



**IMF Working Paper**

Strategy, Policy, and Review Department

**Macprudential Policy, Incomplete Information and Inequality: The Case of Low-Income and Developing Countries<sup>1</sup>****Prepared by Margarita Rubio and D. Filiz Unsal**

Authorized for distribution by Rupa Duttgupta

March 2017

**IMF Working Papers describe research in progress by the author(s) and are published to elicit comments and to encourage debate.** The views expressed in IMF Working Papers are those of the author(s) and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

**Abstract**

In this paper, we use a DSGE model to study the passive and time-varying implementation of macroprudential policy when policymakers have noisy and lagged data, as commonly observed in low-income and developing countries (LIDCs). The model features an economy with two agents; households and entrepreneurs. Entrepreneurs are the borrowers in this economy and need capital as collateral to obtain loans. The macroprudential regulator uses the collateral requirement as the policy instrument. In this set-up, we compare policy performances of permanently increasing the collateral requirement (passive policy) versus a time-varying (active) policy which responds to credit developments. Results show that with perfect and timely information, an active approach is welfare superior, since it is more effective in providing financial stability with no long-run output cost. If the policymaker is not able to observe the economic conditions perfectly or observe with a lag, a cautious (less aggressive) policy or even a passive approach may be preferred. However, the latter comes at the expense of increasing inequality and a long-run output cost. The results therefore point to the need for a more careful consideration toward the passive policy, which is usually advocated for LIDCs.

JEL Classification Numbers: E44; E32; G18

Keywords: Macroprudential policy, low-income developing countries, incomplete information, collateral requirements, credit, inequality

Author's E-Mail Address: [margarita.rubio@nottingham.ac.uk](mailto:margarita.rubio@nottingham.ac.uk); [DUnsal@imf.org](mailto:DUnsal@imf.org)

<sup>1</sup> The authors would like to thank C. Patillo, R. Duttgupta, C. Papageorgiou, P. Loungani, M. Iacoviello, P. Rabanal, M. Ghilardi, D. Furceri, C. Gueye, D. Coady, M. Francese, R. Bouis, A. Mourmouras, S. Rafiq, A. Levine, J. A. Carrasco-Gallego, G. Nuño, R. Portillo, and C. Thomas for their very useful comments. Special thanks to the seminar participants at the IMF, the Bank of England, the University of Konstanz, the Reserve Bank of New Zealand, the Federal Reserve Bank of Cleveland, and the University of Nottingham. We also want to acknowledge the very useful comments received at the NCID Workshop, the Workshop in Development in Economics (La Sapienza, Rome), the SED Conference, the ANAECO Workshop (University of Valencia), the CGBCR Conference (University of Manchester), and the "Macroprudential Policies: Experiences and Challenges" workshop (Central Bank of Chile). The paper was also presented at the ASSA Meeting 2016 session "Macroprudential Policy in Low-Income and Developing Countries." We wish to thank L. Guerrieri, F. Signoretti and M. Kirchner for their very useful discussions. This paper is part of a research project on macroeconomic policy in low-income countries supported by U.K.'s Department for International Development (DFID). This paper should not be reported as representing the views of DFID

<b>Contents</b>	<b>Page</b>
Abstract	2
1. Introduction	5
2. The Model	8
2.1 Entrepreneurs/Firms	9
2.2 Households	10
2.3 Capital Producers	11
2.4 Equilibrium	11
2.5 Welfare	12
2.6 Macroprudential Policy Alternatives	13
2.6.1 Active Policy: A Macroprudential Rule	13
2.6.2 Passive Policy	15
3. Dynamic Properties	15
3.1 Parameter Values	15
3.2 Impulse Responses	16
4. Macroeconomic and Financial Effects of Macroprudential Policy	18
4.1 Active Policy with Complete Information	18
4.2 Active Policy with Incomplete Information	20
4.3 Passive Policy	21
5. Macroprudential Policy and Inequality	22
6. Macroprudential Policy and Welfare	24
6.1 Active Policy with Complete Information	25
6.2 Active Policy with Incomplete Information	25
6.3 Passive Policy	25
7. Policy Comparison	27
7.1 Macroeconomic and Financial Stability	27
...7.2 Welfare and Inequality	31
8. Concluding Remarks	32
<b>Tables</b>	
1. Benchmark Calibration	16
2. Policy Comparison. Volatilities and Steady States	30
3. Policy Comparison. Welfare and Inequality	32

**Figures**

1. Collateral requirement response (in levels)	17
2. Impulse responses to a demand shock. Benchmark (No macropru), active, and passive approaches.	18
3. Standard deviation of borrowing for different values of the reaction Parameter. Active policy	19
4. Standard deviation of borrowing for different values of the rule reaction Parameter. Active policy	20
5. Financial stability implied by increasing collateral requirements. Passive policy	21
6. Steady state output implied by increasing collateral requirements. Passive policy	22
7. Steady state consumption implied by increasing collateral requirements. Passive policy.	23
8. Gini Coefficient implied by increasing collateral requirements. Passive policy	24
9. Gini Coefficient. Active policy, complete information	25
10. Welfare gains for different values of the reaction parameter. Active policy, complete information.	26
11. Welfare gains for different values of the reaction parameter. Active policy, incomplete information.	27
12. Welfare gains implied by increasing collateral requirement. Stochastic model (Second order approximation). Passive policy.	28
13. Welfare gains implied by increasing collateral requirement. Deterministic model. Passive policy.	29
14. Collateral Requirements and Financial Stability. Active versus Passive.	30
15. Collateral Requirements and Welfare gains. Active versus Passive.	32
References	34

# 1 Introduction

The recent financial crisis has emphasized that there is the need for policies that enhance the stability of the financial system, namely macroprudential policies. However, the policy agenda is still very much evolving and there is scarce evidence on the implementation of these policies around the globe, especially for low-income and developing countries (LIDCs).<sup>1</sup> Hence there is a need to build theoretical frameworks that may help countries undertake these policies in the most effective manner.

There are several ways macroprudential instruments could be designed and implemented, with important implications for the financial system and the overall economy. At least, it has to be taken into account that macroprudential policy has both benefits as well as costs. The benefits, when tools are used effectively, include a more stable financial system, which in principle reduces the probability of a crisis and its impact when/if it happens. However, these tools could have other economic implications as they could restrict credit and financial access more broadly; and could bring short and long-run output costs.<sup>2</sup>

One plausible approximation of a macroprudential policy implementation is time-varying rules that tie policy settings to a pre-defined indicator. In theory, it is useful to vary macroprudential instruments over the cycle—it does not imply any long-run output cost, it could help to overcome political pressures on the policy moves and time-inconsistency problems. An alternative option would be a passive policy in which instruments tighten borrowing requirements permanently.

The design of these policies will depend on the characteristics of each country. The literature has focused on studying macroprudential tools in developed countries, but the research on the desirability of these measures and how they should be designed for LIDCs is close to nonexistent. LIDCs have also experimented with several macroprudential tools in recent years—as in other countries, the procyclicality of bank lending in LIDCs tend to amplify the cycle under temporary shocks, with potential consequences for financial system stability (Masson, 2014). Macroprudential policy is generally considered useful in LIDCs, there is much less agreement and discussion on what tools should be used or how they should be designed. Griffith-Jones et al. (2015) point out that the financial systems and their regulation in LIDCs are still in their early stages of development, and that financial development in these countries should be geared towards achieving simultaneously the goals of financial stability and inclusive growth.

---

<sup>1</sup>While the LIDCs are a diverse group of countries, they share characteristics common to all countries at a low level of development. According to the IMF definition (IMF, 2014a), there are 60 countries in this group, accounting for about one-fifth of the world population; Sub-Saharan Africa accounts about 60 percent of the LIDC population.

<sup>2</sup>See Arregui (2013).

---

LIDCs are in general in a process of financial and institutional development with implications both for the nature of financial stability risks and the conduct of macroprudential policies. For developed countries, global thinking and practice seem to favor time-varying rules on instruments such as loan-to-values or capital requirement ratios. However, for LIDCs, this may not be the case. As Gottschalk (2014) points out, international financial regulation has been designed having in mind developed and emerging countries and includes some complex rules that LIDCs have difficulties in following.<sup>3</sup> For LIDCs, the combination of limited data availability, volatile economic conditions, and weak supervisory capacity can mean that a passive policy can be preferred, an active and time-varying use of macroprudential policy may be inadvisable. Maintaining permanently high capital or collateral requirements could be a more effective approach under these circumstances (IMF, 2014b). Nevertheless, these type of policies may bring dramatic output effects through affecting the cost and availability of credit which is already scarce in LIDCs. Such policies may also favor more well-off segments of the population and enhance inequality, which can undermine progress in health and education, cause investment-reducing political and economic instability in LIDCs (IMF, 2014c).

In this paper, we use a DSGE model with capital collateral for borrowing and high collateral requirements to capture some specific features of LIDCs. We focus on how macroprudential policy design should take into account data and capacity limitations, which is generally an important feature in these countries but not confined to them. We proxy these data problems with the absence of complete information (without noise and lag). The model features two types of agents; households and entrepreneurs. Entrepreneurs can access financial markets as long as they own capital collateral. Macroprudential policy is represented by changes in the collateral requirement. We compare a passive macroprudential policy, in which collateral requirements are increased permanently; with an active policy, in which the collateral requirements respond to deviations of credit with respect to its steady state. For our comparison, we consider two scenarios: (i) macroprudential policymakers have complete information, (ii) macroprudential policymakers have incomplete information in which financial indicators are not observed with accuracy and in a timely manner.

In order to evaluate policies we adopt a positive approach complemented with welfare analysis. As

---

<sup>3</sup>According to Gottschalk (2014), some of these countries seemed to feel that adoption of these complex rules was a way to signal they were adopting standards of international best practice, even if they were not the most appropriate to meet their needs (See Beck et al., 2013, chapter 5). Nevertheless, complexity of policies is a relevant issue for LIDCs given their limited technical capacity to validate and monitor complex models, and the lack of sufficiently large and reliable databases. Gottschalk (2014) argues that countries have eventually realized that the rules were not appropriate to them and prefer simpler alternatives.

in Angelini et al. (2014), among others, we take regulation as given and calculate welfare values under this assumption to compare different ways of implementing macroprudential policy.

This paper relates to different strands of the literature. On the one hand, it builds from DSGE models with collateral constraints such as Kiyotaki and Moore (1997), Iacoviello (2005) or Iacoviello and Minetti (2006). However, in our paper, unlike the others, the main source of collateral is capital, which better reflects the features of LIDCs.<sup>4</sup> This paper is also related with the literature that studies macroprudential policies in a DSGE model, introducing such policies as a rule on financial regulation. Examples of these papers are Kannan et al. (2012), Unsal (2013), Angelini et al. (2014) and Rubio and Carrasco-Gallego (2014). However, all these papers refer to advanced and emerging economies, there is no mention to low-income or developing countries. Those papers use capital requirements or loan-to-values as macroprudential instruments. In our paper, the instrument is the collateral requirement, which has a great importance on those countries. On the other hand, our study adds incomplete information in the specification of the macroprudential rule, as in the literature on monetary policy rules with incomplete information. For instance, Berg et al. (2010) and Portillo et al. (2016) study monetary policy responses under incomplete information for LIDCs.<sup>5</sup> In the broader monetary policy literature, Aoki (2003) or Orphanides (2003) analyze optimal monetary policy with noisy indicators. Nevertheless, these studies focus on monetary policy, not on macroprudential policies.

To our knowledge, our paper is the first one that studies alternative ways of implementing macroprudential policy under incomplete information. This is a relevant problem in LIDCs although it can also be applicable to some emerging and advanced economies. Thus, the features that we incorporate in the model for LIDCs are not confined to them.<sup>6</sup> This paper permits to analyze different policy options within a rigorous micro-founded model, suitable for policy evaluation. It provides a theoretical counterpart to empirical studies and policy papers that point out that the particular features of these countries may alter the desirable and effective way to implement macroprudential policy.

We also touch upon the effects of these policies on inequality, a relatively unexplored topic in the context of macroprudential policy. In LIDCs, improving inequality remains as one of the most important

---

<sup>4</sup>The main source of macro-financial fragility in advanced and emerging economies has generally been housing booms. In LIDCs, however, mortgage markets are still underdeveloped.

<sup>5</sup>There are several other papers that incorporate specific features of LIDCs in a DSGE setting. See Baldini et al. (2015) and Dabla-Norris et al. (2015), for example. These papers are however silent on how macroprudential policies should be implemented in such countries.

<sup>6</sup>We acknowledge that there are other issues relevant to LIDCs—such as low financial deepening, commodity exporters, low capacity, informality in the access to finance, limited financial access, high exposure of the banking system to the government and weak policy frameworks for monetary and fiscal policy—that could have an impact on how macroprudential policies should be designed and implemented. Future work should incorporate some of these features.

---

macroeconomic policy objectives and policymakers generally attach considerable weight to distributional consequences of policies. By providing some insights on the inequality implications of macroprudential measures, we aim to bring a more complete picture on the issue for these countries.<sup>7</sup>

Results show that macroprudential tools are effective in improving financial stability by lowering the volatility of credit. If the macroprudential policymaker is able to observe economic indicators (complete information case), active time-varying policies are preferred to passive approaches. Active policies, being countercyclical, are more effective to achieve financial stability without incurring in any long-run output cost. Passive policies, although they also enhance a more stable financial system, they are not as effective and they imply a permanently lower steady-state output. However, if policymakers observe the economic data with a lag and with some noise (incomplete information case), this may not be the case. Under these circumstances, a more cautious (less aggressive) response or even a passive approach may be more advisable even though the latter entails an output cost. Nevertheless, this cost is not evenly distributed among agents and inequality increases. Welfare values are in line with these results.

The policy implications of these results are clear—there should be an effort in these countries to improve data and capacity issues to better monitor financial systems and to develop time-varying approaches which do not imply long-run output or inequality costs. In the meantime, a less aggressive response to financial sector developments could be desirable.

The rest of the paper continues as follows. Section 2 presents the basic model. Section 3 shows the dynamic properties of the model. Section 4 describes the macroeconomic and financial effects of macroprudential policy. Section 5 describes how alternative implementation of this policy affects inequality. Section 6 presents welfare results. Section 7 provides a policy comparison. Section 8 concludes.

## 2 The Model

We consider an infinite-horizon economy. The economy is populated by infinitely lived agents, entrepreneurs (borrowers) and households (savers). There are capital producers that sell the capital goods output to entrepreneurs. Households rent labor to entrepreneurs and consume the final good; they also trade non-contingent one-period bonds issued by entrepreneurs. Entrepreneurs consume and use labor

---

<sup>7</sup>Several recent studies analyze inequality implications of various policies and shocks in a heterogenous agents setting which may allow the interaction of availability/cost of credit with occupational choice and/or firm entry. Dabla-Norris et al. (2015), for example, find that lower collateral constraints bring sizeable inequality gains as some of the high productivity/lower income households become entrepreneurs and increase their income. As we use a representative agents model, these important channels are shut down.



and capital to produce the final good; and use capital as collateral to access financial markets. The macroprudential instrument is the collateral requirement.

## 2.1 Entrepreneurs/Firms

Entrepreneurs produce the final consumption good according to a Cobb-Douglas production function in domestically located labor  $l_t$  and capital  $k_t$ , which depreciates at rate  $\delta$  over time:

$$Y_t = k_t^\mu l_t^{1-\mu} \quad (1)$$

Entrepreneurs maximize their lifetime utility from the consumption flow  $c_t$ . We denote with  $E_t$  the expectation operator conditional on time  $t$  information and with  $\gamma$  the entrepreneurs' discount factor. Entrepreneurs solve the following problem:

$$\max_{c_t, b_t, l_t, k_{t+1}} E_0 \sum_{t=0}^{\infty} \gamma^t \ln c_t$$

subject to the flow of funds:

$$k_t^\mu l_t^{1-\mu} + b_t + q_t (1 - \delta) k_t = c_t + q_t k_{t+1} + R_{t-1} b_{t-1} + w_t l_t. \quad (2)$$

where  $\gamma$  is the entrepreneurial discount factor,  $b_t$  represents borrowing of the entrepreneur,  $R_t$  is the gross interest rate,  $q_t$  is the price of capital and  $w_t$  is the real wage.<sup>8</sup>

Assuming that  $k$  is collateralizable, we denote  $z$  the value of capital collateral required to obtain one unit of loans. Then, the entrepreneur faces the following borrowing constraint:

$$b_t \leq \frac{1}{z} \frac{q_t k_t}{R_t} \quad (3)$$

This collateral constraint is analogous to the ones used in Kiyotaki and Moore (1997) or Iacoviello (2005) but using capital instead of land and housing as collateral. We consider that collateralizing debt with capital reflects better the features of LIDCs.<sup>9</sup>

Entrepreneurs choose labor and capital and how much to borrow from households; The first-order conditions are as follows:

<sup>8</sup>Entrepreneurs are perfectly competitive.

<sup>9</sup>In many LIDCs micro-finance institutions are important suppliers of new credit, which is often uncollateralized, to households and small firms. We abstract from such institutions in this paper.

$$\frac{1}{c_t} = E_t \left( \frac{\gamma R_t}{c_{t+1}} \right) + \lambda_t R_t \quad (4)$$

$$w_t l_t = (1 - \mu) y_t \quad (5)$$

$$\frac{1}{c_t} q_t = E_t \frac{\gamma}{c_{t+1}} \left( \mu \frac{y_{t+1}}{k_t} + q_{t+1} (1 - \delta) \right) + \lambda_t q_t \frac{1}{z} \quad (6)$$

where  $\lambda_t$  is the Lagrange multiplier of the borrowing constraint. The first-order conditions are the consumption Euler equation (4), labor demand (5), and capital demand (6). The consumption Euler equation and the capital demand differ from the usual formulations because of the presence of the Lagrange multiplier on the borrowing constraint.

## 2.2 Households

We denote households' variables with a prime. Households enter each period with a bond coming to maturity. They derive utility from consumption and leisure.<sup>10</sup> They rent labor to the entrepreneur, lend  $b_t$ , while receiving back the amount lent in the previous period times the agreed gross interest rate  $R$ .

Preferences are given by:

$$\max_{c'_t, b'_t, l_t} E_0 \sum_{t=0}^{\infty} \beta^t \left( \ln c'_t - \frac{1}{\eta} l_t^\eta \right) \quad (7)$$

where  $\beta$  is the discount factor, which is assumed to be greater than  $\gamma$ , the discount factor for entrepreneurs.<sup>11</sup>

Households maximize (7) subject to the flow of funds:

$$c'_t + b'_t = R_{t-1} b'_{t-1} + w_t l_t \quad (8)$$

Solution of this problem yields the following first-order conditions:

$$\frac{1}{c'_t} = \beta E_t \left( \frac{R_t}{c'_{t+1}} \right) \quad (9)$$

<sup>10</sup>Notice that entrepreneurs derive utility only from consumption because they do not work.

<sup>11</sup>In a neighborhood of the steady state equilibrium, the multiplier associated with the entrepreneurs collateral constraint is positive, as long as the entrepreneurial discount factor  $\gamma$  is lower than the households' discount factor  $\beta$ , which in turn prices bonds.

$$w_t = c_t' l_t^{\eta-1} \quad (10)$$

where equation (9) represents the Euler equation for consumption. Equation (10) is the labor supply schedule.

### 2.3 Capital Producers

Competitive capital producers use investment as materials input  $i_t$  and produce new capital goods sold at price  $q_t$ . We assume that the marginal return to investment in terms of capital goods is decreasing in the amount of investment undertaken due to the presence of adjustment costs.

The representative firm solves:

$$\max_{i_t} q_t \left[ \left( \frac{i_t}{k_t} \right) - \frac{\phi}{2} \left( \frac{i_t}{k_t} - \delta \right)^2 \right] k_t - i_t \quad (11)$$

The first order condition for  $i_t$  is as follows:

$$q_t = \left[ 1 - \phi \left( \frac{i_t}{k_t} - \delta \right) \right]^{-1} \quad (12)$$

Equation (12) captures the price of a unit of capital and it represents the optimality condition for the capital-producing firms with respect to the choice of  $i_t$ .<sup>12</sup>

### 2.4 Equilibrium

Goods markets clear:

$$Y_t = c_t + c_t' + i_t \quad (13)$$

Financial markets clear:

$$b_t + b_t' = 0 \quad (14)$$

Capital markets clear, so that the stock of capital used by the firms in the economy evolves according to the following equation:

---

<sup>12</sup>This specification of capital production is standard in the literature. See for instance Bernanke et al. (1999) or Unsal (2013).

$$k_{t+1} = \left[ \left( \frac{i_t}{k_t} \right) - \frac{\phi}{2} \left( \frac{i_t}{k_t} - \delta \right)^2 \right] k_t + (1 - \delta) k_t \quad (15)$$

## 2.5 Welfare

To be able to assess the implications of different policies, we numerically evaluate welfare. As discussed in Benigno and Woodford (2008), the two approaches that have been traditionally used for welfare analysis in DSGE models include either characterizing the optimal Ramsey policy, or solving the model using a second-order approximation to the structural equations for given policy and then evaluating welfare using this solution. We obtain a solution for the equilibrium implied by a given policy by solving a second-order approximation to the constraints, then evaluating welfare under the policy using this approximate solution, as in Schmitt-Grohe and Uribe (2004). As in Mendicino and Pescatori (2007), we evaluate the welfare of the two types of agents separately.<sup>13</sup> The individual welfare for savers and borrowers, respectively, as follows:<sup>14</sup>

$$W_t \equiv E_t \sum_{m=0}^{\infty} \gamma^m \log c_{t+m}, \quad (16)$$

$$W'_t \equiv E_t \sum_{m=0}^{\infty} \beta^m \left[ \log c'_{t+m} - \frac{(l_{t+m})^\eta}{\eta} \right], \quad (17)$$

The second-order approximation captures the volatilities of the variables as well the steady-state values of the variables. In the case of the passive policy we also look at the deterministic model to see how the changes in the steady state contribute to total welfare.

To make the results more intuitive, we present welfare changes in terms of consumption equivalents. The consumption equivalent measure defines the fraction of consumption that needs to be given up to equate the welfare under the new policy to the welfare under the baseline case (the policy is not active). A positive value means a welfare gain, hence indicates that the new policy is more desirable from a welfare point of view. The derivation of the welfare benefits in terms of consumption equivalent units is as follows:

<sup>13</sup>See Monacelli (2006) for an example of the Ramsey approach in a model with heterogeneous consumers.

<sup>14</sup>Following Mendicino and Pescatori (2007), we define social welfare as a weighted sum of the individual welfare for the different types of households:

$$\widehat{W}_t = (1 - \gamma) W_t + (1 - \beta) W'_t.$$

Each agent's welfare is weighted by her discount factor, respectively, so that the all the groups receive the same level of utility from a constant consumption stream.

$$CE = \exp [(1 - \gamma) (W^P - W^*)] - 1, \quad (18)$$

$$CE' = \exp [(1 - \beta) (W^P - W'^*)] - 1, \quad (19)$$

where the superscripts in the welfare values denote the benchmark case when policy is not active and the case in which it is, respectively.<sup>15</sup>

## 2.6 Macprudential Policy Alternatives

### 2.6.1 Active Policy: A Macprudential Rule

As an approximation for a realistic active (time-varying) macroprudential policy, we consider a Taylor-type rule for collateral requirements.<sup>16</sup> We can think of regulations on the required collateral as a way to moderate credit booms. When observing a credit boom, increasing collateral requirements, restricts the loans that borrowers can obtain and hence mitigates the credit cycle.

An issue in the implementation of a macroprudential rule would be the availability of relevant and timely data. Therefore, we consider the rule both when there is complete information and when there is incomplete information (noisy/inaccurate and lagged data). The presence of noise and lags in the data may trigger unwarranted or ineffective policy responses which may introduce further volatility to the economy. The evaluation of alternative policy strategies should therefore consider cases where policy reacts to data that is not available in real time (when a policy response must be decided) or it is available with substantial noise.

**The rule with complete information** Here, we propose the following rule:

$$z_t = z_{SS} \left( \frac{E_t b_{t+1}}{b_{SS}} \right)^{\phi_b}, \quad (B1)$$

where  $z_{SS}$  is the steady-state value for the collateral requirement.  $\phi_b \geq 0$  measures the response of the collateral requirement to expected deviations of credit from its steady state. This kind of rule would be countercyclical, delivering higher requirements during credit booms, therefore restricting the credit

<sup>15</sup>We follow Ascari and Ropele (2009).

<sup>16</sup>Here we just consider collateral to granted loans. In reality, in LIDCs, credit booms may be brought by loans to private non-financial companies executing public commands and/or public investment projects. In this paper we abstract from the public sector.

in the economy and increasing financial stability.<sup>17</sup> This policy, as opposed to a passive one, does not imply a change in the steady state of the economy when implemented.

**The rule with incomplete information** The macroprudential rule with complete information implicitly assumes that the macroprudential regulators observe the current state of the economy promptly and accurately, and can therefore adjust policy based on this information. In LIDCs, this may not be the case—substantial data lags and frequent data revisions are common in these countries.<sup>18</sup> As in the monetary policy literature, the availability of relevant and timely data is certainly important for the correct and efficient implementation of rules.<sup>19</sup>

To study the case with incomplete information, we assume that variables are observed both with a lag and with an error. We consider that accurate measures of these variables, which are required for the implementation of an optimal rule, are not known until much later and with noise. We conjecture that (i) the policymaker observes credit with a lag of four quarters, and (ii) observes  $b_{t-4}$  with an error ( $x_t$ ), so  $b_{t-4} = \tilde{b}_{t-4} + x_t$ .<sup>20</sup> The policy rule then becomes:

$$z_t = z_{SS} \left( \frac{b_{t-4} - x_t}{b_{SS}} \right)^{\phi_b}, \quad (20)$$

As pointed out by Orphanides (2003), the information problem makes that the policy authority is also reacting to the noise processes. It is obvious that this may introduce undesirable movements in the macroprudential tool and make it less effective.

We assume that the noise follows an AR(1) process:

$$x_t = \varphi x_{t-1} + v_t \quad (21)$$

where  $v_t$  is drawn from an independent zero mean normal distribution with variance  $\sigma_v^2$ .

<sup>17</sup>We have experimented with other rules. The collateral requirement responding to the credit-to-GDP delivers very similar results. When it responds to credit growth we encounter indeterminacy issues.

<sup>18</sup>The noise in data could reflect statistical inaccuracy or estimation errors—the series that come with a lag or some unobservable theoretical concept (for example natural rate of interest or credit gap) are typically estimated in practice. Additionally, on the conceptual front, defining a steady-state level of credit in LIDCs would also be particularly challenging given the ongoing financial deepening in those countries.

<sup>19</sup>See Orphanides (2003) and Aoki (2003).

<sup>20</sup>We adopt this specification given that data revisions are very common in these countries. Otherwise, we can assume that policy makers observe  $b_t$  with a noise instead. Our results hold for both specifications. An alternative approach for policy makers would be to estimate  $b_t$  with learning over time. Given capacity limitations in LIDCs, for simplicity, we rule out this possibility.

## 2.6.2 Passive Policy

For passive macroprudential policy we consider a permanent change in the collateral requirement ( $z$ ), the macroprudential instrument, as opposed to varying it depending on economic or financial conditions.<sup>21</sup> Such policies are typically advocated for LIDCs as they are simpler in implementation than a time-varying approach as the data and capacity requirements could be less demanding. One implication of using this policy is that, since it represents a permanent change, the economy would reach a different steady state when it is implemented. Increasing collateral requirements means, for example, restricting credit permanently which may be undesirable.

## 3 Dynamic Properties

In this section, we compute impulse responses for an active versus a passive use of macroprudential policy with complete information to understand how dynamics change when macroprudential policies are in place. We present impulse responses for the three most paradigmatic cases: the benchmark case with no macroprudential policies, the active rule with complete information, and the passive policy (corresponding to increasing collateral requirements to the average increase implied by the active rule in order for the two cases to be comparable).

### 3.1 Parameter Values

Table 1 presents a summary of the parameter values used for the benchmark calibration.<sup>22</sup> As a benchmark collateral requirement, we use data from the World Bank Enterprise Survey Data. In Sub-Saharan Africa, the value of collateral needed for a loan is 183.2%. The deep parameters are taken from the literature. The discount factor for households takes the usual value of 0.99 to reflect an annualized interest rate of approximately 4%. The discount factor for entrepreneurs is slightly lower so that they are impatient agents.<sup>23</sup> The capital depreciation takes a standard value of 3%. The capital share is about one third. The labor supply value, reflects a labor supply elasticity of one third, in line with the literature.<sup>24</sup> For

<sup>21</sup> A number of LIDCs already set the minimum regulatory capital ratio higher than international standards. For example, a higher regulatory ratio is imposed in Moldova, Uganda and Tanzania (See IMF, 2014,b).

<sup>22</sup> We calibrate the model for a generic LIDC. Calibration for a specific country may pose difficulties because of data availability and results may not be applicable to other LIDCs due to large cross-country heterogeneity.

<sup>23</sup> The value of this parameter is not crucial for the results, as long as there is a difference between households and entrepreneurs discount factors that makes the collateral constraint to be binding. We take this value in line with Iacoviello and Minetti (2006), in which it implies a steady state in which the return on entrepreneurial investment is 8%.

<sup>24</sup> These values are consistent with Iacoviello and Minetti (2006).

our analysis, we will consider demand shocks, that is, an additive shock  $\varepsilon_t$  in the log-linearized version of the Euler equation for households (equation 9).<sup>25</sup> We assume that  $\log(\varepsilon_t)$  follows an exogenous stochastic stationary AR (1) process around a constant mean. As in the standard framework, this type of shock may reflect changes in tastes or components of demand that do not react to the real interest rate, such as government expenditures. As in Rabanal (2004), the persistence of the demand shock is set to 0.80.

---

---

**Table 1: Benchmark Calibration**

---

---

$\beta$	Discount Factor Households	0.99
$\gamma$	Discount Factor Entrepreneurs	0.98
$z$	Collateral Requirement	183.2
$\delta$	Capital depreciation	0.03
$\mu$	Capital Share	0.35
$\eta$	Labor supply	3
$\rho$	Shock persistence	0.8

---

---

### 3.2 Impulse Responses

Figure 1 displays the dynamics of the level of the collateral requirement, the instrument of the macroprudential policymaker, when there is a demand shock. We compare the active rule and a passive approach with the benchmark case, in which there is no macroprudential policy in place. For the active rule, we consider a reaction parameter of 0.5 and complete information.<sup>26</sup> We calibrate the passive rule in a comparable manner to the active one—we take the average increase of the collateral requirement implied by the active macroprudential rule for the first 20 periods (of the impulse responses) and approximate a permanent equivalent increase in collateral requirement as a passive macroprudential policy.<sup>27</sup>

For the benchmark case, the collateral requirement remains at its steady-state level (calibrated to

---

<sup>25</sup>We look at demand-side shocks (fiscal shocks to shocks to external aid, for example) that are prominent for LIDCs. There does not seem to be an established consensus on the benefits of macroprudential policy in the face of supply shocks. For example, as opposed to Kannan et al. (2012) and Angelini et al. (2014), Rubio and Carrasco-Gellago (2014) find the countercyclical use of macroprudential policy effective and welfare improving in response to both demand and supply shocks. The source of the shock matters more if the interactions between monetary and macroprudential policy are studied because supply shocks may decrease inflation while increasing credit gap (or growth), and hence may call for a conflicting monetary and macroprudential responses. We do not focus on these interactions in this paper. We have also experimented with technology shocks and have found that demand shocks emphasize our results and strengthen the positive effects of macroprudential policies on financial stability.

<sup>26</sup>For presentation purposes, we do not include impulse responses for the incomplete information case, since they are very unstable and make it difficult the comparison. They are available upon request.

<sup>27</sup>In the benchmark case, it is an increase in the requirement from 183.2 to 250, approximately.



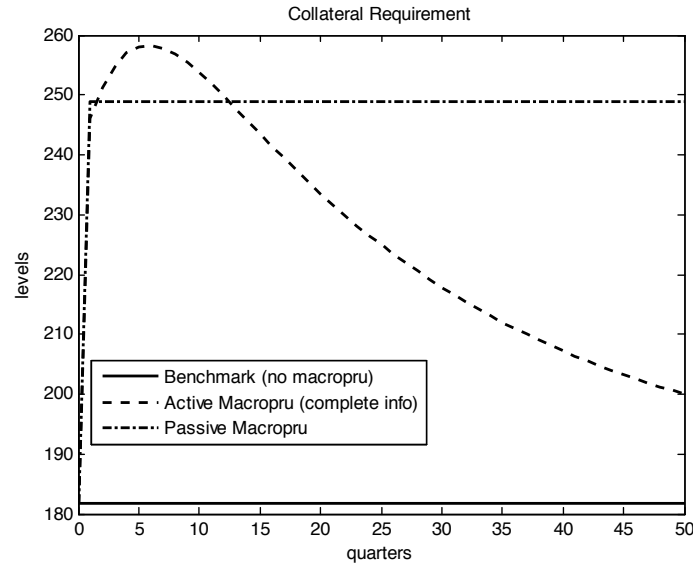


Figure 1: Collateral requirement response (in levels)

183.2) through the life of the shock. In the case of the active rule, collateral requirements increase and eventually go back to the steady state after a certain number of periods. A positive demand shock generates an extra amount of income in the economy and pushes up investment, consumption, output and borrowing. In order to avoid credit to increase in excess, the macroprudential policymaker, uses the countercyclical rule and increases collateral requirements. However, as the shock's impact passes away gradually, collateral requirements also return to their initial value.

For the passive implementation of the policy, collateral requirements increase permanently. Note that this policy also achieves the goal of cutting credit but not in a countercyclical and temporary way. Increasing collateral requirements once and for all does not only decrease short-term dynamics of credit but also its steady state. As output in the steady state also decreases, the passive policy entails a long-run output cost.

Figure 2 displays impulse responses for a demand shock for the variables of interest in the model.<sup>28</sup> We can observe from the graph that macroprudential policy mitigates the effects of the shock for aggregate output, especially if the policy is an active one, because of the countercyclical nature of the rule. The increases in the collateral requirement that we observed in figure 1 cut down borrowing in both macroprudential cases, more strongly though for the active rule. This dampening in credit makes entrepreneurial consumption not to increase as much as in the benchmark case, mitigating the effects of the

<sup>28</sup>Note that impulse responses show percent deviations of variables from their steady states. For the case of the active policy the steady state is not changing with respect to the benchmark, however, for the passive policy, there is a change to a new steady state.

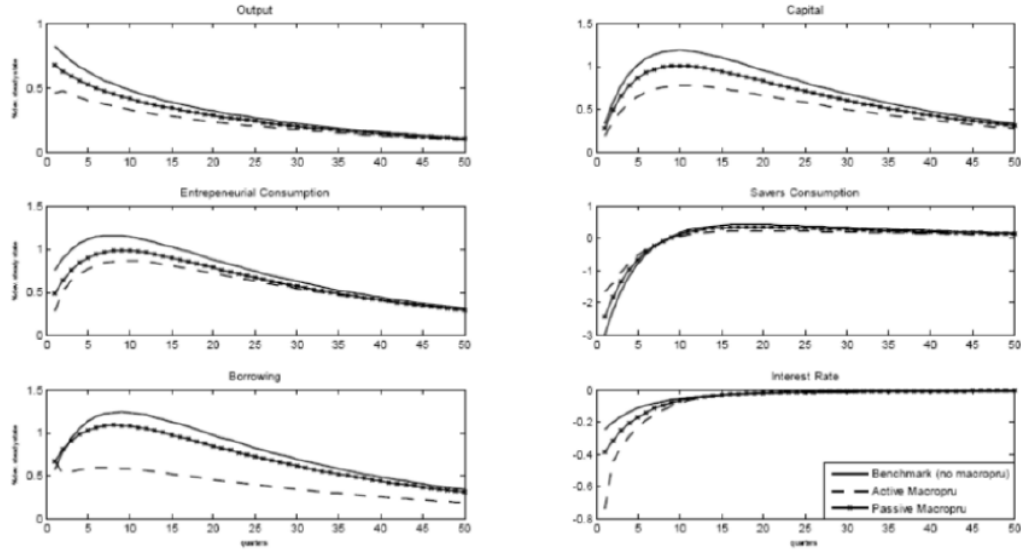


Figure 2: Impulse Responses to a demand Shock. Benchmark (No macropru), active, and passive approaches.

initial expansionary shock. Household consumption is the mirror image of entrepreneurial consumption since they now save less, responding to the cut in credit. The interest rate decreases more with a macroprudential tool as in our setup, the interest rate is also determined by the collateral requirement. When the requirements increase, the demand for credit decreases and that makes its price decrease as well.<sup>29</sup>

Overall, we see from the dynamics of the model that the increase in the collateral requirement (that macroprudential policy implies) effectively impacts credit, the goal of the macroprudential policymaker. The effect is stronger for the active policy—although it mitigates further the effects of the shock than the passive policy, it does not have long run credit and output implications.

## 4 Macroeconomic and Financial Effects of Macroprudential Policy

### 4.1 Active Policy with Complete Information

Figure 3 displays the financial stability implied by the rule for different values of the parameter  $\phi_b$ . We take the standard deviation of borrowing as a proxy for financial stability. Not surprisingly, the more aggressive the rule is in reacting to deviations of credit from its steady state, the more effective to deliver financial stability is (in the sense of achieving a lower volatility of credit). We see however that the marginal gains in terms of financial stability are decreasing. In fact, for very large values of the

<sup>29</sup>From equations (4) and (6), one can see that the interest rate is inversely related to collateral requirement.

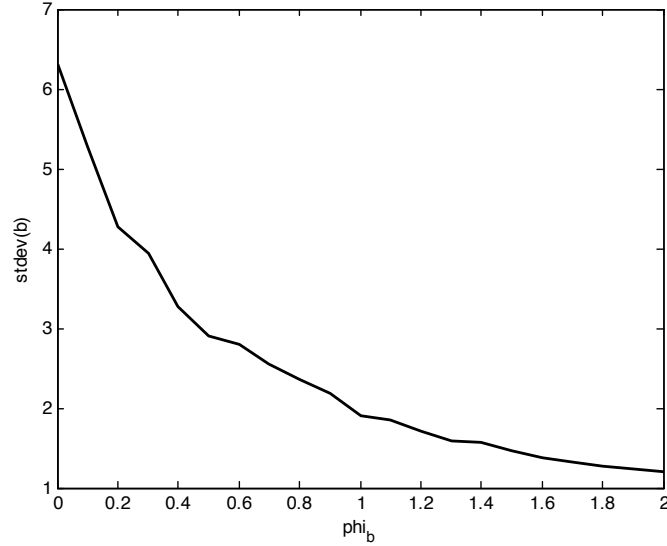


Figure 3: Standard deviation of borrowing for different values of the reaction parameter. Active policy.

reaction parameter, financial stability is still improving but at a very small rate. Given this feature, it is not possible to find a value of the reaction parameter for which the variability of credit is minimized such that we could take it as optimal. This finding goes in line with monetary policy studies that try to find an optimal parameter for the inflation coefficient in a Taylor rule. For instance, in Schmitt-Grohé and Uribe (2007), they find that deviating from the optimal policy rule by setting the inflation coefficient anywhere above unity yields virtually the same level of welfare as the optimal rule. Here, we also find that up to a certain threshold, the improvement in financial stability associated to increasing the aggressiveness of the rule is negligible.<sup>30</sup> For our analysis, we take a value of 0.5 for this parameter, in order to take a conservative value that is not too far from the monetary policy literature on Taylor rules.<sup>31</sup> Note again the steady state of output remains at the initial level in this case and therefore, the policy does not imply a long-run output cost.

## 4.2 Active Policy with Incomplete Information

Figure 4 shows the volatility of credit implied for different values of  $\phi_b$ , the reaction parameter of the macroprudential rule, both when there is complete and incomplete information. For our experiments,

<sup>30</sup>Schmitt-Grohé and Uribe (2007) find that removing the upper bound on policy parameters optimal policy calls for a much larger inflation coefficient (namely 332), but yields a negligible improvement in welfare. If we check the volatility of borrowing associated with extreme values, we also find negligible improvements. For instance, a coefficient of 100 implies a standard deviation of borrowing of 0.423537 and a coefficient of 1000 a standard deviation of 0.421284.

<sup>31</sup>The original Taylor estimates for inflation and output response in the Taylor rule are 1.5 and 0.5 respectively.

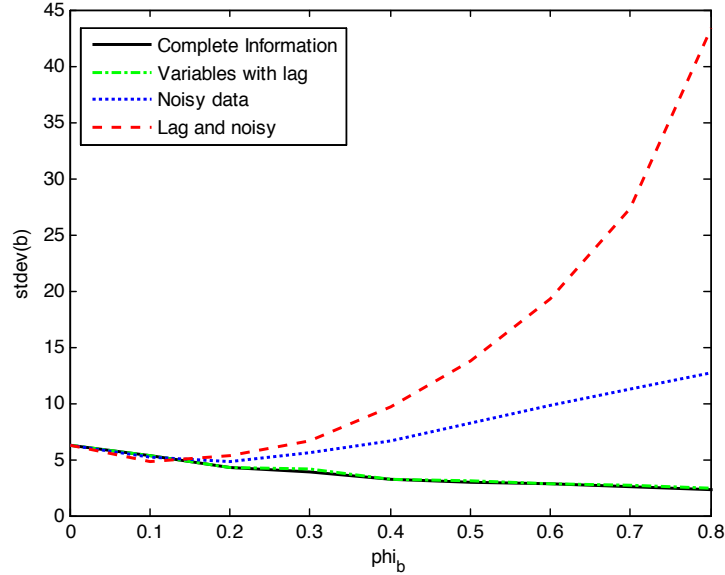


Figure 4: Standard deviation of borrowing for different values of the rule reaction parameter. Active policy.

we have considered a 1% shock in the data noise with 0.8 persistence.<sup>32</sup> For incomplete information, we present three cases: (i) the data comes with a lag, (ii) the data is noisy, and (iii) the data comes with a lag and it is noisy.

We see that for very low values of the reaction parameter, the rule is delivering similar results with complete and incomplete information. This implies that for more cautious implementation of the policy, information problems matter less. Although more aggressive responses are effective under complete information, they are counterproductive under incomplete information as they make credit more volatile.

If variables are observed with a lag, the rule performs only marginally worse than with complete information. When variables are observed with noise, the rule is less effective than with complete information and worsens in fact the stability of the financial system. The combination of lagged and noisy data exacerbates the results—in this case the macroprudential regulator generates more instability compared with the case with no macroprudential policy. However, again, if the policymaker is more cautious (responds with a low value of the reaction parameter 0.1), the effects of the policy are more limited.<sup>33</sup>

This graph suggests that if there is incomplete information and an active rule is applied, financial

<sup>32</sup>Orphanides (2003) estimates the standard error and persistence of the noise in the data used for US monetary policy. He finds that the standard error is close to 1% and with high persistence. Given the difficulties of an analogous estimation for LIDCs, we take these values as a benchmark.

<sup>33</sup>In subsequent sections, we will call this case "cautious rule under incomplete information."

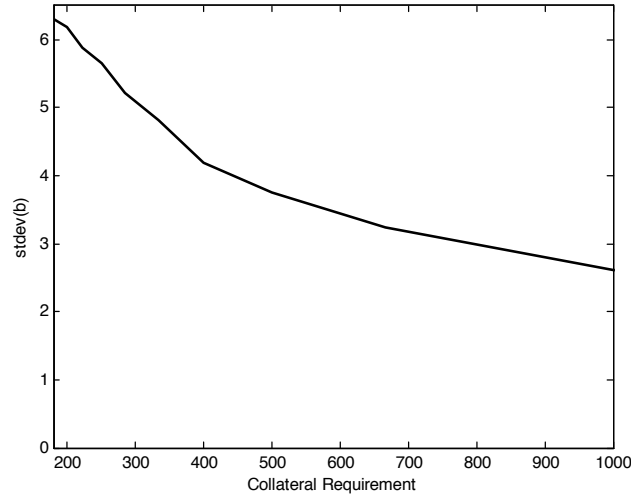


Figure 5: Financial stability implied by increasing collateral requirements. Passive policy.

stability might get worse than the case with no macroprudential policy, especially if the rule is aggressive. Results are in line with the general finding in the literature on monetary policy under incomplete information that policy performance may change significantly with noisy and lagged data to the extent that the use of an active policy rule can increase rather than decrease instability. Nevertheless, as in the previous case, this policy does not represent a long-run output cost.

In the rest of the paper, incomplete information refers to the case in which the data are noisy and lagged.

### 4.3 Passive Policy

Given that the active policy with incomplete information—as commonly observed in LIDCs—may not be desirable, we now turn to an alternative policy. More specifically, in the presence of data and capacity limitations, a simple approach that does not rely too much on data collection or processing may be preferable—that is, a passive policy. As noted above, for passive macroprudential policy rule we consider a permanent change in the collateral requirement. This action may have implications for financial stability since now, the collateral constraint becomes tighter once and for all. On the one hand, this would improve financial stability. However, increasing the collateral requirements permanently implies reducing the steady state of credit and output. Therefore, even though this policy represents a benefit in terms of financial stability, it may also entail a long-term cost in terms of output which is not desirable.

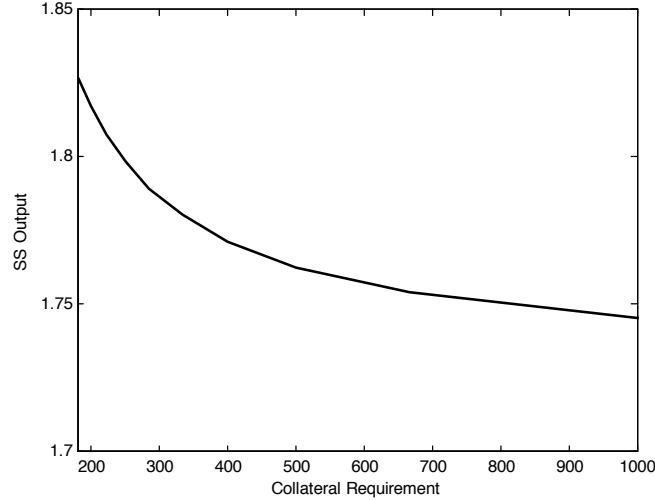


Figure 6: Steady state output implied by increasing collateral requirements. Passive policy.

Figure 5 displays the standard deviation of borrowing when collateral requirements are increased with respect to the benchmark initial point (183.2%). When collateral requirements increase, the standard deviation of credit decreases—a passive macroprudential policy is able to achieve a higher financial stability.

However, as figure 6 shows, this policy also implies a lower steady-state level of output. Here, we show the output in the steady state that is obtained when increasing the collateral requirement permanently, that is, making the collateral constraint tighter for entrepreneurs. This policy, even though enhancing financial stability, would limit the ability of entrepreneurs to access financial markets and therefore to borrow and produce. This means that the economy has permanently less resources for production and therefore the steady-state output decreases.<sup>34</sup>

## 5 Macroprudential Policy and Inequality

The findings from the previous section suggest that, if the financial stability is the only policy objective, the passive policy should be preferred under incomplete information. However, this policy entails an output cost. The natural next step, especially from a point of view of LIDCs income per capita remains

<sup>34</sup>Note that after a certain level of collateral, the impact of an increase in collateral on the steady state output becomes negligible. Even in lower collateral levels, however, the impact on steady state output seems rather small. If our framework would allow for occupational change—as in Dabla-Norris et al. (2015), for example, such that a credit tightening may push some (productive) entrepreneurs to become workers—the output impact could have been more dramatic. Nevertheless, this result is in line with the literature on advanced and emerging markets that has found that the long-run cost of increases in capital requirements or buffers on credit and output are generally small (See IMF 2014,b).

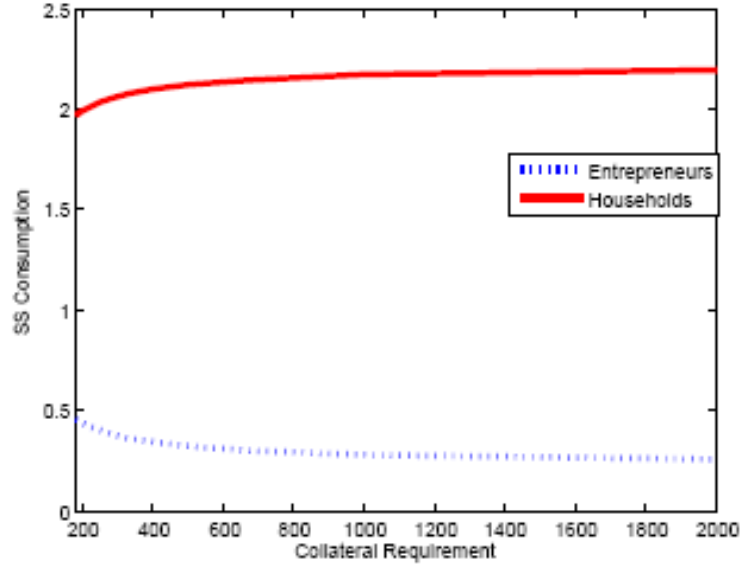


Figure 7: Steady state consumption implied by increasing collateral requirements. Passive policy.

low alongside high inequality, is to check how this reduction in output is distributed among entrepreneurs and households.<sup>3536</sup> We base our inequality assessment in terms of consumption, as it is regarded as more consistent with welfare-based considerations than income inequality (see Attanasio and Pistaferri, 2016).

Figure 7 displays the steady state consumption implied by each level of the collateral requirement. This gives us a sense of the inequality that it is present in the economy. Initially, entrepreneurs have a lower level of consumption in the steady state than households.<sup>37</sup> However, the gap between the two widens when we apply a passive macroprudential policy—the steady state output loss implied by the policy is not evenly distributed among agents. This means that introducing such a macroprudential tool is increasing the inequality among agents as an undesirable side effect.<sup>38</sup>

A way to numerically assess the level of the implications on inequality is to look at the Gini coefficient which measures the inequality among agents of the levels of income or consumption. A Gini coefficient of zero expresses perfect equality, that is, everyone has the same income. A Gini coefficient of 100 expresses

<sup>35</sup>Given the binding collateral constraint, the model allows only for the presence of households with a given financial wealth. However, it is often the case that many households (especially in the bottom deciles of the income distribution) have zero or very low financial wealth and savings.

<sup>36</sup>As mentioned before, results for inequality are only indicative because the agent heterogeneity in this model only comes from borrowers and savers. Capital producers are not consumers and do not enter the distributional analysis.

<sup>37</sup>Given the difference in discount factors, entrepreneurs represent the low-income agents in the economy. Households are the savers of the economy and they are never in debt.

<sup>38</sup>Given the structure of the model and the difference in discount factors, distributional outcome do not affect ownership of production factors (capital and labor) and financial wealth.

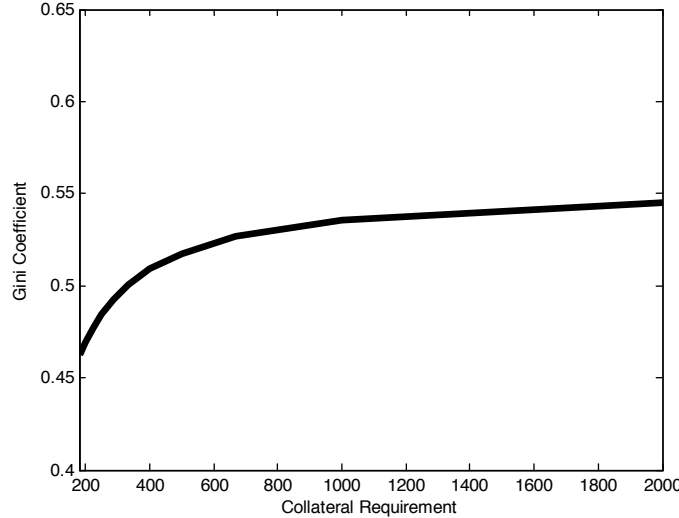


Figure 8: Gini Coefficient implied by increasing collateral requirements. Passive policy.

maximal inequality among agents, for instance only one person has all the income or consumption, and all others have none. In our case, we just have two levels of income, low and high, corresponding to the two agents in the model, entrepreneurs and households, respectively. Thus, we can use a simplified calculation of the Gini coefficient as follows: if the high income group is  $u$  % of the population and earns a fraction  $f$  % of all income, then the Gini coefficient is  $f - u$ .<sup>39</sup> We approximate wealth of each individual by their consumption in the steady state.

Figure 8, showing the Gini coefficient implied by each level of collateral requirements, conveys the above results. As collateral requirements increase, the Gini coefficient becomes larger, meaning that inequality goes up.<sup>40</sup> Therefore, even though using a passive policy may be a priori a good way of introducing macroprudential tools when there is data uncertainty, it has to be taken into account that, as a side-effect, inequality increases permanently. This is not the case though with active policy. As shown in Figure 9, under an active policy, Gini coefficient improves temporarily—given the positive shock—but it goes back to the (same) steady state after a few quarters.

<sup>39</sup>For example, if the richest represent a 20% of total population and have 80% of all income, this would lead to an income Gini coefficient of 60%. Or, an often cited case, if 1% of all the world's population owns 50% of all wealth, this means a wealth Gini coefficient of 49%. See Litchfield (1999).

<sup>40</sup>We have adjusted the proportion of entrepreneurs (borrowers) to match the initial Gini coefficient close to the average value in LIDCs.



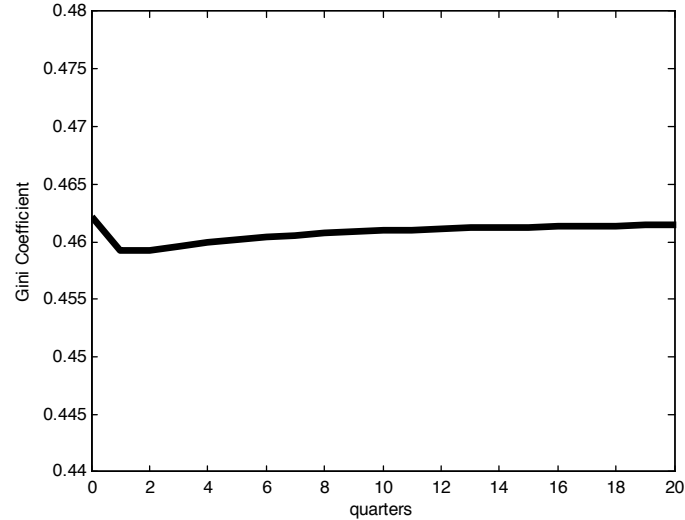


Figure 9: Gini Coefficient. Active policy, complete information.

## 6 Welfare

In this section, we present welfare gains associated with changes in policy. Our welfare measure in the stochastic model, as mentioned earlier, would include volatilities and steady-values of consumption (of entrepreneurs and households) and labor (of households). To disentangle the impact of changes in volatilities and steady states, for the passive policy, we also present the results from the deterministic model.

### 6.1 Active Policy with Complete Information

In terms of welfare, figure 10 displays welfare gains from increasing the aggressiveness of the macroprudential rule. We can observe that entrepreneurs benefit from the macroprudential policy because it delivers a more stable financial system, as also shown in figure 3. However, although this policy does not entail a long-run output cost, it implies a cost in the short run. Savers, whose consumption is not directly affected financial stability, are worse off because of the cost in terms of output, even if it occurs in the short run. In the aggregate, the economy is better off with the measure.

### 6.2 Active Policy with Incomplete Information

Welfare losses from active policy under incomplete information are presented in figure 11. This policy is welfare decreasing, especially for more aggressive rules, confirming the fact that a more financially

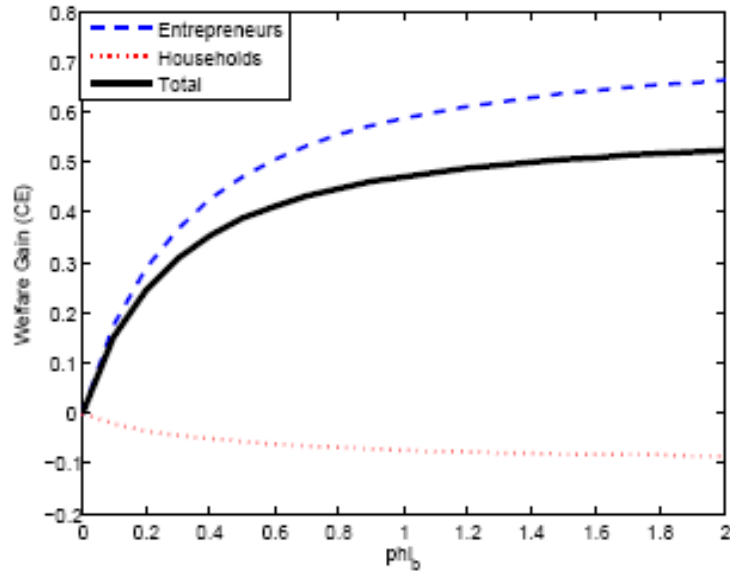


Figure 10: Welfare gains for different values of the reaction parameter. Active policy, complete information.

unstable scenario is created. With this policy we do not even observe a welfare trade-off among agent—the active policy generates more instability in general makes all agents worse off and hence it is not welfare enhancing for anyone in our set up. Implementing an active policy, which is desirable in the case of complete information, is welfare decreasing if taken with the noisy and lagged data.

### 6.3 Passive Policy

The welfare gains implied by the passive policy (Figure 12) are consistent with the above mentioned effects on financial stability and output cost. Increasing collateral requirements implies increasing financial stability and this benefits entrepreneurs. Entrepreneurs welfare directly depends on the volatility of consumption, which in turn, given the collateral constraint, is a direct function of the volatility of borrowing, our proxy for financial stability. The collateral constraint holds with equality in this model and therefore, entrepreneurial consumption is determined by the amount of loans that firms can take. Thus, even though increasing the collateral requirement represents an output cost, as seen in Figure 6, entrepreneurs are better off given the improvement in financial stability (Figure 5). For savers though, this is not the case. Savers are worse-off with the measure because their consumption does not depend on financial stability. In the aggregate, however, the economy benefits from the increase in financial stability, mainly coming from the entrepreneurs' side.

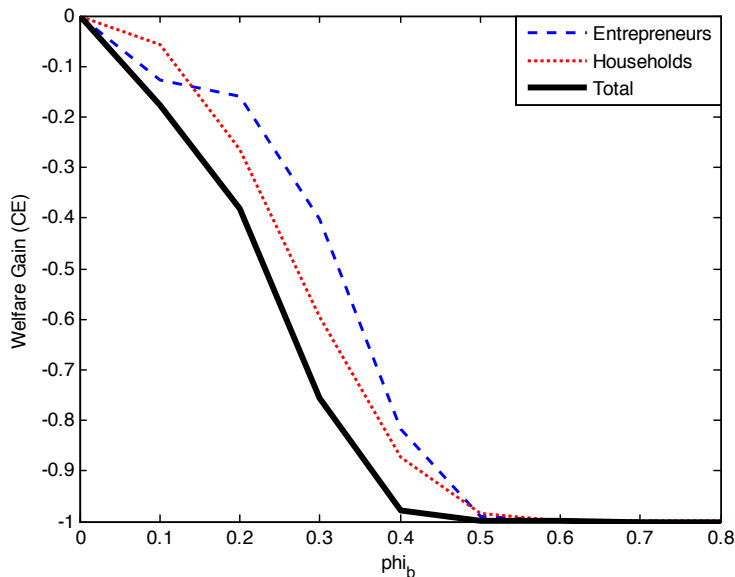


Figure 11: Welfare gains for different values of the reaction parameter. Active policy, incomplete information.

In order to disentangle the welfare effects associated with changes in the steady state, we present figure 13. This figure displays the welfare gains for the deterministic case, which represents the change in the steady state due to the policy. We see that in this case, entrepreneurs are worse off. This is because, as we have seen, when applying the policy, borrowing and output decrease permanently, and this cut is unevenly distributed. Entrepreneurs end up in a steady state with less consumption and households slightly benefit, that is, inequality increases. Therefore, there is a welfare loss for entrepreneurs and a welfare gain for households. In the aggregate, welfare is slightly increasing, reflecting the fact that there is a redistribution of welfare among agents.

## 7 Policy Comparison

In this section we present a detailed comparison of different ways of implementing macroprudential policy. As in Angelini et al. (2014) and other studies, the existence of macroprudential regulator is not microfounded in this paper. Rather, we take a positive approach in our evaluation, since as it presents a broader view of the costs and benefits of macroprudential policy which may not be fully captured by the utility function of agents. We take the existence of the collateral constraint and the financial policy as given and compare policies in terms of financial and macroeconomic volatility, as well as inequality,

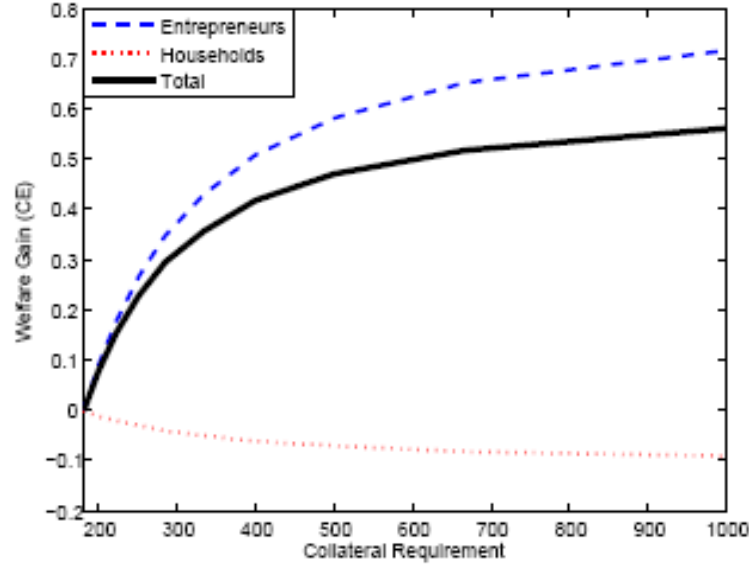


Figure 12: Welfare gains implied by increasing collateral requirement. Stochastic model (Second order approximation). Passive policy.

and (utility-based) welfare.<sup>41</sup> Hence, we consider that the objective of the macroprudential policymaker is to minimize the volatility in the economy without compromising well-being of economic agents, which we proxy by welfare and inequality. We will rank policies using these criteria.

## 7.1 Macroeconomic and Financial Stability

In this subsection we study the implications of the different policies for financial and macroeconomic stability, as well as for the steady state of the economy, both under complete and under incomplete information. We consider that a policy is preferable when it implies higher stability without a macroeconomic cost.

Figure 14 shows how financial stability changes with the collateral requirement for passive policy (the black dashed line). For the active policy we consider both the cases of complete and incomplete information. The active rule with complete information corresponds to the black solid horizontal line. The active rule with incomplete information is represented by the green dashed-dotted horizontal line. For both rules we present the standard deviation of credit implied by a reaction parameter of 0.5. The lines are horizontal because financial stability does not depend on the collateral requirement, since at the steady state, it remains constant at the initial calibrated value. We also present in the graph, what we

<sup>41</sup>This analysis could be comparable to using Taylor curves to rank monetary policies. Taylor curve, or policy frontiers, display the trade-off between inflation and output stabilization, so that a policy that reduces the volatilities of these variables the most is preferred. See for instance Iacoviello (2005), among others, for such evaluations.

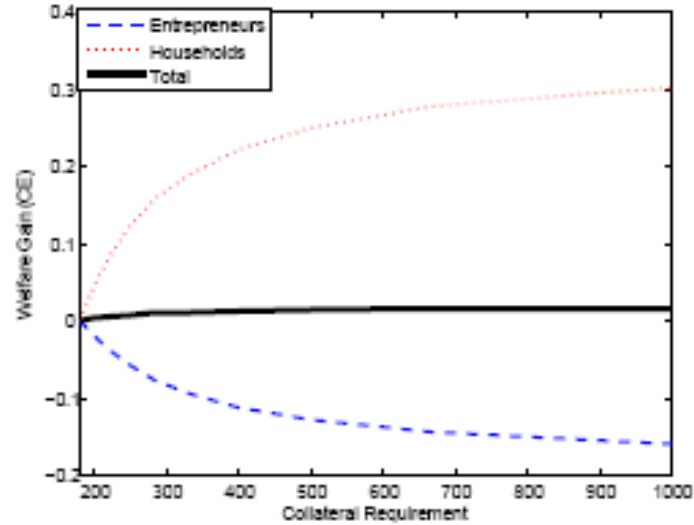


Figure 13: Welfare gains implied by increasing collateral requirement. Deterministic model. Passive policy.

have called the "cautious rule," that is, the rule with incomplete information with a reaction parameter of 0.1, for which financial instability is not increasing with the policy but its effectiveness is limited. This "cautious rule" corresponds to the red dotted line.

Furthermore, figure 14 also displays the steady-state values of borrowing and output for both the passive and the active rules (blue and black triangles, respectively). In turn, the black and blue circles correspond to the respective steady states of output.

From the graph, we can see that the active rule with complete information is preferred to the passive rule, in the sense that it implies a lower variability of borrowing, for plausible parameters of the collateral requirement. Furthermore, apart from the active rule being preferable from the point of view of financial stability, it does not have associated a long-term steady-state cost in terms of borrowing and output. In order for the passive rule to achieve the same financial stability as the active rule, the collateral requirement would have to go permanently as high as 833 percent, which would imply a steady-state output of 1.74 (an output loss of 5.1%)<sup>42</sup>. However, if there is incomplete information, things change. The active rule under incomplete information always delivers higher variability of borrowing than a passive approach, even though the latter entails a long-run output cost. For the "cautious rule," the active rule is preferred to the passive rule up to a value of the collateral requirement of approximately 312

<sup>42</sup>These results are in line with the general consensus that time-varying rules should be preferred to passive ones in advanced economies.

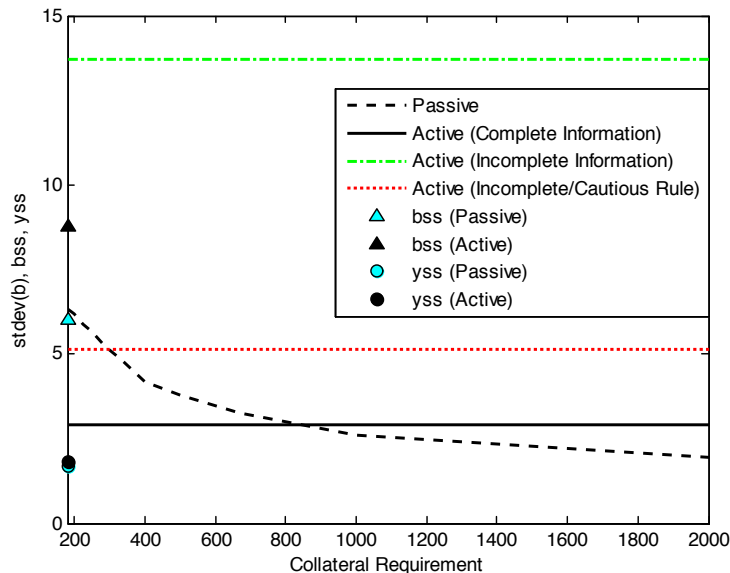


Figure 14: Collateral Requirements and Financial Stability. Active versus Passive.

percent. The "cautious rule" under incomplete information is able to deliver higher financial stability than the case with no macroprudential policies but its effectiveness is limited with respect to a more aggressive rule with complete information.<sup>43</sup>

**Table 2: Policy Comparison. Volatilities and Steady States**

	Benchmark	Active (Complete Inf)	Active (Incomplete Inf)	Passive
$\sigma_b$	6.31	2.91	13.72	5.15
$\sigma_y$	2.69	1.72	3.56	2.17
$b_{SS}$	8.75	8.75	8.75	6.03
$y_{SS}$	1.83	1.83	1.83	1.80

Table 2 shows the standard deviations of borrowing and output, as a proxy for financial and macroeconomic stability, for the benchmark (with no macroprudential policy) and for the passive and active rules (both complete and incomplete information).<sup>44</sup> As for the impulse responses, for the active rule, we consider a reaction parameter of 0.5. For the passive rule, we again take the average increase of the

<sup>43</sup>Quantitative results should be taken with some caution since the rule is not optimally implemented and the value of the noise is not calibrated to a specific case. We focus on the point that with a plausible parameter of the reaction parameter and a large enough shock, results under the complete information case may be reversed in the case of lagged and noisy data.

<sup>44</sup>For robustness, we also check the standard deviation of credit growth. We find that with respect to the benchmark (0.70), both the active rule with complete information and the passive rule deliver a lower standard deviation (0.67 and 0.69, respectively). The active rule with incomplete information delivers the highest volatility (1.73).

collateral requirement implied the macroprudential rule for the first 20 periods (of the impulse responses) and approximate a permanent equivalent increase as a passive macroprudential policy.

Table 2 also presents the steady-state values of borrowing and output, in order to have a sense of the long-run cost that each policy has associated. With complete information, an active rule is preferred to a passive rule in terms of both macroeconomic and financial stability, since the standard deviation of borrowing and output decreases with respect to the benchmark case with no macroprudential policy. Furthermore, the rule does not imply a long-run cost for the economy, since the steady-state values of these two variables remain the same. However, under incomplete information, a passive approach would be more advisable for the objective of attaining a low variability of credit and output, even though it generates a long-run steady-state cost in terms of output and borrowing.<sup>45</sup>

Apart from their impact macroeconomic and financial stability, distributional consequences of alternative policies may be of interest, especially in LIDCs where reducing inequality remains a top policy priority. We take up this issue in the next section.

## 7.2 Welfare and Inequality

Figure 15 compares the total welfare gains (entrepreneurs and households) for the three policies: passive, active with complete information and active with incomplete information. We can observe that the passive policy is preferred to the active one only if collateral requirements increase to more than 400%. However, if there is incomplete information, the policy always generates losses and the passive policy would always be preferable. Nevertheless, as we have seen, this latter policy implies a long-run output cost that is unevenly distributed among agents and increases inequality. This is captured by the welfare calculated for the changes in the steady state (deterministic case).

In Table 3 we present the exact welfare values and inequality implications corresponding to each policy:

---

<sup>45</sup>This result is analogous to the monetary policy literature with noisy data. In this literature, when the economy is difficult to monitor, it is better to adopt more cautious rules (See Orphanides, 2003). Aoki (2013) finds similar results.

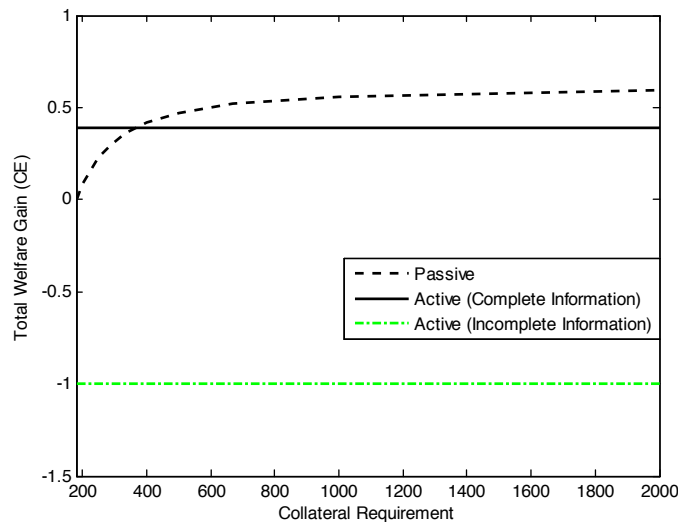


Figure 15: Collateral Requirements and Welfare gains. Active versus Passive.

**Table 3: Policy Comparison. Welfare and Inequality**

	Benchmark	Active (Complete)	Active (Incomplete)	Passive
Welfare gain	-	0.38	-0.99	0.22
$c_{SS}$	0.19	0.19	0.19	0.15
$c'_{SS}$	6.34	6.34	6.34	6.53
Gini	0.46	0.46	0.46	0.48

We see that the active policy is preferred to the passive one, in terms of welfare, only under complete information. Otherwise, a passive approach is more advisable but at the cost of generating more inequality in the economy. Indeed, there is a cost in steady-state consumption with passive policy and this is distributed differently among agents. In particular, consumption of entrepreneurs (borrowers), which can be proxied as the poor people of the economy, drops. However, consumption for households goes up, implying an increase in inequality. This result is supported by the Gini coefficient, which is higher for the case of the passive policy.

## 8 Concluding Remarks

In this paper we use a DSGE model to analyze the alternative ways of implementing macroprudential policy in LIDCs. In particular, we focus on the passive versus active implementation of the policy under different information assumptions. In our set-up, passive policy implies increasing collateral requirements



permanently. An active policy is represented by a countercyclical rule on collateral requirements that respond to expected deviations of credit from its steady state. However, for LIDCs, we consider that this indicator may be observed with a noise and/or with a lag.

Results show that macroprudential tools are effective to reduce financial instability, since they lower the volatility of credit. We find that if the macroprudential regulator observes economic indicators timely and without an error, an active time-varying policy is preferred to a passive approach. An active policy, being countercyclical, is more effective to achieve financial stability without incurring in a long-run output cost. A passive policy, although it also improves stability of the financial system, is not as effective as an active one and it implies a permanently lower steady-state output.

However, under incomplete information—noisy and lagged data—, this may not be the case. Under these circumstances, a more cautious (less aggressive) policy or a passive approach may be more advisable for macroeconomic and financial stability, though at the expense of a long-run output cost that is not evenly distributed among agents. We find that a passive policy increases inequality in the economy.

Welfare results are in line with these findings. Macroprudential tools, since they imply a more stable financial system, are welfare enhancing for the constrained group because their consumption volatility directly depends on the variability of borrowing. Looking at the welfare values, we conclude that the active policy is preferred to the passive one, only under complete information. In a situation with incomplete information, commonly observed in LIDCs, passive approaches are preferable but reduce welfare of entrepreneurs due to lower steady-state consumption.

The results from the paper therefore point toward the need for a more careful approach toward the passive macroprudential tools which is usually advocated for LIDCs. Long-run output, inequality and welfare implications of such tools could outweigh their macroeconomic and financial stability benefits. Instead, it is more advisable for these countries to step up further the efforts to reduce data and capacity problems which, alongside the improvements in the policy framework and implementation, would allow them to better monitor financial systems and be able to use time-varying approaches more effectively. As they make progress on these fronts, a less aggressive response to financial sector developments could be desirable.

---

## References

- [1] Angelini, P., Neri, S., Panetta, F., (2014), The Interaction between Capital Requirements and Monetary Policy, *Journal of Money, Credit and Banking*, 46 (6)
- [2] Angeloni, I., Faia, E., (2013) ‘Capital regulation and monetary policy with fragile banks.’ *Journal of Monetary Economics* 60 (3), pp. 311–324
- [3] Aoki, Kosuke (2003), "On the optimal monetary policy response to noisy indicators," *Journal of Monetary Economics*, Vol. 50, pp. 501–523
- [4] Arregui, N., Beneš, J., Krznar, I., Mitra, S., and Oliveira Santos A., (2013), Evaluating the Net Benefits of Macroprudential Policy: A Cookbook, IMF Working Paper 13/167
- [5] Ascari, G., Ropele, T., (2009), Disinflation in a DSGE Perspective: Sacrifice Ratio or Welfare Gain Ratio?, Kiel Institute for the World Economy Working Paper, 1499
- [6] Attanasio, O., Pistaferri, L., (2016), "Consumption Inequality," *Journal of Economic Perspectives*, 30 (2), pp. 1–27
- [7] Baldini, A., Beneš, J., Berg, A., Dao, M. C., and Portillo, R., (2015), "Monetary Policy in Low Income Countries in the Face of the Global Crisis: A Structural Analysis," *Pacific Economic Review* 20 (1)
- [8] Beck, T., Maimbo, S. M., (2013), *Financial Sector Development in Africa*, The World Bank
- [9] Benigno, P., Woodford, M., (2008), *Linear-Quadratic Approximation of Optimal Policy Problems*, mimeo
- [10] Bernanke, B. S., Gertler, M., and Gilchrist, S., (1999), “The Financial Accelerator in a Quantitative Business Cycle Framework,” *Handbook of Macroeconomics*, ed. J. B. Taylor and M. Woodford, Vol. 1C, pp. 1341–93
- [11] Dabla-Norris, E., Ji, Y., Townsend, R., and Unsal, D.F., Identifying Constraints to Financial Inclusion and their Impact on GDP and Inequality: A Structural Framework for Policy, IMF Working Paper, 15/22
- [12] Gottschalk, R., (2014), Institutional Challenges for Effective Banking Regulation and Supervision in Sub-Saharan Africa, ODI Working Paper 406

- [13] Griffith-Jones, S., Gottschalk, R., Spratt, S., (2015), *Achieving Financial Stability and Growth in Africa*, Routledge book
- [14] Iacoviello, M., (2005), "House Prices, Borrowing Constraints and Monetary Policy in the Business Cycle," *American Economic Review*, Vol. 95 (3), pp. 739-764.
- [15] Iacoviello, M., Minetti, R., (2006), "International Business Cycles with Domestic and Foreign Lenders," *Journal of Monetary Economics*, Vol. 53, No. 8, pp. 2267-2282
- [16] IMF (2014) (a), *Proposed New Grouping in WEO Country Classifications: Low-Income Developing Countries*, IMF Policy Paper
- [17] IMF (2014) (b), *Staff Guidance Note on Macroprudential Policy*, IMF Staff Papers
- [18] IMF (2014),(c), *Redistribution, Inequality, and Growth*, IMF Staff Discussion Note
- [19] Kannan, P., Rabanal, P., Scott, A.M., (2012), *Monetary and Macroprudential Policy Rules in a Model with House Price Booms*, *The B.E. Journal of Macroeconomics*, 12 (1)
- [20] Kiyotaki, N., Moore, J., (1997), "Credit Cycles." *Journal of Political Economy*, 105(2), pp. 211–48
- [21] Litchfield, J. (1999)., *Inequality: Methods and Tools*, The World Bank
- [22] Martinez, J., Rabanal, O., Unsal, D.F., "Credit Markets and Macroprudential Policy in Low-Income and Developing Countries", forthcoming IMF working paper.
- [23] Masson, P., (2014), *Macroprudential Policies, Commodity Prices and Capital Inflows*, Bis Paper 76
- [24] Mendicino, C., Pescatori, A., (2007), *Credit Frictions, Housing Prices and Optimal Monetary Policy Rules*, mimeo
- [25] McCallum (2001), "Should Monetary Policy Respond Strongly to Output Gaps?," *American Economic Review*, 91(2), pp. 258-262
- [26] Monacelli, T., (2006), "Optimal Monetary Policy with Collateralized Household Debt and Borrowing Constraint," in conference proceedings "Monetary Policy and Asset Prices" edited by J. Campbell
- [27] Orphanides, Attanasios (2003), "Monetary Policy Evaluation With Noisy Information," *Journal of Monetary Economics*, Vol. 50, No. 3, pp. 605–631

- [28] Portillo, R., Unsal, D. F., O'Connell, S., Pattillo, C., "Operational Frameworks, Signaling and the Transmission of Monetary Policy in Low-Income Countries," *Monetary Policy in Sub-Saharan Africa*, Rafael Portillo and Andrew Berg (eds), forthcoming Oxford University Press.
- [29] Rabanal, P., (2004), *Monetary Policy Rules and the U.S. Business Cycle: Evidence and Implications*, IMF Working Paper WP/04/164
- [30] Rubio, M., Carrasco-Gallego, J.A., (2014), "Macroprudential and monetary policies: Implications for financial stability and welfare," *Journal of Banking & Finance*, Elsevier, vol. 49 (C), pp. 326-336
- [31] Schmitt-Grohe, S., Uribe, M., (2004), "Solving Dynamic General Equilibrium Models Using a Second-Order Approximation to the Policy Function," *Journal of Economic Dynamics and Control*, 28, 755-775
- [32] Schmitt-Grohé, S., Uribe, M., (2007), "Optimal simple and implementable monetary and fiscal rules," *Journal of Monetary Economics* 54, pp. 702–1725
- [33] Unsal, D. F., (2013), "Capital Flows and Financial Stability: Monetary Policy and Macroprudential Responses," *International Journal of Central Banking*, 9(1), pp. 233-285