural approach for an emerging economy

Alexie Alupoaiei[*1] Simona Ichim[1] Florian Neagu[1] Radu Popa[1]

Abstract

In the context of high macroeconomic and financial volatility, it is appropriate to implement stricter macroprudential borrower-based measures, such as loan-to-value (LTV) ratios. Lower (stricter) LTV ratios can lead to decreased inequality in consumption. However, the effects on wealth inequality are mixed. On one hand, lower LTV supports decrease in non-performing loans, which can have positive consequences on wealth inequality. On the other hand, it reduces access to finance that might have negative consequences on wealth inequality. In the absence of negative unexpected economic shocks, loosening (higher) LTV ratios may lead to an increase in home ownership, which can have positive effects on reducing wealth inequality. In terms of credit risk, our results underline that a tighter LTV policy is associated with lower default rates. Moreover, our analysis based on a novel approach suggests that potential effects on inequality could be also taken into account within calibration of the LTV policy.

Keywords: default, inequality, loan-to-value, macroprudential policy

JEL codes: C53, E27, E32, E44.

1. Introduction

The Global Financial Crisis and the COVID-19 pandemic have prompted significant interventions by authorities to protect the economy and financial system from severe negative impacts with the potential for systemic consequences. Banks, companies, and households have received significant monetary, fiscal, and financial support to help them cope with these developments. These interventions have raised questions about their potential effects on inequality. In this paper, we

[*] Alexie Alupoaiei
alex.alupoaiei@gmail.com
[1] National Bank of Romania and Bucharest University of Economic Studies

delve into these debates, examining how macroprudential measures targeting borrowers influence inequality. The design and implementation of these macroprudential instruments can have important implications for both the financial system and the real economy. Monnin (2017) synthesizes a wide range of existing theoretical and empirical evidence to conclude that both monetary and macroprudential policies can have non-neutral impacts on the distribution of income and wealth.

We propose a novel view for the structural approaches by evaluating the welfare effects of the macroprudential policy in terms of inequality (for consumption, income and wealth). Implications on wealth inequality are capture also through dynamics of the non-performing loans on mortgage. Different from the standard work stream on the DSGE models, here the so-called welfare effects are assessed in a positive way, and not in a normative one. More exactly, our results are not derived under certain optimal LTV policies associated with the welfare maximization of the economic agents. Instead, we investigate the so-called welfare effects in terms of inequality within an event study for which we considered the Global Financial Crises.

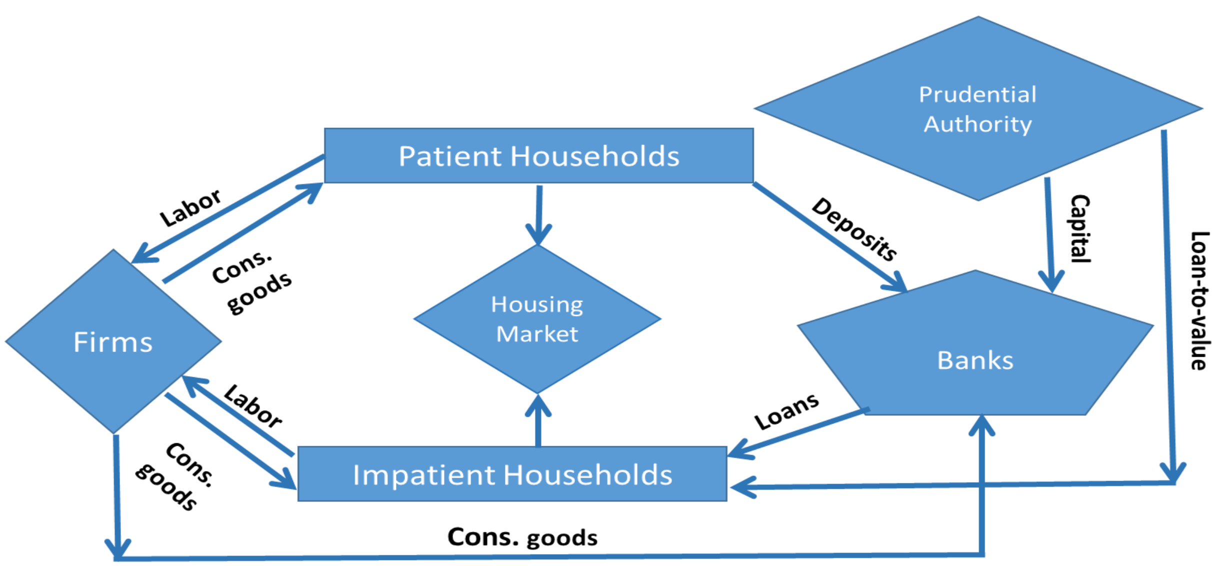
We choose Romania as a European emerging economy case study for several reasons. Firstly, it has the longest history among emerging European countries in using borrower-based measures (LTV and DSTI have been in place since 2004). Secondly, Romania is a good example of a small, open emerging economy that has faced high macroeconomic vulnerability. Finally, the Romanian banking sector is largely foreign-owned, so the policy stance includes feedback effects from foreign parent banks. Here we use a financial-business cycle model with heterogeneous agents similar to the one formulated in Iacoviello (2013) or Rubio and Carrasco-Gallego (2014). Additionally to the works mentioned before, here we suppose that borrowers optimally choose to default (endogenous default) as in de Walque *et al* (2010). Following the narrative of Eskelinen (2021), in this paper we aim to quantitatively investigate how different LTV regimes affect the economy in the short-run and long run (steady-state effects). Similar to Rubio and Unsal (2017), we account for inequality by using a simplified measure for the Gini index.

Obtained results show that a tighter LTV policy leads to lower default rates (and lower wealth inequality) in the context of very adverse scenarios. There is a trade-off between inequality in consumption and wealth: a tighter LTV policy leads to a decrease in consumption inequality, at the cost of an increase in wealth consumption. The counterfactual experiments we conduct underline that obtained results are highly dependent on the volatility regime in place. On the other hand, the results point out that a dynamic approach used for the LTV calibration could greatly improve the society's welfare in terms of lower inequality. Broadly speaking, our conclusions are in line with those in Bianchi (2011) and Martin and Georgescu (2021). Moreover, our results suggest that, within the LTV's calibration process, policy makers could also consider the resulting effects on inequality.

2. Methodology

We formulate a financial-business cycle (FBC) model in the spirit of Iacoviello (2013) and Rubio and Carrasco-Gallego (2014), while the interpretations and notations are closed to those in Alupoaiei *et al* (2022). According to the diagram bellow, there are two types of households: saving and borrowing households. Saving households have two sources of income: remuneration for their deposits at banks and wage for the work supplied for firms. They use the procured income to finance their consumption streams, to save money and to buy real estate properties from the housing market. On the other side, the received salary is the only source of income for the borrowers, with no savings in the banks. In order to buy a home from the housing market, the borrowers have to get a loan from the bank. Moreover, borrowers face a collateral constraint in the form of a loan-to-value (LTV) limit.

Figure 1. Diagram of the financial-business cycle model



Source: own depiction based on the existing literature

On the production sector, firms use labor supplied by households (savers and borrowers) to produce consumption goods. The financial intermediaries (banks) collect deposits from savers and grant loans to borrowers. Banks are subject of a macroprudential requirement, according to which their liabilities cannot exceed a certain level of their assets. The macroprudential requirement that can be interpreted as the countercyclical capital buffer (CCyB) is in fact a collateral constraint similar to the one the borrowers are facing. Further, we use representative agents for each of the blocks in the economy.

2.1. Savers

A representative saver aims to maximize a standard utility function that consists of consumption goods (non-durable), housing and leisure (inversely related to working time), being subject to a budget constraint. Therefore, the optimization program of a representative saver is defined by:

$$\max E_0 \sum_{t=0}^{\infty} \beta_s^t \left[\log(C_{s,t}) + j\log H_{s,t} - \frac{{N_{s,t}}^{\eta}}{n}\right] \tag{1}$$

$$C_{s,t} + D_t + q_t H_{s,t} = R_{s,t-1} D_{t-1} + W_{s,t} N_{s,t} + q_t H_{s,t-1} \tag{2}$$

where $C_{s,t}$, $H_{s,t}$, $N_{s,t}$ and D_t are the household's consumption, housing, work and deposits, while q_t, $R_{s,t}$ and $W_{s,t}$ represents the housing price (expressed in units of output), interest for saving and wage for the supplied work. The other elements from the optimization program above are the expectation operator E_0, the subjective discount factor $\beta_s \in (0,1)$, the housing weight within the saver's utility j and the aversion for the worked time n, with $\frac{1}{(n-1)}$ being the Frisch labor supply elasticity. The model used here works with flows, which means the budget constraint is in fact a flow-of-funds constraint. The budget constraint states that the representative saver's income comes obtained from the supplied work $W_{s,t}N_{s,t}$, the deposits saved at the previous moment in time $R_{s,t-1}D_{t-1}$, respectively from the selling at the spot price in the housing market q_t of the previously acquisitioned real estate properties $H_{s,t-1}$. The representative saver use his income to finance the consumption of goods $C_{s,t}$, new savings D_t, respectively the new demand for housing $H_{s,t}$ at the spot price q_t.

The representative saver's optimal program is defined by the first order conditions (FOCs) obtained for consumption $C_{s,t}$, housing demand $H_{s,t}$, labor supply $N_{s,t}$ and deposits D_t:

$$\lambda_{s,t} = \frac{1}{C_{s,t}} \tag{3}$$

$$\lambda_{s,t} q_t = \frac{j}{H_{s,t}} + \beta_s E_t \lambda_{s,t+1} q_{t+1} \tag{4}$$

$$\lambda_{s,t} W_{s,t} = {N_{s,t}}^{\eta-1} \tag{5}$$

$$\lambda_{s,t} = \beta_s E_t \lambda_{s,t+1} R_{s,t} \tag{6}$$

where λ_t denotes the Lagrange multiplier on the budget constraint that equalizes the marginal utility of consumption. By combining the FOCs for consumption and deposits, we obtain the standard Euler equation (last relation above)[2]. The second optimal equation above denotes the saver's housing demand (intertemporal condition), while the third equation is the labor supply, which is an intratemporal condition.

2.2. Borrowers

The representative borrower solves an optimization problem similar to that from the previous case. Additional to the saver's program, the representative borrower gets loans from the bank and is subject to an additional constraint that poses a limit to his capacity to borrow. The optimization problem faced by the representative borrower is:

$$\max E_0 \sum_{t=0}^{\infty} \beta_b^t \left[\log\left(C_{b,t}\right) + j \log H_{b,t} - \frac{{N_{b,t}}^{\eta}}{n} \right] \tag{7}$$

$$C_{b,t} + (1 - def_t) R_{b,t-1} B_{t-1} + q_t H_{b,t} + \frac{\Gamma}{2}\left(def_{t-1} R_{b,t-2} B_{t-2}\right)^2 = B_t + W_{b,t} N_{b,t} + q_t H_{b,t} \tag{8}$$

$$R_{b,} B_t \leq E_t LTV_t q_{t+1} H_{b,t} \tag{9}$$

[2] Optimal conditions above (intertemporal and intratemporal) equate the marginal benefits and costs.

where $\beta_b \in (0,1)$ is the related discount factor, $C_{b,t}$, $H_{b,t}$, $N_{b,t}$ and B_t denotes the household's consumption, housing, work and loans, while $R_{b,t}$ and $W_{b,t}$ represents the interest for loans and the wage for supplied work. def_t denotes the share of the installments to the bank (debt plus accrued interest) that the representative borrower chooses not to pay (default). The default decision comes with a cost $\frac{\Gamma}{2}\left(def_{t-1}R_{b,t-2}B_{t-2}\right)^2$ for the debtor, entering on the expenditure side, with Γ being a penalty cost parameter. The default in this paper is defined in line with de Walque *et al* (2010), being determined endogenously as a rational decision of the representative borrower. Unlike de Walque *et al* (2010) who consider both pecuniary and non-pecuniary costs, here we consider only pecuniary costs for default. An important departure from de Walque *et al* (2010) is that here we consider that the penalty costs are applied to the whole installment (debt plus accrued interest), and not just to the amount of debt. The second constraint above states that the borrower's payment obligations $R_{b,}B_t$ cannot exceed a fraction from his assets $E_t LTV_t q_{t+1} H_{b,t}$, where LTV_t denotes the collateral limit that is set by the regulator. The income side of the borrower's balance sheet says that his income comes from supplied work $W_{b,t}N_{b,t}$, from selling the previously acquisitioned amount of real estate $H_{s,t-1}$ at the spot price in the housing market q_t, respectively from getting a loan B_t. The representative borrower uses the income to get consumption goods $C_{b,t}$, to pay a share of the due installments to bank $def_t R_{b,t-1} B_{t-1}$ and the cost of its past decisions on default $\frac{\Gamma}{2}\left(def_{t-1}R_{b,t-2}B_{t-2}\right)^2$, respectively to finance a new demand for housing $H_{b,t}$ at the spot price q_t.

In order to maximize the utility function subject to the budget constraint, respectively to the collateral constraint, the representative borrower gets first order conditions with respect to consumption $C_{b,t}$, housing demand $H_{b,t}$, labor supply $N_{b,t}$, loans B_t and default def_t:

$$\lambda_{b,t} = \frac{1}{C_{b,t}} \tag{10}$$

$$\lambda_{b,t} q_t = \frac{j}{H_{b,t}} + \beta_b E_t \lambda_{b,t+1} q_{t+1} + \lambda_{b,t} \mu_{b,t} LTV_t \frac{1}{R_b} q_{t+1} \tag{11}$$

$$\lambda_{b,t} W_{b,t} = N_{b,t}{}^{\eta-1} \tag{12}$$

$$\lambda_{b,t} = \beta_b{}^2 E_t \lambda_{b,t+2} \Gamma\left(E_t def_{t+1} R_{b,t}\right)^2 B_t + \beta_b E_t \lambda_{b,t+1}(1 - E_t def_{t+1}) R_{b,t} + \lambda_{b,t}\mu_{b,t} \tag{13}$$

$$\lambda_{b,t} R_{b,t-1} B_{t-1} = \beta_b E_t \lambda_{b,t+1} \Gamma\left(R_{b,t-1}B_{t-1}\right)^2 def_t \tag{14}$$

where $\lambda_{b,t}$ denotes the Lagrange multiplier on the budget constraint which equals the marginal utility of consumption. As in Iacoviello (2013), the Lagrange multiplier on the collateral constraint $\mu_{b,t}$ is normalized by the marginal utility of consumption.

2.3. Bankers

The optimization program of a representative banker consists of an utility function, a budget constraint and a capital adequacy constraint:

$$\max E_0 \sum_{t=0}^{\infty} \beta_f^t \left[\log\left(C_{f,t}\right)\right] \tag{15}$$

$$C_{f,t} + R_{s,t-1}D_{t-1} + B_t = D_t + (1 - def_t)R_{b,t-1}B_{t-1} + (1 - lgd)def_{t-1}R_{b,t-2}B_{t-2} \tag{16}$$

$$D_t \leq (1 - CAR_t)B_t \tag{17}$$

where $\beta_f \in (0,1)$ is the related discount factor, CAR_t denotes the capital adequacy ratio, while lgd represents the loss given default for the granted loans. Regarding the side of financial connections, the banker's balance sheet is a mirror to the balance sheets of the two households. Exception from the previous mention is the presence of $(1 - lgd)def_{t-1}R_{b,t-2}B_{t-2}$, which was introduced in order to bring the model as close as possible to how things occur in real life.

In addition to the budget constraint, the representative banker faces another constraint that limits his ability to borrow up to a certain level of his assets. The representative banker aims to maximize the utility in respect to the two existing constraints, by taking first order conditions for consumption $C_{f,t}$, deposits D_t and loans B_t:

$$\lambda_{f,t} = \frac{1}{C_{s,t}} \tag{18}$$

$$\lambda_{f,t} = \beta_s E_t \lambda_{t+1} R_{s,t} + \lambda_{f,t}\mu_{f,t} \tag{19}$$

$$\lambda_{f,t} = \beta_s E_t \lambda_{t+1}(1 - E_t def_{t+1})R_{b,t} + {\beta_f}^2 E_t \lambda_{f,t+2}(1 - lgd)E_t def_{t+1}R_{b,t} + \lambda_{f,t}\mu_{f,t}(1 - CRR_t) \tag{20}$$

where $\lambda_{f,t}$ denotes the Lagrange multiplier on the budget constraint (that equals the marginal utility of consumption) and $\mu_{f,t}$ represents the Lagrange multiplier on the collateral constraint, being normalized by the marginal utility of consumption.

2.4. Firms

As compared with the previous agents, the firms face a static optimization problem (no intertemporal decisions), which supposes to maximize the profit Π_t that comes from the difference between produced output Y_t and labor costs:

$$\max \Pi_t = Y_t - W_{b,t}N_{b,t} - W_{s,t}N_{s,t} \tag{21}$$

$$Y_t = A_t N_{s,t}^{\alpha} N_{b,t}^{1-\alpha} \tag{22}$$

According to the second relation above, the output is produce with a benchmark Cobb-Douglas production function (iso-elastic), only with work (no capital). The production function defined above combines the work supplied by the two types of households, where $\alpha \in (0,1)$ represents the relative size of the savers within the production process. The resulted output is perturbed by a zero-mean shock to the total factor productivity A_t. Getting first order conditions with respect to how much work to hire, it results the following first order conditions for firms:

$$W_{s,t}N_{s,t} = \alpha Y_t \tag{23}$$

$$W_{b,t}N_{b,t} = (1-\alpha)Y_t \tag{24}$$

2.5. Macroprudential authority, inequality and shocks

We consider that macroprudential policy is responsible with setting limits for capital and the LTV policy. Here we use the capital adequacy ratio as a proxy for the limit on capital. Firstly, the two macroprudential rules are calibrated by using some long-term levels:

$$CAR_t = \overline{CAR} \tag{25}$$

$$LTV_t = \overline{LTV} \tag{26}$$

Secondly, a Taylor style rule is used to calibrate the LTV by considering deviations of the housing prices from the steady state level:

$$LTV_t = \overline{LTV} + \varphi_q \log\left(\frac{q_t}{q^{ss}}\right) \tag{27}$$

where φ_q is the loan-to-value' sensitivity to housing price gap $\left(\frac{q_t}{q^{SS}}\right)$, with q^{SS} being the steady state housing price.

We approximate inequality by accounting for differences existing between the two households in terms of consumption, income and wealth. Following Rubio and Unsal (2017), we use a simplified approach for the Gini index to measure the inequality. According to this approach, if the rich people are endowed with E% and their share in society is S%, then the resulting Gini index will be E% - S%. Here we are not referring to inequality in society as a whole, restricting our attention on the financial sector. As we mentioned before, the two households differ in the way they purchase housing properties: the rich people (savers) buy with cash, while the less rich people (borrowers) take a loan from the bank. By less rich households we only refer to the way they procure the financial resources in order to buy a house. By S% we mean the share of those who use cash to purchase a house and equalize the share of savers in the production process (α). We will define E% differently for consumption, income and wealth inequality. Formulas for the three Gini indices are defined by:

$$Gini\_Cons_t = \left(\frac{C_{s,t}}{C_{b,t} + C_{s,t}} - \alpha\right) \cdot 100 \tag{28}$$

$$Gini\_Income_t = \left(\frac{R_{s,t-1}D_{t-1} + W_{s,t}N_{s,t}}{W_{b,t}N_{b,t} + R_{s,t-1}D_{t-1} + W_{s,t}N_{s,t}} - \alpha\right) \cdot 100 \tag{29}$$

$$Gini\_Welfare_t = \left(q_t \frac{H_{s,t}}{H_{b,t} + H_{s,t}} - \alpha\right) \cdot 100 \tag{30}$$

Unlike the representative borrower, the saver additionally receives income from bank' deposits. For wealth inequality, we calculate the Gini index based on the market value of the housing holdings, as the LTV changes has both cyclical and long-term (equilibrium) effects on the real estate prices. In the standard calculation of inequality indices, S% has low values, but in our case it has a high value, which supports the idea that our concept of inequality is associated with financial inclusion. A level of the Gini index close to 100% means more inequality, and vice versa. In our case, due to the computational limitations, as well as to the fact that we are referring de facto to financial inclusion (and the share of the rich is high), the Gini index can be negative as well. But in our interpretations, according to the broader notion of inequality based on the Gini index, we will refer only to positive values of the index.

The model defined here is perturbed from the (deterministic) steady state (long-run equilibrium) by an unexpected shock to the total factor productivity, which follow a standard AR(1) stochastic process:

$$A_t = {A_{t-1}}^{\rho_A} exp(\varepsilon_t^A) \tag{31}$$

where ρ_A is the auto-regressive coefficient, while $\varepsilon_t^A \sim N(0, \sigma_A^2)$ is an i.i.d. innovation, normally distributed with zero mean and variances denoted by σ_A^2.

2.6. Markets clearing

In this paper we work with a flow-based model where the markets clear every period. Equilibrium in the goods market supposes that the final output equalizes each period the total amount of expenditures, which consist in the final consumption of the three agents, as well as the expenditure generated by the default decision:

$$Y_t = C_{s,t} + C_{b,t} + C_{f,t} + \frac{\Gamma}{2}\left(def_{t-1} R_{b,t-2} B_{t-2}\right)^2 \tag{32}$$

By normalizing to 1 the real estate market, the implied clearing condition is:

$$H_{s,t} + H_{b,t} = 1 \tag{33}$$

Finally, the clearing conditions for the labor market, respectively for the lending and deposit markets are:

$$N_{s,t} = N_{s,t}, N_{b,t} = N_{b,t} \tag{34}$$

$$B_t = B_t, D_t = D_t \tag{35}$$

The above conditions state that no excess supply of labor, loans and deposits exists in equilibrium.

Equilibrium

Definition. *For any defined exogenous states* $\{A_t\}$ *and policy processes* $\{CAR_t, LTV_t\}$*, a* ***competitive equilibrium*** *is defined via the set of prices* $\{R_{b,t}, R_{s,t}, q_t, W_{b,t}, W_{s,t}\}$ *and allocations* $\{C_{b,t}, C_{s,t}, C_{f,t}, H_{b,t}, H_{s,t}, N_{b,t}, N_{s,t}, B_t, D_t, def_t\}$ *such that:*

1) *the saver, borrower and banker maximize their utility*

2) *the firms maximize their profits*
3) *markets clear*
4) *the following complementary conditions (borrowing constraints) are satisfied:*

$$\left(R_{b,t}B_t - E_t LTV_t q_{t+1} H_{b,t}\right)\mu_{b,t} = 0 \tag{36}$$

$$(D_t - (1 - CAR_t)B_t)\mu_{f,t} = 0 \tag{37}$$

with $\mu_{b,t}, \mu_{f,t} > 0$.

3. Calibration and results

The model is calibrated to a quarterly frequency for a European emerging economy (Romania). The discount factors for saver and borrower are associated with long-run trends regarding the remuneration of deposits, respectively the cost of loans. To calibrate the subjective banker's discount factor, we use data regarding the return on equity in the banking sector. In line with other works for the Romanian economy, we calibrate the labor elasticity related parameter to 3.06.

As in Iacoviello (2013) and Eskelinen (2021), the housing weight within the households' utility (j) was set to 0.1. On the production side, the labor income share for savers is calibrated to 0.67. This parameter is set by looking at data regarding the share of real estate transactions made with cash. The parameters governing the total factor productivity's dynamics are calibrated using the empirical estimates, resulting a persistence coefficient of 0.96 and a standard deviation of approximately 1%. To calibrate the capital adequacy ratio we use data starting with 2013.

Empirically, it is observed a collateral of around 20% for the real estate loans, which means the long-run LTV is 80%. In Romania, there is a government program ("The First Home program") which has an important impact on mortgage and real estate markets, because loans under this program are originated with an LTV of 95% due to the state guarantee. Under such circumstances, here we consider that an easing macroprudential regime is associated with a 90% LTV. When a dynamic approach is used for the LTV setting, the long-run LTV is set to 80%, while the sensitivity to housing price gap is calibrated to 0.8, suggesting a strong reaction of the macroprudential policy to developments in the housing market.

Given that the model is perturbed by only one shock (a disturbance to the total factor productivity), the volatility of housing prices is lower than it is empirically observed. For this reason, we set a higher reaction parameter in order to generate changes in the LTV level of magnitudes similar to ones observed within the real macroprudential practice. With this calibration for the dynamic approach, when strong shocks hit the economy, the LTV reaches a level of approximately 90%. The loss given default level is set to 20% based on the common practice, while the steady state level of the default rate is calibrated to 2.6% according to mortgage loans data. As in de Walque *et al* (2010), the cost of default is calibrated by using the steady state conditions.

Table 1. Parameter calibration for the DSGE model

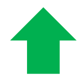
Discount factor for savers (β_s)	0.985
Discount factor for borrowers(β_b)	0.974
Discount factor for bankers (β_f)	0.973
Housing weight within utility (j)	0.1
Labor elasticity related parameter (η)	3.06
Labor income share for savers (α)	67%
Technology shock persistence (ρ_A)	0.96
Technology shock standard deviation (σ_A)	0.97%
Capital adequacy ratio grid $(\overline{CAR})$	20%
Loan-to-value $(\overline{LTV})$	[80%, 90%]
LTV sensitivity to housing prices gap (φ_q)	0.8
Loss given default *(lgd)*	0.2
Steady state default for mortgage loans *(def)*	2.6 %

Source: own calculations

Following the line in Eskelinen (2021), we disentangled the effects of LTV changes into long-run effects (on the steady state) and cyclical effects. An easing regime regarding the minimum downpayment required for mortgage loans has major effects on the cost of default. In Table 2, we summarize the effects on the long-run equilibrium associated with an increase in LTV from 80% to 90%.

Changes provided below are computed as ratios between the related quantities obtained in each regime. As we can observe from the arrow orientation, the increase in the long-run (steady state) LTV to 90% brings increases in all the long-run levels for the variables in the table.

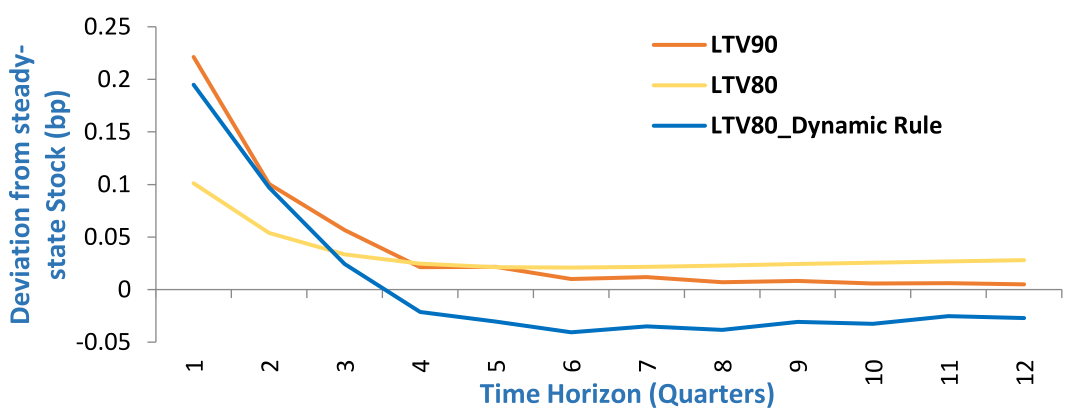
Table 2. Long-run (steady state) effects by increasing the LTV from 80% to 90%

Lending	Deposits	Real estate prices	Housing Holdings with Loans
			

Source: own calculations. The arrow's orientation shows a related increase or decrease, while the color shows the magnitude of the effects: green for reduced changes (less than 1%) and red for significant changes (higher than 10%)

As the arrows' color indicates (green or red), an increase in the LTV from 80% to 90% determines low changes (in terms of magnitude) in the real estate prices, housing holdings taken with loans (owned by the representative borrower) and output. On the other hand, the increase of the long-run LTV determines significant changes in terms of deposits, lending, bank profitability and the cost of default.

Figure 2. Impulse–response functions of the default rate to a negative technology shock for different LTV policies



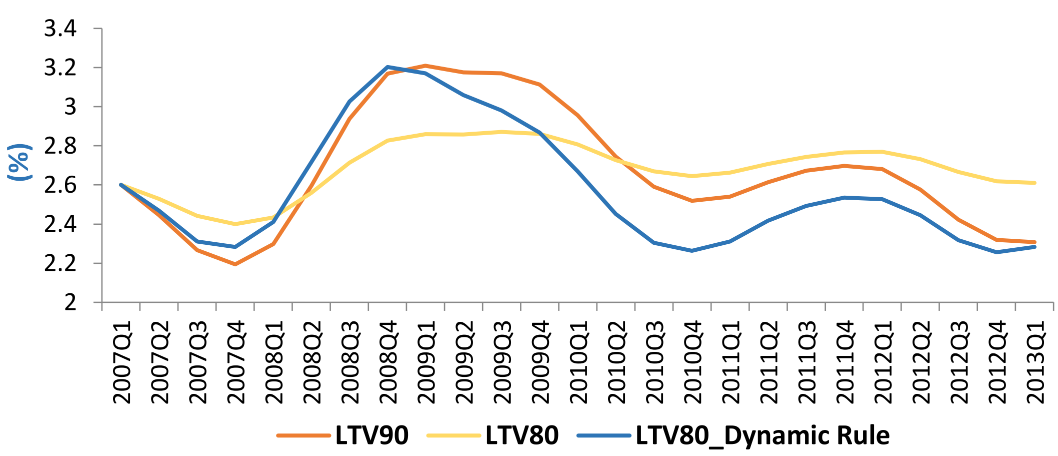
Source: own calculations

The most notable impact determined by the LTV increase is for the cost of default. For a low LTV, it is more expensive for borrowers to default because they are subject to tight constraints. A lower LTV is also beneficial for banking, as they lose less in the case of a default. The net impact of the LTV increase is beneficial for the bank profitability, as the credit channel dominates the negative effects from default.

The second part of our analysis focuses on how the LTV changes affect the cyclical developments in the economy. This aspect is divided into two parts. First of all, we analyze how the default rate evolves in the case of an economic contraction by considering different levels of the LTV. Therefore, we study an unexpected decrease in the total factor productivity by 1%. As it can be observed from the plot above, the initial response of the default rate (in terms of deviations from the steady state) is higher for the 90% LTV compared to the case when the LTV is set to 80%. In the case of a dynamic LTV, the response of the default rate to an economic contraction is closer to the one obtained with a static 90% LTV. Therefore, the default rate responds less to an economic contraction for a lower LTV, but it is important to remember here that our model is flows based. After the Global Financial Crisis, the peak in the stock of non-performing loans is reached in 2013 for Romania, thus much later after the crisis occurrence.

In order to get a deeper view regarding the interconnection between the LTV policy and the welfare of borrowers in terms of default and inequality, we elaborate some counterfactual experiments about the financial crisis in 2008-2009. Specifically, instead of using stochastic simulations of an unanticipated productivity shock as the main driver behind the boom-bust transition, we use the empirical evolution of productivity. Thus, within the model we introduce quarterly changes of the total factor productivity observed between 2007Q1 and 2013Q1. Since the data on total factor productivity is with an annual frequency, we use spline interpolation to obtain quarterly values of the index, which are further used to calculate quarterly growth rates.

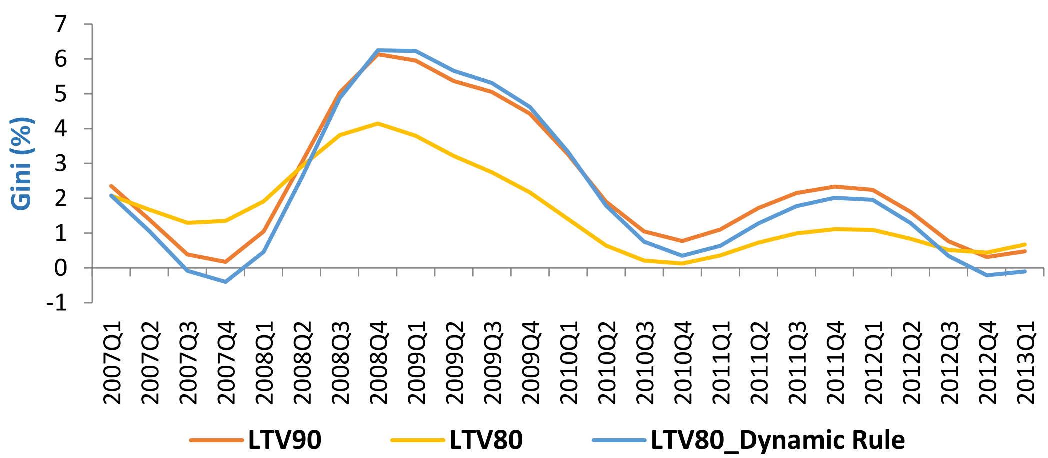
Figure 3. Boom-bust evolution of default rate for different LTV policies



Source: own calculations

Within the counterfactual experiments we consider successively the LTV is set to 80%, 90%, respectively set according to the dynamic rule that we defined in the previous section. In the plot above we can notice a higher default rate during the pre-crisis period for the 80% LTV as compared with the other two cases of the LTV setting. In contrast, the very strong shocks that hit the economy for several quarters in a row led to a higher default rate for the 90% LTV, respectively for the dynamic LTV. Instead, for the case of a dynamic LTV, which responds to changes in macro-financial conditions, the default rate falls below the levels recorded for the other two cases and remained so for the rest of the considered period. After the contraction in the total factor productivity has passed, the default rate for an LTV of 80% is higher as compared with the default rate for the 90% LTV. This aspect arises in good times as the borrower agent in the model finds it optimal to default more for the 80% LTV given the lower resulting penalties.

Figure 4. Boom-bust evolution of consumption inequality for different LTV policies

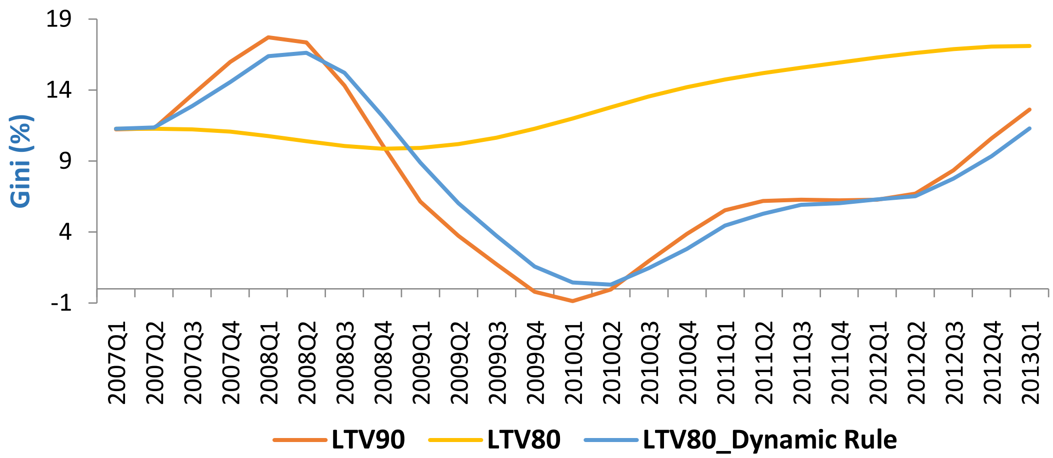


Source: own calculations

In line with Eskelinen (2021), we analyze separately how inequality in consumption, income and wealth (real estate) evolves during the boom-bust cycle in 2007-2012. The Gini index ranges between 0% and 100%, where high values indicate higher inequality and vice versa. Negative values of the Gini index should not be taken into account, being due to the approximation that is available for models where the heterogeneity is not approached in the form of distributions. Looking firstly at the inequality in consumption, for the period before the financial crisis outbreak, we notice that the Gini index for the 80% LTV is higher as compared with the two other cases.

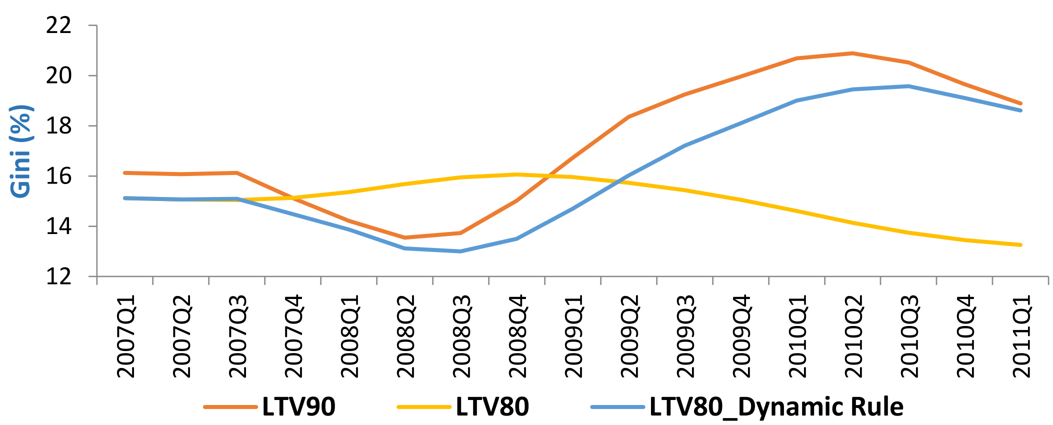
Instead, after the outbreak of the financial crisis, the situation is reversed and the Gini index for an LTV of 80% is below the levels recorded with an LTV of 80% (which means more equality), respectively the dynamic LTV. This aspect can be attributed to tighter conditions for entering the credit market, in this way their consumption being not affected by defaults.

Figure 5. Boom-bust evolution of wealth inequality for different LTV policies



Source: own calculations

Figure 6. Boom-bust evolution of income inequality for different LTV policies



Source: own calculations

In terms of wealth inequality (figure 5), an LTV of 80% results in a lower level of the Gini index until the effects of the 2008-2009 financial crisis. Later, however, the inequality in terms of wealth increases for the 80% LTV, while the observed gap between inequalities narrows as the economy stabilizes. This evolution comes as tighter collateral requirements causes a higher decrease in the housing prices. Under these conditions, the saver, who gets housing properties with cash, finds it more appealing to enter the real estate market. In the Annex, we present the evolution of the real estate prices[3], respectively the evolution of the household holding of borrowers and savers.

The dynamic of income inequality (figure 6) is somehow mirrored by wealth inequality. After the negative shocks that affect productivity have passed, the saver focuses his investments on deposits rather than real-estate, when the LTV is 90% or the LTV is set according to a dynamic rule. This leads to a higher income by comparing with the 80% LTV case, as we underlined before, the housing investments appearing more attractive for the saver when the collateral constraints are tight.

4. Conclusions

We analyze the welfare effects in terms of inequality associated with different LTV policies. To do this, we use a financial-business cycle model in the spirit of Iacoviello (2013) and Rubio and Carrasco-Gallego (2014), in which we incorporate endogenous default as in de Walque *et al* (2010). Following the narrative of Eskelinen (2021), we investigate how different LTV regimes affect long-run equilibrium and the cyclical behavior of key variables. Following Rubio and Unsal (2017), we use a simplified measure for the Gini index to investigate inequality in terms of consumption, income and wealth.

Our results show that although relaxing collateral conditions (e.g. a 90% LTV compared to a benchmark of 80%) has steady-state positive effects, the short-term effects can be reversed depending on the policy maker's goals and the level of volatility. In the long-run, loosening LTV policies leads to more lending, increased bank profitability, and more home ownership among borrowers. However, in a scenario where unexpected shocks have negative effects, a higher LTV ratio leads to a short-term increase in the default rate, which may increase wealth inequality.

We conduct counterfactual investigations on the 2008-2009 financial crisis to explore the potential effects of different LTV policies. Specifically, we consider two static LTV regimes: a benchmark

[3] Expressed in output units such as Iacoviello (2013).

regime with an LTV of 80%, and a loosening regime with an LTV of 90%. Additionally, we investigate a dynamic rule for the LTV, in which the LTV ratio responds to changes in real estate prices (for example, an increase in real estate prices would lead to a reduction in the LTV ratio). Our results indicate that the benchmark regime (80% LTV) has a lower default rate during the outbreak of the financial crisis (with potential positive effects on wealth inequality), but after the crisis has passed, the default rate is higher than in the easing regime (90% LTV). This last conclusion should be also interpreted with care for practical purposes, having in mind the Romanian government program that subsidize first-home buyers, allowing also for higher LTV.

Our results on inequality are consistent with the findings of Eskelinen (2021), which suggest that there is a trade-off between inequality in consumption and inequality in wealth. For example, during the 2008-2009 financial crisis, a tighter LTV policy led to a reduction in consumption inequality, but at the cost of increased wealth inequality. This trade-off should be taken into account when considering the appropriateness of a tighter LTV policy, particularly in the context of high volatility. However, when using a dynamic rule for setting the LTV, the results are closer to those obtained with a static rule set at 90% LTV. This is likely due to the fact that during the financial crisis, the large negative shocks to productivity led to a significant decrease in real estate prices and increase in LTV ratios. Overall, our results indicate that looser macroprudential borrower-based measures are more appropriate in a lower volatility environment. Additionally, our analysis suggests that potential effects on inequality could be also taken within calibration of the LTV policy.

Funding. The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Competing Interests. The authors have no relevant financial or non-financial interests to disclose.

References

Alupoaiei, A., Kubinschi, M. and F. Neagu. 2022. *Looking for the Macroprudential Policy Stance in Romania*. Forthcoming.

Bachmann, R, and R. Sebastian. 2017. *Systematic Monetary Policy and the Macroeconomic Effects of Shifts in Loan-to-Value Ratios*. CEPR Discussion Paper 12024.

Brandao-Marques, M.L., Gelos, M.R., Narita, M.M. and Nier, E., 2020. *Leaning against the wind: a cost-benefit analysis for an integrated policy framework*. IMF Working Paper No. 20.

Bianchi, J., 2011. *Overborrowing and systemic externalities in the business cycle*. American Economic Review. 101 (7), 3400–3426.

de Walque, G., Pierrard, O., and A. Rouabah. 2010. *Financial (in)stability, supervision and liquidity injections: A dynamic general equilibrium approach*. The Economic Journal, 120(549):1234–1261.

Eskelinen , M. 2021. *Monetary policy, agent heterogeneity and inequality: insights from a three-agent New Keynesian model*. ECB Working Paper Series 2567.

Georgescu, Oana-Maria and Martín, Diego Vila. 2021. *Do macroprudential measures increase inequality? Evidence from the euro area household survey*. ECB Working Paper Series 2567.

Iacoviello, M. 2013. *Financial Business Cycles*. Mimeo, Federal Reserve Board

Lim, C., F. Columba, A. Costa, P. Kongsamut, A. Otani, M. Saiyid, T. Wezel, and X. Wu. “Macroprudential Policy: What Instruments and How to Use Them? Lessons from Country Experiences“, IMF Working Paper No. 238, 2011

Monnin, P. 2017. *Monetary Policy, Macroprudential Regulation and Inequality*. Discussion Notes 1702, Council on Economic Policies.

Neagu, F., Tatarici, L. and Mihai, I., 2015. *Implementing Loan-to-Value and Debt Service-To-Income measures: A decade of Romanian experience*, NBR Occasional Papers no. 15.

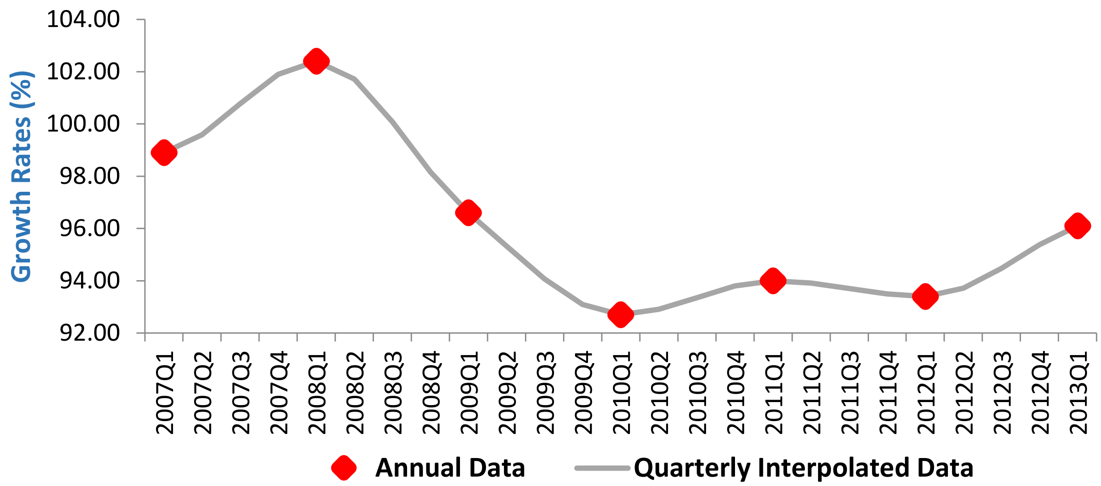
Nier, E., R. Popa, M. Shamloo and L. Voinea. 2019. *Debt Service and Default: Calibrating Macroprudential Policy Using Micro Data*. IMF Working Papers No. 19.

Rubio. M and J. Carrasco-Gallego. 2014. *Macroprudential and Monetary Policies: Implications for Financial Stability and Welfare*. Journal of Banking and Finance. 49, 326-336

Rubio, M. and F. Unsal. 2017. *Macroprudential Policy, Incomplete Information and Inequality: The case of Low-Income and Developing Countries*. IMF Working Papers. 17.

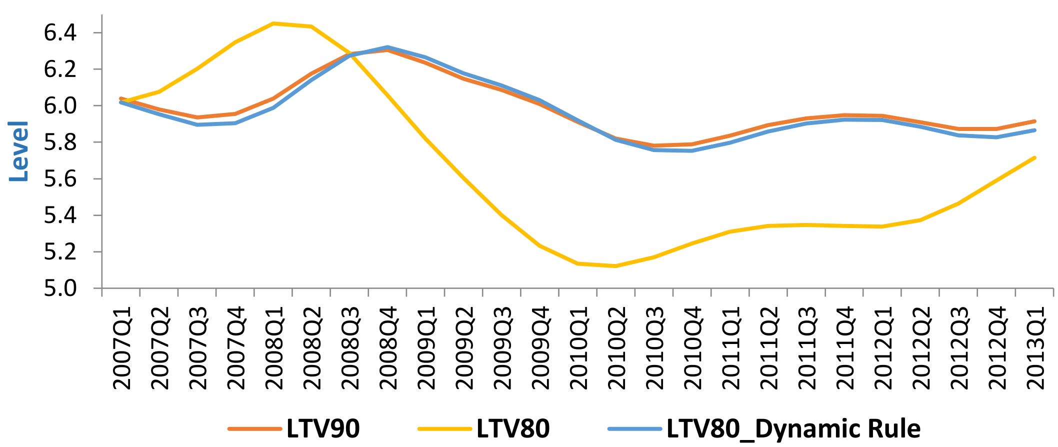
Annex. Additional results of the paper

Figure A1. Boom-bust evolution of the total factor productivity (TFP)



Source: AMECO, own calculations

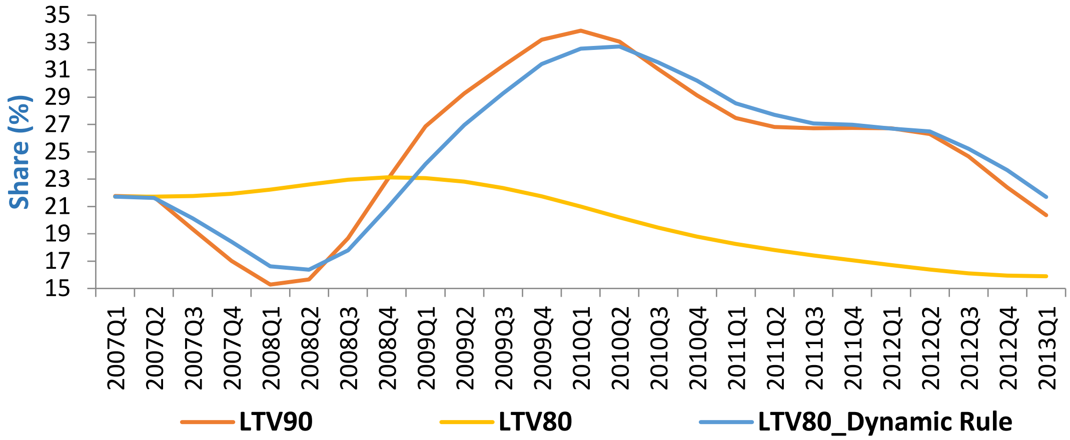
Figure A2. Boom-bust evolution of the housing prices[4]



Source: own calculations

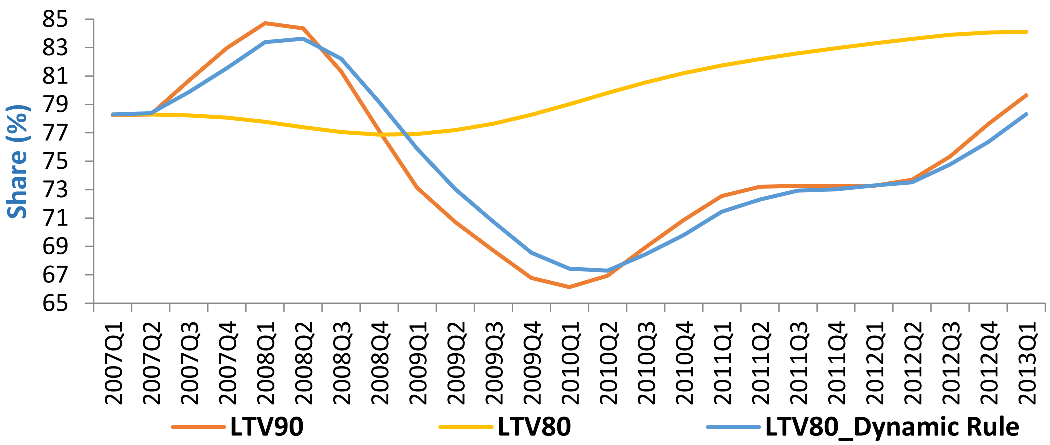
[4] Expressed in output units such as Iacoviello (2013).

Figure A3. Boom-bust evolution of the housing acquisitions with loans



Source: own calculations

Figure A4. Boom-bust evolution of the housing acquisitions with cash



Source: own calculations