

# Capital Regulation, Monetary Policy, and Financial Stability\*

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This paper examines the roles of bank capital regulation and monetary policy in mitigating procyclicality and promoting macroeconomic and financial stability. The analysis is based on a dynamic stochastic model with imperfect credit markets. Macroeconomic stability is defined in terms of a weighted average of inflation and output-gap volatility, whereas financial stability is defined in terms of three alternative indicators (real house prices, the credit-to-GDP ratio, and the loan spread), both individually and in combination. Numerical experiments associated with a housing demand shock show that in a number of cases, even if monetary policy can react strongly to inflation deviations from target, combining a credit-augmented interest rate rule and a Basel III-type countercyclical capital regulatory rule may be optimal for promoting overall economic stability. The greater the degree of policy interest rate smoothing, and the stronger

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the policymaker's concern with financial stability, the larger is the sensitivity of the regulatory rule to credit growth gaps.

JEL Codes: E44, E51, F41.

"Preserving financial stability is so closely related to the standard goals of monetary policy (stabilizing output and inflation) that it ... seems somewhere between foolish and impossible to separate the two functions."

Alan S. Blinder,  
"How Central Should the Central Bank Be?" (2010, p. 12)

"Ensuring financial stability requires a redesign of macroeconomic as well as regulatory and supervisory policies with an eye to mitigating systemic risks. For macroeconomic policies, this means leaning against credit and asset price booms; for regulatory and supervisory policies, it means adopting a macroprudential perspective."

Bank for International Settlements,  
"79th Annual Report" (2009, p. 14)

## 1. Introduction

The recent crisis in global financial markets has led to a substantial number of proposals aimed at strengthening the financial system and at encouraging more prudent lending behavior in upturns. Many of these proposals aim to mitigate the alleged procyclical effects of Basel II capital standards. Indeed, several observers have argued that by raising capital requirements in a contracyclical way, regulators could help to slow credit growth and choke off asset-price pressures before a crisis occurs. A recent proposal along these lines, put forward by Goodhart and Persaud (2008), involves essentially adjusting the Basel II capital requirements to take into account and act at the relevant point in the economic cycle.<sup>1</sup> In particular, in the

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<sup>1</sup>Buiter (2008) extended the Goodhart-Persaud proposal by suggesting that capital and liquidity requirements be applied to all highly leveraged financial institutions, not only banks.

Goodhart-Persaud proposal, the capital adequacy requirement on mortgage loans would be linked to the rise in both mortgage lending and house prices.<sup>2</sup> The Turner Review (See Financial Services Authority 2009) also favors countercyclical capital requirements, and so do Brunnermeier et al. (2009), who propose to adjust capital adequacy requirements over the cycle by two multiples—the first related to above-average growth of credit expansion and leverage, the second related to the mismatch in the maturity of assets and liabilities.<sup>3</sup> At the policy level, there has been concrete progress toward establishing new standards in this area; the Basel Committee on Banking Supervision (BCBS) has developed a countercyclical framework that involves adjusting bank capital in response to excess growth in credit to the private sector, which it views as a good indicator of systemic risk. On November 12, 2010, G20 leaders adopted BCBS's proposal to implement a countercyclical capital buffer ranging from 0 to 2.5 percent of risk-weighted assets, as part of the new Basel III framework (see Basel Committee on Banking Supervision 2010).

At the same time, the global financial crisis has led to renewed calls for central banks (and regulators) to consider more systematically potential trade-offs between the objectives of macroeconomic stability and financial stability, or equivalently whether the central bank's policy loss function (and therefore its interest rate response) should account explicitly for a financial stability goal. The issue is not new; it has long been recognized, for instance, that an increase in interest rates aimed at preventing the development of inflationary pressures may, at the same time, heighten uncertainty and foster volatility in financial markets. The debate (which predates the recent crisis) has focused on the extent to which monetary policy should respond to perceived misalignments in asset prices, such as

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<sup>2</sup>Goodhart and Persaud argue that their proposal could be introduced under the second pillar of Basel II. While Pillar 1 consists of rules for requiring minimum capital against credit, operational, and market risks, Pillar 2 is supposed to take into account all the additional risks to which a bank is exposed, in order to arrive at its actual capital needs. However, by using only Pillar 2 at the discretion of local regulators, it can allow banks to engage in regulatory arbitrage.

<sup>3</sup>Although not as explicit, Blinder (2010) has also endorsed the view that central banks should try to limit credit-based bubbles through regulatory instruments (rather than interest rates) and refers to it as possibly becoming the "new consensus" on how to deal with asset-price bubbles.

real estate and equity prices.<sup>4</sup> In that context, several observers have argued that trying to stabilize asset prices per se is problematic for a number of reasons—one of which being that it is almost impossible to know for sure whether a given change in asset values results from changes in underlying fundamentals, non-fundamental factors, or both. By focusing on the *implications* of asset-price movements for credit growth and aggregate demand, the central bank may be able to focus on the adverse effects of these movements—without getting into the tricky issue of deciding to what extent they represent changes in fundamentals.

This paper is an attempt to address both sets of issues in a unified framework. We examine the role of both monetary policy and a capital regulation rule that bears close similarity to some recent proposals to mitigate the procyclical tendencies of financial systems, and we evaluate their implications for macroeconomic stability and financial stability—defined in terms of the combined volatility of inflation and the output gap, on the one hand, and the volatility of a measure of potential financial stress, on the other. We do so under a Basel II-type regime, with endogenous risk weights on bank assets. Among the issues that we attempt to address are the following: to promote financial stability, how should countercyclical bank capital requirement rules be designed? Instead of adding a cyclical component to prudential regulation, shouldn't policymakers use monetary policy to constrain credit growth directly? To what extent should regulatory policy and monetary policy be combined to ensure both macroeconomic and financial stability? Put differently, are these policies complementary or substitutes?

Quantitative studies of these issues are important for a number of reasons. Regarding the design of countercyclical bank capital rules, several observers have noted that there are indeed significant potential practical problems associated with their implementation—including the period over which relevant financial indicators (credit growth rates, for that matter) should be calculated. More important perhaps is the possibility that these rules may operate in counterintuitive ways, depending on the degree of financial-sector

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<sup>4</sup>See, for instance, Chadha, Sarno, and Valente (2004), Filardo (2004), Akram, Bardsen, and Eitrheim (2006), Faia and Monacelli (2007), and Akram and Eitrheim (2008). Wadhvani (2008) provides a brief overview of the literature.

imperfections. In particular, in countries where bank credit plays a critical role in financing short-term economic activity (as is often the case in developing economies), a rule that constrains the growth in overall credit could entail a welfare cost. At the same time, of course, to the extent that it succeeds in reducing financial volatility and the risk of a full-blown crisis, it may also enhance welfare. The net benefits of countercyclical bank capital rules may therefore be ambiguous in general and numerical evaluations become essential.

Regarding the role of monetary policy, the key issue is whether a central bank with a preference for output and price stability can improve its performance with respect not only to these two objectives but also to financial stability, by responding to excessive movements in credit and/or asset prices in addition to fluctuations in prices and activity. In a relatively complex model, understanding the conditions that may lead to trade-offs among objectives often requires quantitative experiments.

To conduct our analysis, we extend the New Keynesian model described in Agénor, Alper, and Pereira da Silva (2012). Important features of that model are that it accounts explicitly for a variety of credit market imperfections and bank capital regulation.<sup>5</sup> A housing sector is introduced, and the role of real estate as collateral examined. Specifically, we establish a direct link between house prices and credit growth via their impact on collateral values and interest rate spreads on loans: higher house prices enable producers to borrow and invest more, by raising the value of the collateral that they can pledge and improving the terms at which credit is extended. This mechanism is consistent with the evidence suggesting that a large value of bank loans to (small) firms, in both industrial and developing countries, is often secured by real estate. To capture financial

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<sup>5</sup>There is a small but growing literature on the introduction of capital regulation in New Keynesian models with banking; recent papers include Aguiar and Drumond (2007), Dib (2009, 2010), Hirakata, Sudo, and Ueda (2009), Gerali et al. (2010), and Meh and Moran (2010). Some contributions have also attempted to integrate countercyclical regulatory rules in this type of model; they include Kannan, Scott, and Rabanal (2009), Levieuge (2009), Angeloni and Faia (2010), Covas and Fujita (2010), Darracq Pariès, Kok Sorensen, and Rodriguez Palenzuela (2010), and Angelini, Neri, and Panetta (2011). However, as is made clear later, our approach differs significantly from all of these contributions, making comparisons difficult.

instability, we consider three alternative indicators, both individually and in combination: real house prices, the credit-to-GDP ratio, and the loan spread.<sup>6</sup> This is also in line with the literature suggesting that financial crises are often preceded by unsustainable developments in the real-estate sector and private-sector credit, and a large increase in bank interest rate spreads.<sup>7</sup>

In this context we examine the implications of two alternative policy rules for economic stability: a standard Taylor-type interest rate rule augmented to account for credit growth and (in line with the Basel III regime) a countercyclical regulatory rule that relates capital requirements also to credit growth. Our numerical experiments show that even if monetary policy can react strongly to inflation deviations from target, combining a credit-augmented interest rate rule and a Basel III-type countercyclical capital regulatory rule may be optimal for promoting overall economic stability. The greater the degree of interest rate smoothing, and the stronger the policymaker's concern with financial stability (when measured in terms of either the credit-to-GDP ratio and/or loan spread volatility), the larger is the sensitivity of the regulatory rule to credit growth gaps.

The paper continues as follows. Section 2 presents the model. We keep the presentation very brief, given that many of its ingredients are described at length in Agénor, Alper, and Pereira da Silva (2012); instead, we focus on how the model presented here departs from that paper, especially with respect to the financial sector and countercyclical policy rules. The equilibrium is characterized in section 3. Key features of the steady state and the log-linearized version, as well as a brief discussion of an illustrative calibration, are discussed in section 4. We present in section 5 the impulse response functions associated with our base experiment: a temporary, positive housing demand shock. Section 6 discusses the two alternative countercyclical rules alluded to earlier, involving an augmented monetary policy rule and a capital regulatory rule, both defined in terms of deviations

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<sup>6</sup>The concept of financial stability has remained surprisingly elusive in the existing literature; see Goodhart (2006). Our focus in this paper is on alternative, operational, quantitative measures of financial instability.

<sup>7</sup>See Calderón and Fuentes (2011) and International Monetary Fund (2011). Gerdesmeier, Reimers, and Roffia (2010) found that credit aggregates also play a significant role in predicting asset-price busts in industrial countries.

in credit growth and aimed at promoting stability. Section 7 investigates whether the use of these rules (taken in isolation) generates gains in terms of both financial and macroeconomic stability, that is, whether they entail a trade-off among objectives; to do so we present simulation results of the same housing demand shock under both types of rules, for some specific parameter values. Section 8 discusses optimal policy rules, when the objective of the central bank is to minimize volatility in a measure of “economic stability,” defined as a weighted average of separate measures of macroeconomic stability and financial stability. Section 9 provides some sensitivity analysis. The last section provides a summary of the main results and discusses the implications of our analysis for the ongoing debate on reforming bank capital standards.

## 2. Outline of the Model

The core model presented in this paper departs from Agénor, Alper, and Pereira da Silva (2012) essentially by introducing a housing market and linking it with collateral and loans for investment purposes. To save space, this section provides only a brief outline of the model in most respects—except for bank regulation and the optimization problem of the bank, for which a more formal analysis is presented.<sup>8</sup>

We consider a closed economy populated by six types of agents: infinitely lived households, intermediate good (IG) producers, a final good (FG) producer, a capital good (CG) producer, a monopoly commercial bank, the government, and the central bank, whose mandate also includes bank regulation. The final good is homogeneous and can be used either for consumption or investment, although in the latter case additional costs must be incurred.

There are two types of households, constrained and unconstrained.<sup>9</sup> *Constrained households* do not participate in asset markets and follow a rule of thumb which involves consuming all their

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<sup>8</sup> A detailed, formal presentation of the model is available in the working paper version of this article, which is available upon request.

<sup>9</sup> As discussed later, the distinction between these two types of households is useful to understand the dynamics of consumption following housing demand shocks. See Agénor and Montiel (2008) for a discussion of why consumption smoothing may be imperfect in the context of developing countries.

after-tax disposable wage income in each period. They also supply labor inelastically. *Unconstrained households* consume, can trade in asset markets and hold financial assets (including nominal debt issued by the bank), and supply labor to IG producers. As in Iacoviello (2005), Silos (2007), and Iacoviello and Neri (2008), housing services are assumed to be proportional to their stock, which enters directly in the utility function. These households also make their housing stock available, free of charge, to the CG producer, who uses it as collateral against which it borrows from the bank to buy the final good and produce capital. At the beginning of the period, unconstrained households choose the real levels of cash, deposits, bank debt, government bonds, and labor supply to IG firms. They receive all the profits made by the IG producers, the CG producer, and the bank, and pay a lump-sum tax.

Optimization yields a standard Euler equation and a standard labor supply function, which relates hours worked positively to the real wage and negatively to consumption. It also yields three asset demand equations: the first relates the real demand for cash positively to consumption and negatively to the opportunity cost of holding money, measured by the interest rate on government bonds; the second relates the real demand for deposits positively to consumption and the deposit rate, and negatively to the bond rate; and the third is the demand for bank debt,  $V_t^d$ , which is given by

$$\frac{V_t^d}{P_t} = \Theta_V^{-1} \left( \frac{i_t^V - i_t^B}{1 + i_t^B} \right), \quad (1)$$

where  $\Theta_V \geq 0$  denotes an adjustment cost parameter that captures transactions costs associated with changes in household holdings of bank capital,  $P_t$  the price of the final good,  $i_t^B$  the bond rate, and  $i_t^V$  the rate of return on bank debt. Thus, the demand for bank debt depends positively on its rate of return and negatively on the bond rate. Similarly, there is a demand function for housing services, from which it can be established that a positive shock to preferences for housing leads (all else equal) to a rise in today's demand for housing.

The *FG producer's* optimization problem is specified in standard fashion. The final good, which is allocated to private consumption, government consumption, and investment, is produced by assembling a continuum of imperfectly substitutable intermediate



goods. The FG producer sells its output at a perfectly competitive price. Given the intermediate goods prices and the final good price, it chooses the quantities of intermediate goods that maximize its profits.

*IG producers* produce, using capital and labor, a distinct perishable good that is sold on a monopolistically competitive market. At the beginning of the period, each IG producer rents capital from the CG producer and borrows to pay wages in advance. Loans contracted for the purpose of financing working capital (which are short term in nature) do not carry any risk, and are therefore made at a rate that reflects only the marginal cost of borrowing from the central bank,  $i_t^R$ , which we refer to as the refinance rate. These loans are repaid at the end of the period. IG producers solve a two-stage problem. In the first stage, taking input prices as given, they rent labor and capital in perfectly competitive factor markets so as to minimize real costs. This yields the optimal capital-labor ratio. In the second stage, each IG producer chooses a sequence of prices so as to maximize discounted real profits, subject to adjustment costs à la Rotemberg (1982). The solution gives the adjustment process of the nominal price.

The *CG producer* owns all the capital in the economy and uses a linear technology to produce capital goods. At the beginning of the period, it buys the final good from the FG producer. These goods must be paid in advance; to purchase final goods, the CG producer must borrow from the bank. At the end of the period, loans are paid in full with interest. Thus, the total cost of buying final goods for investment purposes includes the lending rate,  $i_t^L$ . The CG producer combines investment goods and the existing capital stock to produce new capital goods, subject to adjustment costs. The new capital stock is then rented to IG producers. The CG producer chooses the level of the capital stock (taking the rental rate, the lending rate, and the price of the final good as given) so as to maximize the value of the discounted stream of dividend payments (nominal profits) to the household. The first-order condition for maximization shows that the expected rental rate of capital is a function of the current and expected loan rates, the latter through its effect on adjustment costs in the next period.

The *commercial bank* (which is owned by unconstrained households) also supplies credit to IG producers, who use it to finance their

short-term working capital needs. Its supply of loans is perfectly elastic at the prevailing lending rate. To satisfy capital regulations, it issues nominal debt at the beginning of time  $t$ , once the level of (risky) loans is known.<sup>10</sup> It pays interest on household deposits (at rate  $i_t^D$ ), the liquidity that it borrows from the central bank (at rate  $i_t^R$ ), and its debt. The maturity period of both categories of bank loans and the maturity period of bank deposits by unconstrained households is the same. In each period, loans are extended prior to activity (production or investment) and paid off at the end of the period. At the end of each period, the bank is liquidated and a new bank opens at the beginning of the next; thus, all its profits are distributed, bank debt is redeemed, and new debt is issued at the beginning of the next period to comply with prudential regulatory rules.

Formally, and abstracting from required reserves and holdings of government bonds, the bank's balance sheet is

$$L_t^F = D_t + V_t + L_t^B, \quad (2)$$

where  $D_t$  is household deposits,  $L_t^F$  total loans,  $L_t^B$  borrowing from the central bank (which covers any shortfall in resources), and  $V_t$  total capital held by the bank, given by

$$V_t = V_t^R + V_t^E, \quad (3)$$

with  $V_t^R$  denoting capital requirements and  $V_t^E$  excess capital.

Given that  $L_t^F$  and  $D_t$  are determined by private agents' behavior, the balance sheet constraint (2) can be used to determine borrowing from the central bank:

$$L_t^B = L_t^F - D_t - V_t. \quad (4)$$

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<sup>10</sup>Thus, capital consists therefore, in the Basel terminology, solely of "supplementary" or "tier 2" capital; there is no "core" or "tier 1" capital, that is, ordinary shares. In practice, to meet capital requirements, banks have often issued hybrid securities that are more like debt than equity. Data from the International Monetary Fund show that at the end of 2008 the average ratio of equity made up of issued ordinary shares to assets was only 2.5 percent for European banks and 3.7 percent for U.S. banks. However, under the new Basel III regime, the definition of capital in terms of common equity has been considerably tightened.

The bank is subject to risk-based capital requirements, imposed by the central bank. It must hold an amount of capital that covers an endogenous percentage of its risky loans.<sup>11</sup> Loans for working capital need bear no risk and are subject to a zero weight in calculating capital requirements. Thus, with  $\sigma_t^F$  denoting the risk weight on loans to the CG producer, capital requirements are given by

$$V_t^R = \rho_t \sigma_t^F L_t^{F,I}, \quad (5)$$

where  $\rho_t \in (0, 1)$  is the “overall” capital ratio, defined later, and  $L_t^{F,I}$  is loans for investment. As in Agénor and Pereira da Silva (2012), and in line with the “foundation” variant of the internal ratings-based (IRB) approach of Basel II, we relate the risk weight to the repayment probability of the CG producer estimated by the bank,  $q_t^F \in (0, 1)$ , because it reflects its perception of default risk.<sup>12</sup>

$$\sigma_t^F = \left( \frac{q_t^F}{\tilde{q}^F} \right)^{-\phi_q}, \quad (6)$$

where  $\phi_q > 0$  and  $\tilde{q}^F$  is the steady-state value of  $q_t^F$ . In the steady state, the risk weight is therefore normalized to unity.<sup>13</sup>

The bank is risk neutral and chooses both the deposit and lending rates, and excess capital, so as to maximize the present discounted

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<sup>11</sup>Because the bank is liquidated at the end of each period, it does not accumulate capital through retained earnings. This is in contrast to Angelini, Neri, and Panetta (2011), for instance.

<sup>12</sup>Under the IRB approach, the estimated credit risk—and the associated risk weights—are assumed to be a function of four parameters: the probability of default (PD), the loss given default, the exposure at default, and the loan’s maturity. Banks adopting the *advanced* variant of this approach must provide all four of these parameters from their own internal ratings models; those adopting the *foundation* variant provide only the PD parameter, with the other three parameters set externally by regulators. Appendix C in Agénor, Alper, and Pereira da Silva (2012) provides a justification for the reduced-form, constant elasticity specification shown in (6), based on Basel II formulas. See also Angeloni and Faia (2010), Covas and Fujita (2010), and Darracq Pariès, Kok Sorensen, and Rodriguez Palenzuela (2010).

<sup>13</sup>The standardized approach in Basel II can be modeled by making the risk weight a function of the output gap, under the assumption that ratings are procyclical, in a manner similar to Zicchino (2006) and Angeloni and Faia (2010), for instance. See Drumond (2009) and Panetta and Angelini (2009) for a discussion of the evidence on this issue.

value of its real profits.<sup>14</sup> Because the bank is liquidated and debt is redeemed at the end of each period, this optimization program boils down to a period-by-period maximization problem, subject to several constraints—the loan demand function from the CG producer, total credit, the balance sheet constraint (4), the definition of total capital (3), and the capital requirement constraint (5). In addition, the bank internalizes the fact that the demand for loans by the CG producer (supply of deposits by unconstrained households) depends negatively (positively) on the lending (deposit) rate, and takes the repayment probability of the CG producer, the value of collateral, capital requirements, prices, and the refinance rate as given.

Expected, end-of-period  $t$  profits in real terms, which are distributed at the beginning of period  $t + 1$ , are given by

$$\begin{aligned} & (1 + i_t^R) \left( \frac{L_t^{F,W}}{P_t} \right) + q_t^F (1 + i_t^L) \left( \frac{L_t^{F,I}}{P_t} \right) + (1 - q_t^F) \kappa p_t^H \bar{H} + \mu d_t \\ & - (1 + i_t^D) d_t - (1 + i_t^R) \left( \frac{L_t^B}{P_t} \right) - (1 + i_t^V) \left( \frac{V_t}{P_t} \right) + 2\gamma_{VV} \left( \frac{V_t^E}{P_t} \right)^{\phi_E}, \end{aligned} \quad (7)$$

where  $\kappa \in (0, 1)$ ,  $\gamma_{VV} \geq 0$ ,  $\phi_E \in (0, 1)$ , and  $\bar{H}$  is the exogenous supply of housing.<sup>15</sup> The second term in this expression on the right-hand side,  $q_t^F (1 + i_t^L) P_t^{-1} L_t^{F,I}$ , represents expected repayment on loans to the CG producer if there is no default. The third term represents what the bank expects to earn in case of default, that is, “effective” collateral, given by a fraction  $\kappa \in (0, 1)$  of “raw” collateral, that is, the housing stock. Coefficient  $\kappa$  can be viewed as a measure of efficiency of enforcement of debt contracts (see Djankov

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<sup>14</sup>To simplify matters, we solve only for the loan rate applicable to the CG producer. In principle, even if loans to IG producers carry no risk and are extended at the marginal cost of funds (the refinance rate), it should be assumed that the bank also determines it as part of its optimization problem—in which case the elasticity of the demand for working capital loans would affect the markup over the refinance rate. For simplicity, we have assumed directly that the cost of these loans is only  $i_t^R$ .

<sup>15</sup>Housing supply could be endogenized by adding a construction sector to the model. This would reduce the volatility of housing prices by allowing the housing stock to respond to demand shocks. However, given the time frame of the model, the assumption of exogenous supply is quite reasonable.

et al. 2008) or an inverse measure of anti-creditor bias in the judicial system (see Cavalcanti 2010). Note also that collateral is “marked to market,” a practice that has become prevalent in recent years and tends to magnify procyclicality in leverage.

The fourth term,  $\mu d_t$ , represents the reserve requirements held at the central bank and returned to the bank at the end of the period (prior to its closure). The term  $(1 + i_t^D)d_t$  represents repayment of deposits (principal and interest) by the bank, whereas the term  $(1 + i_t^R)P_t^{-1}L_t^B$  represents gross repayments to the central bank. The term  $(1 + i_t^V)V_t$  represents the value of bank debt redeemed at the end of the period plus interest.<sup>16</sup> The last term,  $2\gamma_{VV}(V_t^E/P_t)^{\phi_E}$ , captures the view that maintaining a positive capital buffer generates some benefits—it represents a signal that the bank’s financial position is strong and reduces the intensity of regulatory scrutiny (or degree of intrusiveness in the bank’s operations), which in turn reduces the pecuniary cost associated with providing the information required by the supervision authority; the restriction  $\phi_E < 1$  ensures a sensible solution (see Agénor, Alper, and Pereira da Silva 2012).<sup>17</sup>

The first-order conditions for maximization give

$$i_t^D = \left(1 + \frac{1}{\eta_D}\right)^{-1} i_t^R, \quad (8)$$

$$1 + i_t^L = \frac{(1 - \rho_t \sigma_t)(1 + i_t^R) + \rho_t \sigma_t(1 + i_t^V)}{(1 + \eta_F^{-1})q_t^F}, \quad (9)$$

<sup>16</sup>In the full version of the model presented in the working paper version of this article, we add a linear term in  $V_t$ , to capture the cost associated with issuing shares, which includes the cost of underwriting, issuing brochures, etc. The cost of issuing equity could of course be defined in a more general way, to account for the fact that (i) a positive capital buffer provides a signal to markets that the bank is healthy, and (ii) in recessions (expansions), market funding is more difficult (easier) to obtain.

<sup>17</sup>In Dib (2009, 2010), holding bank capital in excess of the required level also generates gains. An alternative approach, which has yet to be implemented (as far as we know) in New Keynesian models of the type discussed here, would be to introduce a “precautionary” demand for excess capital along the lines proposed by Repullo and Suarez (2009). In their framework, banks are unable to access equity markets in every period; by holding capital buffers today, they mitigate the possibility that their ability to lend in the future may be compromised by shocks to their earnings or aggregate economic conditions.

$$\frac{V_t^E}{P_t} = \left( \frac{\gamma_{VV}}{i_t^V - i_t^R} \right)^{1/\phi_E}, \quad (10)$$

where  $\eta_D$  is the interest elasticity of the supply of deposits to the deposit rate and  $\eta_F$  is the interest elasticity of the CG demand for loans (or investment) to the lending rate.

Equation (8) shows that the equilibrium deposit rate is a markup over the refinance rate. Equation (9) indicates that the gross lending rate depends negatively on the repayment probability and positively on a weighted average of the marginal cost of borrowing from the central bank (at the gross rate  $1 + i_t^R$ ) and the cost of issuing debt. Weights on each component of funding costs are measured in terms of the ratio of required capital to (risky) loans,  $\rho_t \sigma_t$  and  $1 - \rho_t \sigma_t$ .

Equation (10) indicates that an increase in the cost of issuing debt,  $i_t^V$ , reduces excess capital, whereas an increase in  $\gamma_{VV}$  raises excess capital. With  $\gamma_{VV} = 0$ , holding capital beyond what is required brings no benefit, so  $V_t^E = 0$  for all  $t$ . Finally, an increase in required capital, by raising the cost of issuing bank debt  $i_t^V$ , has an indirect, negative effect on the desired level of excess capital. There is therefore some degree of substitutability between the two components of bank capital.

As in Agénor, Alper, and Pereira da Silva (2012), the repayment probability  $q_t^F$  is taken to depend positively on the effective collateral-CG loan ratio (which mitigates moral hazard on the part of borrowers), the cyclical position of the economy (as measured by the output gap), and the bank's capital-to-risky-assets ratio, which increases incentives for the bank to screen and monitor its borrowers:

$$q_t^F = \left( \frac{\kappa P_t^H \bar{H}}{L_t^{F,I}} \right)^{\varphi_1} \left( \frac{V_t}{L_t^{F,I}} \right)^{\varphi_2} (y_t^G)^{\varphi_3}, \quad (11)$$

with  $\varphi_i > 0 \ \forall i$  and  $y_t^G = Y_t/\bar{Y}_t$  is the output gap, with  $\bar{Y}_t$  denoting the frictionless level of aggregate output.<sup>18</sup> Our specification is

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<sup>18</sup>This “semi-reduced-form” approach to modeling the loan spread has been adopted in some other contributions, such as Cúrdia and Woodford (2010). In Agénor and Pereira da Silva (2011), the repayment probability is endogenously determined as part of the bank's optimization process. Specifically, they assume that the bank can affect the repayment probability on its loans by expending

thus consistent with the “double moral hazard” framework developed in Chen (2001), Aikman and Paustian (2006), and Meh and Moran (2010), among others, according to which banks have greater incentives to screen and monitor borrowers when more of their capital (relative to their outstanding loans) is at stake.<sup>19</sup> The novelty here is that we assume explicitly that greater monitoring translates into a higher probability of repayment.<sup>20</sup> Indeed, equations (9) and (11) imply a negative relationship between the capital-to-risky-assets ratio and bank lending spreads; direct support for this link is provided by Fonseca, González, and Pereira da Silva (2010) in a study of pricing behavior by more than 2,300 banks in ninety-two countries over the period 1990–2007. Note also that if net worth values are procyclical, both the collateral and the output-gap effects are consistent with the evidence suggesting that price-cost margins in banking, or lending spreads, behave countercyclically (see, for instance, Aliaga-Díaz and Olivero 2010 and Fonseca, González, and Pereira da Silva 2010, tables 6 and 9). Thus, in the model, the “bank capital channel” operates through two effects on the lending rate: a cost effect (through  $i_t^V$ ) and a monitoring incentive effect (through  $q_t^F$ ).

The *central bank’s* assets consist of a fixed stock of government bonds and loans to the commercial bank,  $L_t^B$ , whereas its liabilities consist of currency supplied to (unconstrained) households and firms. Any income made by the central bank from bond holdings and loans to the commercial bank is transferred to the government at the end of each period. Monetary policy is operated by fixing

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effort to select (ex ante) and monitor (ex post) its borrowers; the higher the effort, the safer the loan. Assuming that the cost of monitoring depends (inversely) not only on the collateral-investment loan ratio but also on the cyclical position of the economy and the capital-loan ratio yields a specification similar to (11).

<sup>19</sup>However, there are significant differences in the way bank capital is modeled; here, bank capital is motivated by regulatory requirements rather than by a “pure” moral hazard problem. Also, in Meh and Moran (2010) for instance, bank capital consists mostly of retained earnings.

<sup>20</sup>Mehran and Thakor (2011) and Allen, Carletti, and Marquez (2011) provide rigorous microfoundations for the link between bank capital and monitoring. In Allen, Carletti, and Marquez (2011), a monopoly bank holds capital because it strengthens its monitoring incentive and increases the borrower’s success probability, whereas in Mehran and Thakor (2011), bank capital increases the future survival probability of the bank (as in Repullo and Suarez 2009), which in turn enhances the bank’s monitoring incentives. The reduced-form approach that we use can be viewed as a convenient shortcut for macroeconomic analysis.

the refinance rate,  $i_t^R$ , and providing uncollateralized loans (at the discretion of the commercial bank) through a standing facility.<sup>21</sup> In the baseline experiment, the refinance rate is determined by a contemporaneous, Taylor-type policy rule:

$$i_t^R = \chi i_{t-1}^R + (1 - \chi)[\tilde{r} + \pi_t + \varepsilon_1(\pi_t - \pi^T) + \varepsilon_2 \ln y_t^G] + \epsilon_t, \quad (12)$$

where  $\tilde{r}$  is the steady-state value of the real interest rate on bonds,  $\pi^T \geq 0$  the central bank's inflation target,  $\chi \in (0, 1)$  a coefficient measuring the degree of interest rate smoothing, and  $\varepsilon_1, \varepsilon_2 > 0$  the relative weights on inflation deviations from target and the output gap, respectively, and  $\epsilon_t$  is a stochastic shock, which follows a first-order autoregressive process.

Finally, the *government* purchases the final good and issues nominal riskless one-period bonds. It collects tax revenues and all interest income that the central bank makes from its lending to the commercial bank and its holdings of government bonds. It adjusts lump-sum taxes to balance its budget.

Flows between agents (abstracting from the difference between constrained and unconstrained households) and the links between regulatory capital, the repayment probability, and the lending rate, are summarized in figures 1 and 2.

### 3. Equilibrium

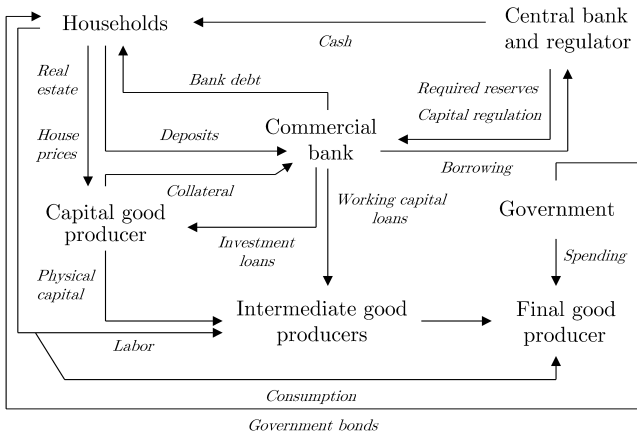
In a symmetric equilibrium, firms producing intermediate goods are identical. Equilibrium conditions must be satisfied for the credit, deposit, goods, labor, housing, bank debt, and cash markets. Because the supply of loans by the commercial bank and the supply of deposits by households are perfectly elastic at the prevailing interest

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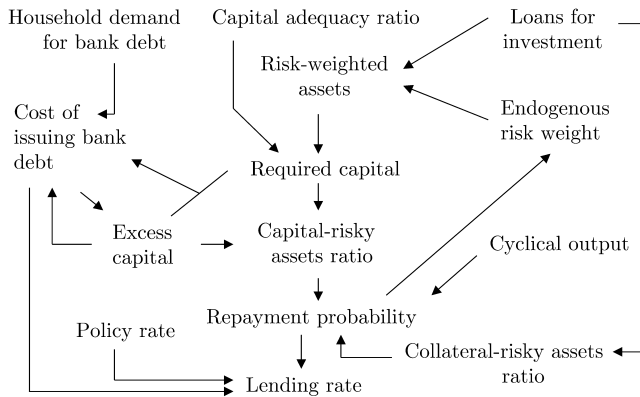
<sup>21</sup> Standing facilities are now commonly used in both high- and middle-income countries to create (narrow) corridors to bound departures of short-term money-market interest rates from target, with open-market operations used for the secondary objective of smoothing liquidity and moderating interest rate fluctuations. These facilities make the quantity of central bank cash endogenous by providing unlimited access—subject to collateral requirements and institutional rules on who is eligible to maintain current balances with the central bank—to extra cash at the posted interest rate. For simplicity, we abstract from collateral requirements (typically low-risk and low-yield assets such as government securities) and open-market operations, and consider a zero-width band around the target rate.



Figure 1. Flows between Agents



**Figure 2. Regulatory Capital, Repayment Probability, and Lending Rate**



rates, the markets for loans and deposits always clear. Equilibrium in the goods markets requires that production be equal to aggregate demand. The equilibrium condition of the market for bank debt is obtained by equating (1) and (3):

$$V_t^d = V_t^R + V_t^E. \quad (13)$$

#### 4. Steady State and Calibration

The steady state of the model is derived in appendix A (available from the authors upon request). With an inflation target  $\pi^T$  equal to zero, the steady-state inflation rate  $\tilde{\pi}$  is also zero. Beyond standard results (on the steady-state value of the marginal cost, for instance), the key results on the steady-state values of interest rates are as follows (with  $\tilde{\sigma}^F = 1$ , by implication of (6)):

$$\begin{aligned}\tilde{i}^B &= \tilde{i}^R = \frac{1}{\beta} - 1 = \tilde{r}, \quad \tilde{i}^D = \left(1 + \frac{1}{\eta_D}\right)^{-1} \tilde{i}^R, \\ \tilde{i}^V &> \tilde{i}^B, \quad \text{for } \Theta_V > 0\end{aligned}$$

and

$$1 + \tilde{i}^L = \frac{(1 - \rho)(1 + \tilde{i}^R) + \rho(1 + \tilde{i}^V)}{(1 + \eta_F^{-1})\tilde{q}^F},$$

where  $\beta \in (0, 1)$  is a discount factor.

From these equations it can be shown that  $\tilde{i}^B > \tilde{i}^D$ . We also have  $\tilde{i}^V > \tilde{i}^B$  for  $\Theta_V > 0$  because holding bank debt is subject to a cost; from the perspective of the household, the rate of return on that debt must therefore compensate for that and exceed the rate of return on government bonds. Of course, when  $\Theta_V = 0$ , then  $\tilde{i}^V = \tilde{i}^B$ . From the above results, and because  $\tilde{i}^B > \tilde{i}^D$ , we also have  $\tilde{i}^V > \tilde{i}^D$  for  $\Theta_V > 0$ ; bank capital is more costly than deposits (or, equivalently, households demand a liquidity premium), as in Aguiar and Drumond (2007). The reason here is that holding bank debt is costly.

To analyze the response of the economy to shocks, we log-linearize the model around a non-stochastic, zero-inflation steady state. The log-linearized equations are summarized in appendix B. A key property of the model is that deviations of real investment from its steady-state level depend on deviations in the lending rate, which depend themselves on deviations in the capital-to-risky-assets ratio. Thus, regulatory policy, just like monetary policy, has a direct effect on aggregate demand.

The calibration of the model, which we view as illustrative, dwells on Agénor and Alper (2012) and Agénor, Alper, and Pereira da Silva (2012) and is described in detail in appendix C. Table 1 summarizes

Table 1. Benchmark Calibration: Parameter Values

Parameter	Value	Description
<b>Household</b>		
$\beta$	0.985	Discount Factor
$\varsigma$	0.6	Elasticity of Intertemporal Substitution
$\eta_N$	1.5	Relative Preference for Leisure
$\eta_x$	0.02	Relative Preference for Money Holdings
$\eta_H$	0.02	Relative Preference for Housing
$\nu$	0.82	Share Parameter in Index of Money Holdings
$\Theta_V$	0.3	Adjustment Cost Parameter, Holdings of Bank Debt
$\varkappa$	0.3	Share of Constrained Households
<b>Production</b>		
$\theta$	10.0	Elasticity of Demand, Intermediate Goods
$\alpha$	0.65	Share of Labor in Output, Intermediate Good
$\phi_F$	74.5	Adjustment Cost Parameter, Prices
$\delta$	0.01	Depreciation Rate of Capital
$\Theta_K$	14	Adjustment Cost Parameter, Investment
<b>Bank</b>		
$\kappa$	0.06	Effective Collateral-Loan Ratio
$\gamma_K$	0.0	Weight of Capital Stock in Total Collateral
$\varphi_1$	0.03	Elasticity of Repayment Probability with Regard to Collateral
$\varphi_2$	0.0	Elasticity of Repayment Probability with Regard to Capital-to-Risky-Assets Ratio
$\varphi_3$	1.5	Elasticity of Repayment Probability Regard to Cyclical Output
$\varphi_q$	0.05	Elasticity of the Risk Weight with Regard to Probability of Repayment
$\gamma_B$	0.05	Cost of Adjustment, Bond Holdings
$\gamma_V$	0.08	Cost of Issuing Bank Capital
$\gamma_{VV}$	0.004	Benefit of Holding Excess Bank Capital
$\rho^D$	0.08	Capital Adequacy Ratio (Deterministic Component)
<b>Central Bank</b>		
$\mu$	0.1	Reserve Requirement Rate
$\chi$	0.0	Degree of Interest Rate Smoothing by Central Bank
$\varepsilon_1$	1.5	Response of Refinance Rate to Inflation Deviations
$\varepsilon_2$	0.15	Response of Refinance Rate to Output Gap
<b>Shocks</b>		
$\rho^\epsilon$	0.6	Degree of Persistence, Monetary Policy Shock
$\rho^H, \sigma_{\xi H}$	0.6, 0.002	Persistence/Standard Deviation, Housing Demand Shock

parameter values.<sup>22</sup> A few parameters are worth noting here; in particular, the adjustment cost parameter for holdings of bank debt,  $\Theta_V$ , is set at 0.3. The share of capital in output of intermediate goods is set at 0.35, whereas the elasticity of demand for intermediate goods is set at 10. Both values are close to those used by Medina and Soto (2007) for Chile. The adjustment cost for transforming the final good into investment,  $\Theta_K$ , is set at 14. The elasticities of the repayment probability with respect to the collateral-to-risky-loans ratio, the bank capital-to-risky-assets ratio, and cyclical output are set at  $\varphi_1 = 0.03$ ,  $\varphi_2 = 0.0$ , and  $\varphi_3 = 0.15$ , respectively.<sup>23</sup> Thus, in the benchmark calibration, we abstract from the “monitoring incentive effect” of the bank capital channel identified earlier. The value of  $\varphi_1$  is close to the elasticity of the external finance premium—the inverse of the repayment probability here—to leverage used by Liu and Seeiso (2012) for South Africa. The elasticities of the risk weight with respect to the repayment probability,  $\varphi_q$ , as well as the cost parameter  $\gamma_{VV}$  are set at low values, 0.05 and 0.004, respectively. Because  $\gamma_{VV}$  is a parameter that could potentially influence in important ways the transmission effects of capital requirements (and thus the performance of the countercyclical regulatory rule), we will later consider alternative values. Our specification of the risk weight (6) implies that its value is unity in the steady state; we set the overall capital adequacy ratio  $\rho$  to 0.08. We also calibrate the excess capital-to-risky-assets ratio to be equal to 0.04. This implies that the steady-state ratio of total bank capital to risky loans is set at about 12 percent (so that  $\tilde{V}^E/\tilde{V}^R = 0.53$ ), in line with the evidence reported in Agénor and Pereira da Silva (2012). For the monetary policy rule, we set  $\varepsilon_1 = 1.2$ ,  $\varepsilon_2 = 0.2$ , and  $\chi = 0.0$  initially, which is in line with the results for Latin America reported by Moura and de Carvalho (2010) and Cebi (2011) for Turkey. The share of government spending in output is set at 20 percent, a value consistent with the evidence for a number of middle-income countries, such as South

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<sup>22</sup>A more complete table is provided in a more detailed version of this article, available upon request.

<sup>23</sup>Higher values of  $\varphi_1$  destabilize the model very quickly. While this may not be inconsistent with recent facts, in the model this is also related to the fact that only housing is used as collateral. If physical capital could also be used for that purpose, it would be possible to increase  $\varphi_1$  quite substantially, as can be inferred from the results in Agénor and Alper (2012).

Africa (see Liu and Seeiso 2012). Our calibration also implies a total (corporate) credit-to-output ratio of about 60 percent, which is consistent with data for several middle-income countries where financial intermediation is bank based and consumer lending remains limited. The proportion of constrained households,  $\kappa$ , is set to 0.3.<sup>24</sup> For the degree of persistence of the housing demand shock, we assume a value of 0.6.

## 5. Housing Demand Shock

To illustrate the functioning of the model when concerns with financial stability are absent, we consider as a base experiment a positive temporary shock to housing preferences that translates into an impact increase in real house prices of 1.6 percentage points.<sup>25</sup> The results are summarized in figure 3, under two cases: the first under the calibration described earlier for the repayment probability, and the second where the probability of repayment is constant (so that  $\varphi_1 = \varphi_2 = \varphi_3 = 0$ ). This allows us to compare in a simple manner the response of the model with and without credit market frictions.

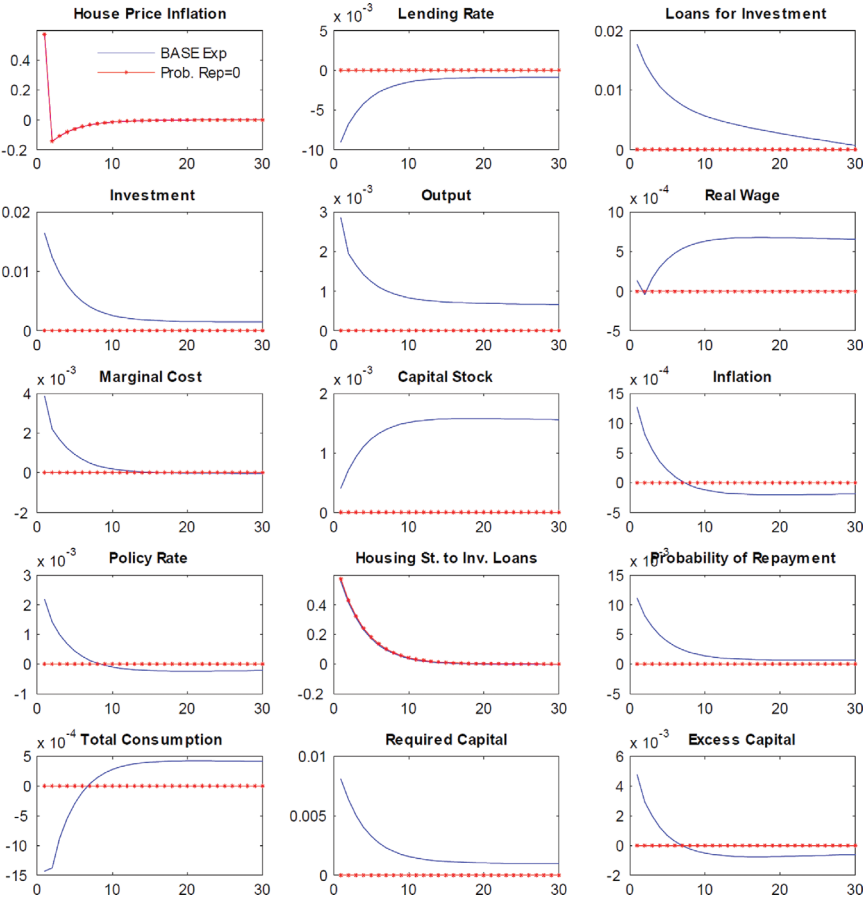
The immediate effect of the shock is to raise housing prices. In turn, this raises the value of collateral and, with credit market frictions, thus the repayment probability. The lending rate therefore drops, thereby stimulating investment in the first period. The increase in aggregate demand is matched by an increase in supply (given sticky prices) and this stimulates the demand for labor. Over time, the increase in investment raises the capital stock; this raises

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<sup>24</sup>This value is substantially lower than some of the results reported in Agénor and Montiel (2008). However, much of the early literature relates to developing countries in general (including therefore low-income countries) and does not account for the financial liberalization that has occurred in many middle-income countries over the past two decades. As a matter of comparison, note that the proportion of constrained households in the euro area estimated by Coenen and Straub (2005) varies between 0.25 and 0.37.

<sup>25</sup>Our goal is to illustrate the dynamics induced by a “fundamental” shock to asset prices, rather than unsustainable changes in expectations. Although the size and the persistence of the effect of our shock on house prices is not comparable to the much more persistent movements in these prices observed during typical booms, the qualitative effects are quite similar to those of a “standard” house-price bubble. A more formal attempt to model asset-price bubbles, involving more persistent shocks, could follow along the lines of Bernanke and Gertler (1999), as done in Levieuge (2009).

**Figure 3. Base Experiment: Positive Housing Demand Shock**  
(Deviations from Steady State)



**Note:** Interest rates, inflation rate, and the repayment probability are measured in absolute deviations; that is, in the relevant graphs, a value of 0.05 for these variables corresponds to a 5-percentage-point deviation in absolute terms.

the marginal product of labor and therefore gross wages. At the same time, the increase in the capital stock tends to lower the rental rate of capital.

The increase in output tends to raise immediately the policy rate; combined with the increase in the gross wage, this tends to

raise the effective cost of labor for the producers of intermediate goods.<sup>26</sup> Because the rental rate of capital does not change on impact (due to the one-period lag in capital accumulation), marginal costs unambiguously increase in the first period. Inflation therefore rises, putting further upward pressure on the policy rate. Over time, the reduction in the rental rate of capital induced by the boom in investment tends to lower marginal costs and inflation.

The higher policy rate (which translates into a higher deposit rate) is also accompanied by a higher interest rate on government bonds. The reason is that the increase in the deposit rate raises demand for these assets; this translates into a reduction in bank borrowing from the central bank. The reduction in money supply must be matched by a lower demand for currency, which is brought about by a higher bond rate. This leads to a shift in consumption from the present to the future for unconstrained consumers, who do not benefit directly from the collateral effect induced by higher house prices because they do not borrow from the banking system; moreover, the intertemporal effect in consumption dominates any wealth effect associated with a positive (but temporary) housing price shock. This downward effect dominates the positive response of spending by constrained consumers (given the increase in their labor income), so that aggregate consumption falls.<sup>27</sup> This mitigates the increase in aggregate demand induced by the initial investment boom. The drop in consumption reduces the marginal utility of leisure and induces unconstrained households to supply more labor, thereby mitigating the upward pressure on real wages.

The increase in the repayment probability lowers the risk weight under the Basel II-type regulatory capital regime that we consider, which tends to reduce capital requirements. However, the increase in risky assets (loans to the CG producer) dominates, which implies that required capital increases; in turn, this tends to raise the rate of return on bank debt. Given that the policy rate increases, the net

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<sup>26</sup>Recall that the effective cost of labor for IG producers is the gross refinance rate  $1 + i_R$  times the real wage.

<sup>27</sup>The fall in consumption, which lowers the demand for currency, attenuates the initial increase in the bond rate. A positive response of aggregate consumption could be obtained by increasing significantly the share of unconstrained households, compared with the base calibration. However, a consumption boom is *not* a stylized fact associated with periods of sustained increases in house prices; see Detken and Smets (2004) and International Monetary Fund (2011).

effect on the demand for excess bank capital is ambiguous in general; given our calibration, it actually increases. The increase in the cost of issuing bank debt mitigates the downward impact on the lending rate associated with the collateral effect. By contrast, in the absence of credit market frictions, the increase in real house prices exerts no collateral effect; the lending rate does not fall on impact, implying that investment does not increase. Because the shock is temporary, the wealth effect associated with higher house prices is muted, and the model does not display any significant dynamics.

Thus, the results of this experiment suggest that with endogenous credit market frictions the model is consistent with the view that a demand-induced boom in housing prices may lead, through a financial accelerator mechanism that operates through collateral values and borrowing costs, to rapid increases in investment, an expansion in output, inflationary pressures, and debt accumulation. Conversely, a bust in housing prices, through the same asset-price channel, can lead to a credit crunch, a contraction in output and investment, and deflation. Because our analysis focused on a temporary shock, the simulation results do not identify explicitly any tendency for instability; however, it is clear from our description of the transmission mechanism that a shock of sufficient duration could well induce unsustainable movements in real and financial variables, and thus economic instability, in the absence of a timely policy response. We now turn to an examination of the policies that could help to mitigate *financial* instability, and the extent to which doing so may entail trade-offs with respect to *macroeconomic* stability.

## 6. Policy Rules for Economic Stability

We now consider two alternative approaches to mitigating financial instability, in line with some recent proposals. The first involves adjusting the refinance rate in response to a financial stability indicator, whereas the second focuses on reducing the degree of procyclicality of the financial system through discretionary regulation of bank capital, in line with the new Basel III regime.

### 6.1 *An Augmented Interest Rate Rule*

In the first approach that we consider, the central bank adjusts its policy rate directly in response to changes in an indicator of financial



stability. Specifically, we replace the interest rate rule (12) with the augmented rule

$$i_t^R = \chi i_{t-1}^R + (1 - \chi)[\tilde{r} + \pi_t + \varepsilon_1(\pi_t - \pi^T) + \varepsilon_2 \ln y_t^G + \varepsilon_3(\Delta \ln l_t^{F,I} - \Delta \ln \tilde{l}^{F,I})] + \epsilon_t, \quad (14)$$

where  $\Delta \ln l_t^{F,I}$  (with  $l_t^{F,I} = L_t^{F,I}/P_t$ ) is the growth rate of real credit to the CG producer, and  $\Delta \ln \tilde{l}^{F,I}$  is the steady-state value of that variable.<sup>28</sup> Thus, in line with the discussion in the introduction, the central bank sets its refinance rate in part to “lean against the wind.” Following a positive shock to housing prices, for instance, and an increase in collateral values, the lending rate drops and stimulates investment; an increase in the refinance rate tends to mitigate the drop in the cost of bank borrowing and therefore to dampen the investment boom. We can analyze the performance of alternative interest rate rules (that is, different values of  $\varepsilon_3 > 0$ ) in terms of specific indicators of macroeconomic stability and financial stability, and compare them with the base case where  $\varepsilon_3 = 0$ .

## 6.2 A Countercyclical Regulatory Capital Rule

The second rule can be introduced by decomposing the overall capital ratio,  $\rho_t$ , into a “deterministic” component,  $\rho^D$ , and a cyclical component,  $\rho_t^C$ :

$$\rho_t = \rho^D + \rho_t^C. \quad (15)$$

Thus, the component  $\rho^D$  can be viewed as the minimum capital adequacy ratio imposed under Pillar 1 of the Basel regime, whereas the component  $\rho_t^C$  can be viewed as the “discretionary” adjustment that now forms part of the Basel III regime.<sup>29</sup> The experiment presented in the previous section assumed that  $\rho_t^C = 0$  and  $\rho_t = \rho^D \forall t$ .

<sup>28</sup>A possible alternative to real credit growth is *nominal* credit growth. However, the latter includes an inflationary component; thus, the benefits of responding to it via an interest rate rule might result from that component.

<sup>29</sup>In the ongoing debate about the implementation of Basel III, there is still discussion as to whether the countercyclical component should be made mandatory or left to the discretion of local regulators. See Repullo and Saurina (2011) and the final section for a critical discussion and some further comments.

Adjustment of the cyclical component follows a simple dynamic rule; we relate it only to deviations of the growth rate of real credit to the CG producer from its steady-state value:

$$\rho_t^C = \theta^C (\Delta \ln l_t^{F,I} - \Delta \ln \tilde{l}^{F,I}), \quad (16)$$

where  $\theta^C > 0$  is the adjustment parameter.<sup>30</sup> Thus, the macroprudential rule is designed so as to directly counter the easing of lending conditions that induces borrowers to take on more debt as house prices increase.

Suppose that in period  $t$  there is an increase in housing prices due to a demand shock. As discussed earlier, the rise in the value of collateral tends to raise the repayment probability immediately, which reduces the lending rate and stimulates borrowing for investment by the CG producer. The increase in house prices is therefore procyclical. A rule like (16), by imposing higher capital requirements, tends to raise directly the cost of issuing debt by the bank, thereby mitigating the initial expansionary effect associated with higher collateral values. Thus, it dampens procyclicality of the financial system. It is consistent with the spirit, if not the letter, of some of the recent proposals to amend or reform Basel II capital standards, such as Goodhart and Persaud (2008), as mentioned in the introduction, and the recently adopted rule under Basel III.<sup>31</sup>

Nevertheless, in the general equilibrium framework, whether the effect on the lending rate is positive or negative depends also on the *net* effect on the repayment probability, which depends (as noted earlier) not only on the collateral-CG loan ratio, but also on the cyclical position of the economy and the bank capital-to-risky-assets ratio. In particular, under the risk-sensitive regulatory regime that we consider, the increase in the repayment probability induced by the improvement in the collateral-to-risky-loans ratio lowers the risk weight and tends to reduce capital requirements. If the counter-cyclical regulatory rule is not too aggressive (in the sense that  $\theta^C$  is

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<sup>30</sup> Although the rule for  $\rho_t^C$  is not a backward-looking rule, we assume that the bank takes  $\rho_t$  as given when solving its optimization problem. Thus, the bank pricing rules derived earlier remain unchanged.

<sup>31</sup> The second dimension of the rule proposed by Brunnermeier et al. (2009), related to the mismatch in the maturity of assets and liabilities, cannot be implemented in our setup.

not too high), the capital-to-risky-assets ratio will fall, and this will tend to mitigate the initial rise in the repayment probability and the drop in the loan rate. If so, then, the monitoring incentive effect will operate in the same direction as the cost effect. By contrast, if the regulatory rule is very aggressive (high  $\theta^C$ ), total capital may increase by more than the increase in risky loans, and this may lead to a *higher* repayment probability and a *lower* lending rate, making the regulatory rule (16) *more*, rather than less, procyclical. Thus the conflicting effects of the two dimensions of the bank capital channel may make the policy counterproductive. Alternatively, if the benefit from holding capital buffers (as measured by  $\gamma_{VV}$ ) is not too large, the regulatory capital rule may be even more effective. To assess the most likely outcomes requires numerical simulations, based on some optimality criteria.

### 6.3 *Stability Measures and Policy Loss Function*

We assume in what follows that the central bank is concerned with two objectives, macroeconomic stability and financial stability. Both concepts, as noted earlier, can be defined in different ways; in this paper, we define macroeconomic stability in terms of a weighted average of the coefficient of variation of inflation and the output gap, with equal weights at first, and financial stability in terms of the coefficient of variation of three alternative indicators: real housing prices, the credit-to-GDP ratio, and the loan spread.<sup>32</sup> Empirical studies of banking crises in developing countries have indeed documented that large increases in credit often precede the occurrence of these crises (see Demirguc-Kunt and Detragiache 2005 and Agénor and Montiel 2008). We also consider composite measures involving all three indicators, and the last two only, given that they—unlike the first—are more directly related to the financial system. In addition, we also define a *composite index of economic stability*, defined first with a weight of 0.8 for macroeconomic stability and 0.2 for financial stability and second with a weight of 0.9 for macroeconomic stability. Thus we consider the case (which we believe to be

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<sup>32</sup>In turn, coefficients of variations are based on the asymptotic (unconditional) variances of the relevant variable.

the more relevant one in practice) where the central bank remains mainly focused on macroeconomic stability.<sup>33</sup>

## 7. Model Dynamics and Policy Trade-Offs

Before we study optimal policies, we begin with a simple examination of how the two rules (14) and (16) operate, independently of each other.

The upper panels in figure 4 show 3D diagrams of macroeconomic and financial stability indicators—measured, in the latter case, using the various indicators described earlier, individually and in combination. In all diagrams,  $\varepsilon_3$  varies between 0 and 2.5 (northwest horizontal axis) and  $\theta^C$  varies between 0 and 10 (northeast horizontal axis).

The outer contour of each graph corresponds to the “corner” cases where either  $\varepsilon_3 = 0$  or  $\theta^C = 0$ . They therefore show how the two rules affect our measures of (in)stability when the underlying shock is the same as described earlier—a positive shock to housing preferences. The outer contours suggest that there is no trade-off among policy objectives: a more aggressive response to credit growth gaps leads, in either case, to a monotonic reduction in *both* macroeconomic and financial volatility, regardless of the measure used.<sup>34</sup> Thus, from the perspective of either policy objective, monetary and countercyclical regulatory policies appear to be substitutes rather than complements.<sup>35</sup> However, the curves have a convex shape, which indicates that the marginal benefit of either policy diminishes as it becomes more aggressive. Indeed, the upper panels suggest that beyond a value of  $\varepsilon_3 = 0.6$ , the gain in terms of reduced

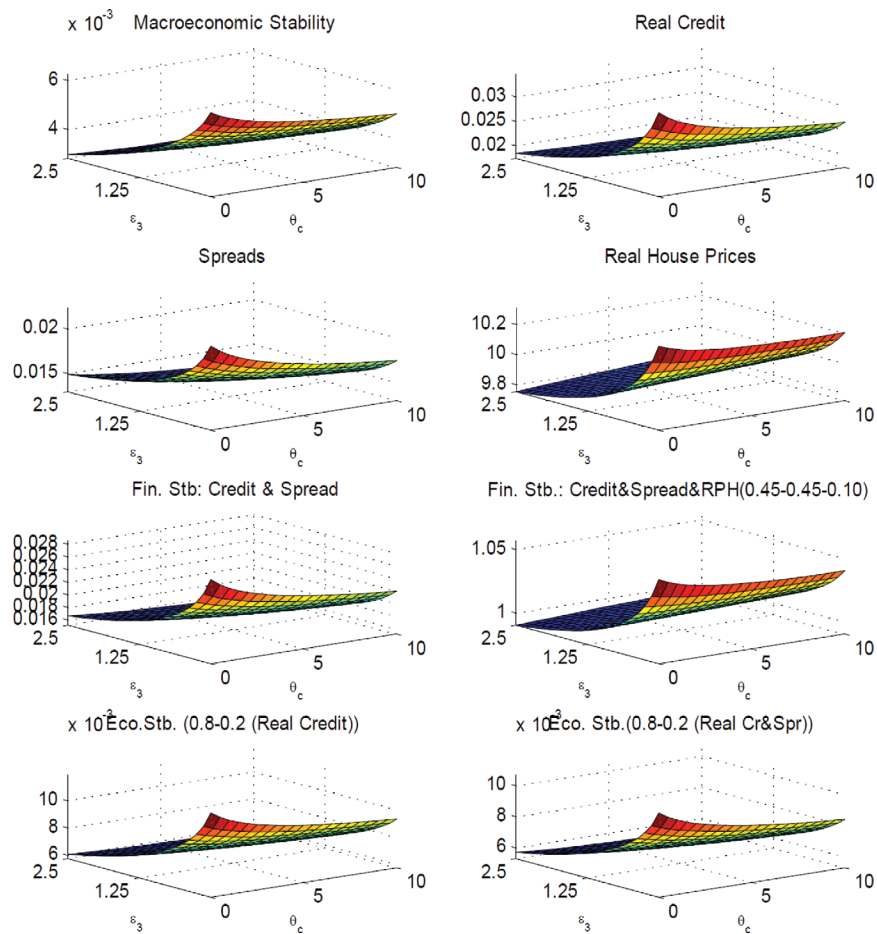
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<sup>33</sup>The policy loss function could also incorporate the volatility of the *change* in the policy rate, to capture the cost attached to nominal interest rate fluctuations. Because this would lead to more persistence, we account for that cost directly by considering different values of the parameter  $\chi$  in our experiments.

<sup>34</sup>Although not reported, the volatility of the refinance rate falls as well, as either policy rule becomes more aggressive. This is because a model with forward-looking private agents, such as this one, has strong expectational effects—households anticipate a stronger reaction from the central bank and factor it into their decision-making process. The result is that monetary policy works partly through the threat of a stronger response instead of actually delivering that stronger response.

<sup>35</sup>Note that the absence of trade-offs relates only to policy responses with respect to housing demand shocks and depends on the fact that we abstract from output-inflation trade-offs by focusing on the volatility of nominal income.

**Figure 4. Housing Demand Shock: Policy Rules and Macroeconomic/Financial Stability Trade-offs**



volatility become smaller; a similar result holds in the lower panels for  $\theta^C$  above 2 when real house prices are used, 2.5 when the credit-to-GDP ratio is used, and 4 when the loan spread is used.

The next step is to examine to what extent their *combination* leads to lower variability in either target. This is also illustrated in figure 4. The upper-level diagrams suggest clearly that, given our base calibration, the marginal contribution of the regulatory capital rule, once an augmented interest rate is in place, decreases rapidly,

in terms of either macroeconomic stability or financial stability. The lower-level diagrams also show the results for the economic stability index described earlier, when financial stability is measured in terms of either the credit-to-GDP ratio or a combination of the credit-to-GDP ratio and the loan spread. Not surprisingly, the results are qualitatively similar: given our base calibration, the marginal contribution of the regulatory capital rule to economic stability decreases rapidly once the augmented interest rate rule is used.

Put differently, countercyclical bank regulation may not provide very large benefits if monetary policy can be made more reactive to an indicator of financial stability. However, to the extent that monetary policy is constrained (because the central bank fears destabilizing markets by raising interest rates too sharply while inflation is subdued, for instance), there may be some degree of complementarity between the two rules: a countercyclical regulatory rule can help to improve outcomes with respect to both objectives. Put differently, the convexity of the curves shown in figure 4 suggests that, if there is a cost in implementing large changes in the policy rate, it may be optimal to combine the two policies.

## 8. Optimal Policies

We now consider how the parameters  $\varepsilon_3$  and  $\theta^C$  in the two rules (14) and (16) can be determined optimally, so as to minimize economic instability, as defined earlier. As can be inferred from figure 4, the fact that there is no trade-off among policy objectives, and that the augmented interest rate rule is more powerful in mitigating volatility, means that, in general, if there is no restriction on the value of  $\varepsilon_3$ , the optimal policy always implies setting  $\theta^C = 0$ . To generate a role for regulatory policy, suppose that the central bank chooses not to react beyond a certain point to changes in credit growth, out of concern that large *changes* in interest rates can generate instability. To account for this, we perform a set of experiments in which we arbitrarily limit the value of  $\varepsilon_3$  to a “plausible” upper limit, which we set at 2.5. At the same time, we impose a higher limit on the parameter  $\theta^C$ , equal to 10. Thus, our analysis is best described as a search for “constrained” optimal policies, with a relatively less aggressive potential response of monetary policy to credit growth gaps.

Tables 2 and 3 report the results. We calculate optimal values based on different sets of two other key parameters: the response

**Table 2. Housing Demand Shock: Optimal Policy Parameters (Relative Weight on Financial Stability: 0.1)**

$\varepsilon_1$				
$(\varepsilon_3, \theta_c)$		1.2	1.5	1.8
<i>Financial Stability Indicator: Real House Prices</i>				
$\chi$	0	2.5, 0	2.5, 0	2.5, 0
	0.4	2.5, 0	2.5, 0	2.5, 0
	0.8	2.5, 0	2.5, 0	2.5, 0
<i>Financial Stability Indicator: Credit-to-GDP Ratio</i>				
	0	2.5, 10	2.5, 7	2.5, 3
	0.4	2.5, 10	2.5, 7.5	2.5, 4
	0.8	2.5, 10	2.5, 9	2.5, 7
<i>Financial Stability Indicator: Loan Spread</i>				
	0	2.5, 10	2.5, 10	2.5, 6
	0.4	2.5, 10	2.5, 10	2.5, 7
	0.8	2.5, 10	2.5, 10	2.5, 10
<i>Financial Stability Indicator: Real Credit and Spread</i>				
	0	2.5, 10	2.5, 8.5	2.5, 4.5
	0.4	2.5, 10	2.5, 9	2.5, 5.5
	0.8	2.5, 10	2.5, 10	2.5, 10
<i>Financial Stability Indicator: Real Credit, Spread, Real House Prices (weight 0.1)</i>				
	0	2.5, 4	2.5, 0	2.5, 0
	0.4	2.5, 4	2.5, 0	2.5, 0
	0.8	2.5, 4	2.5, 2.5	2.5, 2

of the policy rate to deviations of inflation from target,  $\varepsilon_1$ , and the degree of persistence in the policy rate,  $\chi$ . In addition to the baseline value  $\varepsilon_1 = 1.2$ , we consider two other values, 1.5 and 1.8, which capture a more aggressive stance toward inflation. For the smoothing parameter, we consider, in addition to the baseline value  $\chi = 0.0$ , values of  $\chi = 0.4$  and  $\chi = 0.8$ ; again, these alternative values capture the view that underlying preferences reflect a concern

**Table 3. Housing Demand Shock: Optimal Policy Parameters (Relative Weight on Financial Stability: 0.2)**

$\varepsilon_1$				
$(\varepsilon_3, \theta_c)$		1.2	1.5	1.8
<i>Financial Stability Indicator: Real House Prices</i>				
$\chi$	0	2.5, 0	2.5, 0	2.5, 0
	0.4	2.5, 0	2.5, 0	2.5, 0
	0.8	2.5, 0	2.5, 0	2.5, 0
<i>Financial Stability Indicator: Credit-to-GDP Ratio</i>				
	0	2.5, 10	2.5, 7.5	2.5, 3.5
	0.4	2.5, 10	2.5, 8	2.5, 4.5
	0.8	2.5, 10	2.5, 10	2.5, 8.5
<i>Financial Stability Indicator: Loan Spread</i>				
	0	2.5, 10	2.5, 10	2.5, 10
	0.4	2.5, 10	2.5, 10	2.5, 10
	0.8	2.5, 10	2.5, 10	2.5, 10
<i>Financial Stability Indicator: Real Credit and Spread</i>				
	0	2.5, 10	2.5, 10	2.5, 6.5
	0.4	2.5, 10	2.5, 10	2.5, 8
	0.8	2.5, 10	2.5, 10	2.5, 10
<i>Financial Stability Indicator: Real Credit, Spread, Real House Prices (weight 0.1)</i>				
	0	2.5, 0	2.5, 0	2.5, 0
	0.4	2.5, 0	2.5, 0	2.5, 0
	0.8	2.5, 2	2.5, 0.5	2.5, 0.5

with movements in policy rates that are too large, possibly because the central bank believes that large movements can destabilize financial markets.<sup>36</sup> We calculate the value of the loss function defined

<sup>36</sup>Alternatively, high persistence in the policy rate is viewed as desirable because, as argued by Woodford (1999), it allows the government to commit to future inflation targets.



earlier for all values of  $\varepsilon_3$  varying between 0 and 2.5, and  $\theta^C$  varying between 0 and 10. We perform a grid search at intervals of 0.0125 for  $\varepsilon_3$  and 0.5 for  $\theta^C$ , which is quite large but sufficient to illustrate our main points.

When financial stability is measured in terms of financial indicators (the credit-to-GDP ratio and the loan spread, individually or in combination) the results can be summarized as follows. First, regardless of the degree of persistence in the policy rate, and regardless of the strength with which monetary policy can react to inflation deviations from its target value, it is always optimal to use monetary policy to its limit. Second, the stronger monetary policy can react to inflation deviations from its target value (the higher  $\varepsilon_1$  is), the lower should be the reliance on macroprudential policy, particularly so if the weight attached to financial stability in the policy loss function is small (0.1, rather than 0.2). Third, the greater the degree of interest rate smoothing (the higher  $\chi$  is, possibly because the central bank fears destabilizing markets by raising interest rates too sharply), the stronger should be the countercyclical regulatory response—even if monetary policy can react strongly to inflation. Fourth, the stronger the policymaker's concern with financial stability, the stronger should be the sensitivity of countercyclical regulation to the credit growth gap. The second result suggests that monetary and regulatory policies are partial substitutes, whereas the third result suggests that they are partial complements; even with aggressive responses to inflation and credit growth gaps, it is optimal to rely also on the countercyclical regulatory rule as the degree of interest rate smoothing increases.

When financial stability is measured in terms of real house prices (either individually or in combination with the other indicators), the first result continues to hold. The second and the third do not when the indicator is used individually, but when it is used in combination with a relatively low weight (0.1, compared with 0.45 for the others), the second holds when the degree of interest rate smoothing is high ( $\chi = 0.8$ ) and so does the third as  $\chi$  increases, regardless of the value of  $\varepsilon_1$ . Regarding the fourth, again it does not hold when real house prices are used individually, but when it is used in combination with the others (again, with a relatively low weight) and with a high degree of interest rate smoothing, we get what appears to be a counterintuitive result: the stronger the policymaker's concern

with financial stability, the *weaker* should be the sensitivity of countercyclical regulation to the credit growth gap. However, it is not clear that much weight should be attached to this result, because real house prices may not be the most reliable indicator of financial stability.<sup>37</sup>

## 9. Sensitivity Analysis

To assess the sensitivity of the previous results, we consider several additional experiments: a higher elasticity of the repayment probability to the capital-to-risky-assets ratio and the solution of optimal policy parameters in response to productivity and demand shocks.

### 9.1 Response to Capital-to-Risky-Assets Ratio

For the first experiment, we account for a monitoring incentive effect of the bank capital channel (as described earlier) by increasing the elasticity  $\varphi_2$  from its initial value of zero to 0.05. This alternative value is within the two-standard-error confidence interval for the elasticity of the bank loan spread with respect to the capital-to-risky-assets ratio estimated by Fonseca, González, and Pereira da Silva (2010) for developing countries.

The results (which are not reported here to save space) indicate that a stronger bank capital channel (operating through a monitoring incentive effect) strengthens the countercyclical regulatory rule in the presence of risk-sensitive weights. The reason is that following the housing price shock and the initial increase in the repayment probability (as discussed earlier), the weight on risky assets in our Basel II-type regime tends to fall; this lowers capital requirements and therefore tends to reduce the capital-to-risky-assets ratio. In turn, this mitigates the bank's incentives to monitor and *reduces* the repayment probability—thereby offsetting the initial increase in that variable and dampening the initial drop in the lending rate.

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<sup>37</sup> Another proxy for financial (in)stability, as proposed by Granville and Mallick (2009), is the volatility of the deposit-loan ratio. For more micro-based approaches to measuring financial instability, see De Graeve, Kick, and Koetter (2008), Blavy and Souto (2009), and Segoviano and Goodhart (2009).

Thus, a stronger bank capital channel (operating through monitoring and screening incentives) makes the countercyclical regulatory rule more effective.

## 9.2 *Productivity and Demand Shocks*

To assess the sensitivity of optimal policy choices to the nature of shocks, we considered first a positive productivity disturbance, taking the form of a one-percentage-point increase in the technology parameter that characterizes the production function of intermediate goods. The results (which are not shown to save space) indicate that in almost all cases monetary policy should be used to the fullest ( $\varepsilon_3 = 2.5$ ), and macroprudential policy not at all, regardless of the values of  $\varepsilon_1$  and  $\chi$ . The reason is fairly intuitive. With the housing preference shock discussed earlier, a change in real house prices has two immediate effects on the repayment probability: a collateral effect and a cyclical output effect. The countercyclical regulatory rule operates through both channels, as noted earlier. With a productivity shock, however, the first effect is absent on impact and remains muted subsequently, given that in our base calibration the elasticity of the repayment probability with respect to collateral is relatively small. The main channel through which macroprudential policy affects the repayment probability is through the cost of issuing bank capital—but its coefficient is relatively small in the loan interest-rate-setting condition. Thus, monetary policy (which has a large, direct effect on the cost of credit) is more effective to ensure macroeconomic and financial stability. This result continues to hold even with substantially higher values of the elasticity of the repayment probability with respect to the cyclical component of output.

Second, we considered an aggregate demand disturbance, taking the form of a temporary increase in the share of government spending in GDP, from an initial value of 0.2 to 0.22. The results (which, again, are not shown to save space) indicate that, as before, monetary policy should be used to the fullest, whereas in most cases macroprudential policy should be used—except, importantly, when the credit-to-GDP ratio is used as a measure of financial stability, in which case a mild response of the countercyclical capital rule appears to be optimal. The intuition for the general result is similar to what

occurs under the productivity shock; the absence of an initial collateral effect mitigates the magnitude of the impact effect of the shock. Thus, a general implication of this analysis is that the results obtained earlier with a housing preference shock, which militate in favor of the intensive use of macroprudential policy in a variety of policy parameter configurations, hold largely because the shock has a direct effect on collateral values.<sup>38</sup>

Finally, we also conducted some sensitivity analysis with respect to some of the parameters of the model. For lack of space we do not report the full simulation results here, but rather provide a brief intuition of their implications. First, we considered a higher adjustment cost parameter for investment,  $\Theta_K$ . This is a critical parameter because it affects investment demand and thus credit growth and output fluctuations. A higher value of  $\Theta_K$  implies a muted response of credit growth and output in response to shocks, thereby reducing the need for countercyclical monetary and regulatory policies. The value of  $\Theta_K$  also matters for the relative effectiveness of the two policy instruments. Because the policy rate affects the whole structure of interest rates in the economy whereas the regulatory rule directly impinges on the loan rate only, a change in the refinancing rate becomes more detrimental for consumption when the adjustment cost parameter is smaller. This helps to illustrate the view that changes in the policy rate may be too brutal to mitigate financial instability.

Second, we considered a higher value of the adjustment cost parameter for households' holdings of bank debt,  $\Theta_V$ . In the model, as discussed earlier,  $\Theta_V$  is the main determinant of the spread between the returns on bank debt and government bonds. Considering the fact that the interest rate on risky loans is a weighted average of the cost of bank capital and the policy rate (see (9)), and that the regulatory rule determines the weight attached to the cost of bank capital in the loan rate, this parameter plays a major role in the effectiveness of the regulatory rule. Indeed, simulation results

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<sup>38</sup> Another experiment that would have a direct effect on collateral values is a shock to  $\kappa$ , the proportion of physical assets that can be pledged as collateral. Note also that with lower values of  $\varphi_1$  and higher values of  $\varphi_3$ , the repayment probability would be relatively more responsive to movements in cyclical output, and macroprudential regulation could be more effective.

indicate that the higher the value of the adjustment cost of holding bank debt, the more effective the regulatory rule becomes.

Third, we considered a higher share of constrained households,  $\varkappa$ . This parameter has important implications for the responsiveness of consumption to interest rates. Small changes in the value of  $\varkappa$  do not have a large, quantitative impact on the results. However, large changes do matter for the effectiveness of countercyclical policies—especially changes in the policy interest rate. The reason, related to the point made earlier, is that the larger  $\varkappa$  is, all else equal, the lower is the effect of interest rates on consumption. In turn, when consumption becomes less responsive to changes in the policy rate, an interest rate rule operates mainly through investment demand—as is the case for a countercyclical regulatory rule. Thus, with a substantially higher share of constrained households in the economy, monetary and regulatory rules become more similar in terms of their effects on macroeconomic and financial stability.

Fourth, we examined the effects of a higher elasticity of the risk weight with respect to the probability of repayment,  $\varphi_q$ . This parameter plays a key role in determining the degree of procyclicality of a Basel II-type regime (see Agénor, Alper, and Pereira da Silva 2012): a higher elasticity with respect to the repayment probability magnifies fluctuations in regulatory capital. In turn, this translates into higher loan rates in bad times and lower loan rates in good times, resulting in a stronger response of both the policy rate and the countercyclical capital requirement, as both aggregate demand and credit growth fluctuate more. Moreover, the countercyclical capital regulation tool becomes more effective than the policy rate in smoothing out these fluctuations as it, in part, offsets procyclical movements in bank capital.

## 10. Summary and Policy Implications

The purpose of this paper has been to examine the roles of monetary policy and bank capital regulatory policy in mitigating procyclicality and promoting macroeconomic and financial stability. The analysis was based on a dynamic, structural optimizing macroeconomic model with imperfect credit markets and Basel-type bank capital regulation, with both cost and monitoring incentive effects. The

model incorporates also an asset-price/financial accelerator mechanism, by which induced changes in asset prices affect the value of the collateral pledged by borrowers and hence the cost of loans. Macroeconomic stability is defined in terms of the volatility of inflation and the output gap, whereas financial stability is defined in terms of the variability of three alternative indicators, used both individually and in combination: real house prices, the credit-to-GDP ratio, and the loan spread. Our basic experiment showed that with endogenous credit market frictions, a positive housing demand shock, through its effect on collateral values, leads to a credit expansion and an investment boom. This is consistent with the evidence and provides the proper “background” for discussing the roles of monetary and regulatory policies in achieving economic stability.

We next considered two policy rules aimed at mitigating financial instability: a credit-augmented interest rate rule and a Basel III-type countercyclical regulatory capital rule, both based on a “credit growth gap” measure. The premise for the first rule is that a central bank’s response to credit growth may serve to stabilize market conditions (namely, the lending rate) by offsetting the expansionary (balance sheet) effect induced by a positive shock to asset prices. The second rule is motivated by the view that capital regulation should be operated in a more flexible manner to account for changes in systemic risk over the business cycle. In both cases, the underlying view is that the expansion of credit is an essential ingredient in the buildup of imbalances in the financial system.

Numerical experiments with a housing demand shock showed, first, that there are no trade-offs between macroeconomic and financial stability objectives when each instrument is used in isolation. This is related to the fact that in our framework capital regulation is a fairly effective tool for constraining the growth in aggregate demand, because all investment is financed through bank loans. Second, if monetary policy cannot react sufficiently strongly to inflation deviations from targets—due to concerns about interest rate volatility feeding uncertainty about economic fundamentals, or because of fears that sharp changes in interest rates while inflation is low could induce volatility in price expectations and destabilize markets, for instance—combining a credit-augmented interest rate rule and a countercyclical capital regulatory rule is optimal for mitigating

economic instability. This result also holds if monetary policy can respond aggressively to inflation, as long as the degree of interest rate smoothing is high. Third, when financial stability is measured solely in terms of financial indicators, the greater the concern with financial stability (compared with macroeconomic instability) is, the larger the role of countercyclical regulation. Sensitivity analysis suggests that these results are specific to shocks that have a direct effect on collateral values. Put differently, whether macroprudential policy (in the form of a countercyclical capital rule) is effective or not depends on the nature of the shocks to which the economy is subject.

Although our analysis has been conducted in a middle-income country context, our results are useful for the current debate on the role of monetary policy in fostering financial stability and on reforming bank capital standards in both industrial and developing countries.<sup>39</sup> First, some observers have argued that, to the extent that credit growth affects output (as is the case in our model), there may be no reason for monetary policy to react above and beyond what is required to stabilize output and inflation. Our results suggest that this precept is not generally true. Second, as noted in the introduction, in November 2010 the G20, under proposition by the Basel Committee on Banking Supervision (2010), adopted a countercyclical capital buffer rule based on a credit-to-GDP gap measure. The fundamental idea underlying countercyclical regulation is that financial markets, left to themselves, are inherently procyclical. But even though (excessive) risk becomes apparent in bad times, it is mainly generated in boom times. Thus, the time for regulators to intervene is precisely during good times, to prevent excessive risk taking and moderate the growth in bank credit. By operating in a countercyclical fashion, financial regulation therefore helps ensure that banks build up resources in good times to help cushion adverse shocks in bad times. At the same time, it is important to implement countercyclical regulation through relatively simple rules that cannot be easily changed by regulators so they will not become “captured” by the general “exuberance” that characterizes booms nor by vested

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<sup>39</sup>Indeed, the credit market imperfections emphasized in this paper are a matter of differences in degree between developed and developing countries. See Agénor and Pereira da Silva (2010) for a more detailed discussion.

interests (see Brunnermeier et al. 2009). Our analysis suggests, however, that the benefits of these rules may also be less than believed if monetary policy can endogenously respond to (excessive) credit growth. It also casts doubt on the wisdom of making a countercyclical capital requirement component mandatory under Pillar 1 of the new Basel III regime; large structural differences across countries may make the attempt to impose a uniform rule problematic.

The analysis can be extended in several directions. First, as noted earlier, although financial instability is commonly associated with periods of booms and busts in asset prices and credit, there is no widely accepted definition and (hence) indicator of financial stability; in our analysis we used several indicators, both alternatively and in combination. But other indicators are also possible, as suggested by the empirical evidence.<sup>40</sup> More generally, it could be argued that financial instability is associated with fluctuations in several financial and real economic variables rather than in just asset prices. Financial stability may therefore be difficult to assess by merely focusing on a single or a limited set of either financial or real economic variables. A useful extension would be consequently to consider broad (or composite) indicators and examine how our results are altered. In particular, one could combine real house prices with a credit growth gap measure and bank lending rates to derive a *composite* indicator of financial instability, with weights on each individual variable based on the literature that measures the relative importance of each in predicting either banking crises (see Demirguc-Kunt and Detragiache 2005, and Agénor and Montiel 2008) or periods of financial stress (see Misina and Tkacz 2009).

Second, in the definition of our countercyclical regulatory capital rule, we included only loans to capital goods producers, on the grounds that loans for working capital needs are not risky. In practice, however, a legitimate question is whether such a distinction between components of credit can be meaningfully implemented, given well-known fungibility problems and the risk that differences in

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<sup>40</sup>See Segoviano and Goodhart (2009). In De Graeve, Kick, and Koetter (2008) for instance, financial stability is defined and measured as a bank's probability of distress according to the supervisor's definition of problem banks used for supervisory policy.



regulation may encourage banks to engage in distortive practices (see Hilbers et al. 2005). This is a particularly important consideration for middle-income countries, where the institutional and regulatory environment is often weak to begin with. If so, then, there may be little choice but to apply the regulatory rule on *total* credit—with possible adverse welfare effects, in countries where working capital needs represent a large share of bank loans.

Third, a more formal analysis of optimal rules, based on conditional discounted utility of the different categories of agents, would allow a more comprehensive study of the welfare effects of a credit-responsive monetary policy and countercyclical regulatory capital rules, in the presence of both macroeconomic and financial stability objectives.<sup>41</sup>

Finally, we must point out that our assessment of the benefits of countercyclical regulatory rules did not address implementation issues. In general, the implementation of macroprudential regulation requires stronger coordination (in countries where they are independent to begin with) between central banks and supervisory authorities. The issue of how best to achieve such coordination in practice remains a matter of debate. Another practical issue to consider is the extent to which the introduction of macroprudential rules may adversely affect the anti-inflation credibility of the central bank—a particularly important concern in countries where such credibility remains precarious. The risk is that the announcement of greater reliance on macroprudential regulation could give rise to expectations that the central bank may now pursue a more accommodative monetary policy in the face of inflationary pressures, thereby weakening its credibility. A transparent communications strategy that clarifies the nature of macroprudential rules and the way they are expected to operate, while emphasizing the fundamental complementarity between the “traditional” objectives of monetary policy and the goal of financial stability, may thus be essential.

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<sup>41</sup>Faia and Monacelli (2007), for instance, found that monetary policy should respond to increases in asset prices by *lowering* interest rates. In addition, when monetary policy responds strongly to inflation, the marginal welfare gain of responding to asset prices vanishes. However, Angeloni and Faia (2010) found opposite results.

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