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Monetary Policy and Financial Stability: Is There a Conflict?

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June 2010

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Introduction

The recent financial crisis posed challenges for academics and policy makers about monetary policy and motivated thinking about the interconnection between financial stability and monetary policy.

According to the conventional view prior to the crisis "there is no general trade-off between monetary and financial stability" (Issing, 2003). Likewise it was argued that a central bank (henceforth CB) "that was able to maintain price stability would also incidentally minimize the need for lender-of-last-resort" intervention (Anna Schwartz, 2000) This view also led to the argument (advanced by central bankers, Treasury officials and others) that conducting monetary policy and the regulation and supervision of banks and capital markets under one roof creates a potential for a conflict of interest. Therefore it is better to conduct them separately and even in independent institutions. In some countries like the UK, the responsibility for safeguarding financial stability was assigned to a special institution such as the FSA.

The recent crisis, however, vividly demonstrated that a financial crisis could occur even after a relatively long period of worldwide low inflation and even where the task of financial stability is separated from the central bank and assigned to a special institution. It seems, therefore, that the trend towards separation of the two functions may have to be reversed. Together monetary policy and financial regulation provide a large set of cyclical tools that may be best coordinated under the one roof of the CB, see Blanchard et al (2010).

Before the recent crisis it was also natural to view as orthogonal the basic tool of monetary policy- the key monetary policy rate (henceforth KPR) and the regulatory financial stability tools such as liquidity and bank capital requirements. The crisis has caused many to begin to pay closer attention to the interaction and the interrelation between the KPR and the regulatory tools aimed at safeguarding financial stability, and to rethink the wisdom of the institutional separation of monetary policy and financial stability. This wisdom has recently been challenged by Chairman Bernanke (2010) who argued that ”The Federal Reserve's participation in the oversight of banks of all sizes significantly improves its ability to carry out its central banking functions, including making monetary policy, lending through the discount window, and fostering financial stability,"

One of the important lessons of the recent financial crisis is that monetary and financial stability, and the instruments that are used to achieve them, are much more interrelated than thought previously. As recently stated succinctly by Paul Volcker (2010) "Monetary policy and concerns about the structure and condition of banks and the financial system more generally are inextricably intertwined".

It is now recognized that the long period during which CBs have kept low levels of key policy interest rates (KPR), which was justified by the general lower inflation rates in many countries, but without any compensating adjustments of the financial stability instruments, contributed thorough the "risk taking channel" to creating the financial imbalances which finally resulted the recent financial crisis [1]. At the same time, the disconnect between the KPR and interbank rates during the crisis, in many economies, clearly demonstrated the adverse impact that financial instability on the effectiveness of monetary policy.

The purpose of the present paper is to develop an analytical framework where aggregate risk is endogenous, the interaction between the CB monetary policy tool

[1] For a taxonomy of the various ways in which the risk-taking channel operates, see for example Rajan (2005), Borio and Zhu (2008) and Gamacorta (2009). For some empirical evidence of the existence of the risk taking channel, see Jimenez, Ongena and Saurina (2009).

and financial stability regulatory tools (such as capital and reserve requirements) are clearly laid out, and where possible trade-offs between price stability and financial stability can be clearly examined. We use this framework to shed light on the following policy questions: 1) In reaction to external shocks how does the pursuit of price stability conflict with financial stability and vice versa? 2) How is the efficacy of the transmission mechanism of monetary policy affected by financial stability policy instruments3) How can the possible conflict between price and financial stability be resolved or at least reduced?

We use the framework of a general equilibrium overlapping-generations model in which the CB pursues both price and financial stability. Price stability is defined as achieving a target inflation rate (IT) that is determined exogenously in our model. To that end the CB adjusts as necessary its key policy rate (KPR) in order to offset various shocks, which cause inflation to deviate from its target. In our model the KPR serves as the benchmark interest rate for the financial intermediation pricing.

Financial stability policy aims to prevent the systemic risk of run on banks, the collapse of financial intermediation and financial markets. It does so, in our model, by (i) reacting to changes in systemic risk (see definition below). (ii) Preserving the CB's capacity to maintain a credible predetermined partial deposit-insurance scheme. The proportion of deposit insurance is a predetermined ratio.

The capacity of the CB to prevent runs on financial intermediaries, in our model, is not unlimited however. It depends on two important factors. The first is size of the financial resources it commands, which in turn depends on the fiscal backing it receives and the institutional arrangements between the CB and the government. In the model below, the capital of the CB relative to the level of deposits and loans represents this capacity and is a key variable. The second relates to its lending operations. In our model CB lending is extended only against a safe collateral that are reserve requirements deposited at the CB. We address explicitly the limits to which CB's can expand their balance sheets in response to financial crisis. In the 2008 crisis the Federal Reserve, the European Central Bank, the Bank of England and other CB have not only expanded their balance sheets on a very large scale, but have also, by acquiring non-government obligations (such as commercial paper in the US), exposed themselves to unprecedented levels of credit risk. This risk impinges adversely on their operational independence and should thus be an integral part of an analysis that considers the interaction between monetary and financial stability[2]. (See Buiter 2010).

We develop a banking model in which savings are intermediated to finance real investments. Financial intermediaries (FI) are subject to both reserve and capital requirements in order to deal with their exposure to risk externalities. FI impose a leverage constraint on their borrowers

Our main results are: (1) The extent to which changes in the KPR affect the real economy (through their effect on deposit and lending rates) is inversely related to the endogenous level of aggregate risk. (2) Institutional constraints on the ability of banks to obtain funding sources from the CB, such as collateral constraints, affect the way the monetary transmission mechanism operates. (3) Because of the presence of aggregate risk, policy makers may easily face situations of a tradeoff between price stability and financial stability may. In order to improve the terms of the tradeoff, it is essential to take into account the effects of the KPR on financial stability and the effects of the financial stability instruments on the effectiveness of monetary policy.

[2] For an analysis on the importance of the financial independence of central banks see Cukierman (2006) and Benseil, Manzanares, Weller (2005).

The plan of the paper is as follows: section 2 presents a model with an economy comprised of two types of individuals – patient and impatient, a production technology, commercial banks and a central bank. Section 3 analyzes the equilibrium characteristics of our model and section 4 deals with policy considerations including policy effectiveness, pass-through, and the interaction of monetary policy and financial stability**.** Concluding remarks are presented in section 5

2. The Model

We consider an overlapping generations model in which there exists a storable good that in each period can either be consumed or be stored as capital good. A new generation of N young people is born in each period t. Each generation lives two periods and each young individual when born is endowed with w units of the storable good. Old individuals rely in their consumption on their previous period's savings and investment returns.

a. Individuals

There are two types of young individuals in each generation: N_1 patient individuals and N_2 impatient ones, where $N_1 + N_2 = N$ and for simplicity we let $N_1 = N_2 = N/2$. The first type gets more satisfaction from consumption when they are old (as measured by a high β), while the latter type gets more satisfaction from consumption when young (have a low β), where β is the individual's time preferences. For simplicity we assume that individuals of each type are identical in every respect.

Let c_{st}^{j} denotes period t consumption of type s individual, s=1,2, who belongs to generation j, j=y (young), o (old)[3]. Formally, the preferences of individual j, in each point in time t is given by the utility function

(1) $$u(c_{st}^{y}, c_{st+1}^{o}) = v(c_{st}^{y}) + \beta_j c_{st+1}^{o} \quad j = 1,2, \quad \beta_1 > \beta_2 .$$

The function $v : \Re^{+} \to \Re^{+}$ satisfies the standard characteristics: continuous, twice differentiable with $v' > 0, v'' < 0, \lim v'(c) = \infty$ as $c \to 0$. This functional form of the utility function reflects the risk neutrality of the individuals in our economy. Hence every period young individuals seek to maximize

(1a) $$E_t u(c_{st}^{y}, c_{st+1}^{o}) = v(c_{st}^{y}) + \beta_j E_t \{c_{st+1}^{o}\}, \quad j = 1,2, \quad \beta_1 > \beta_2 ,$$

where c_{st}^{y} cannot be contingent on the realization of the state of nature, E is the mathematical expectations.

The young individuals make a decision regarding the desired stock of physical capital, which they want to utilize in a production process a period later (when old). Accordingly, individuals of the old generation in period t+1, have each one access to production process, $f(k)$ that transforms with probability λ their units of time t capital good, k_t, into units of consumption good, y_{t+1}. This production process is subjected to a stochastic process as follows

(2) $$y_{t+1} = f(k_t) = \begin{cases} Ak_t^{\alpha}, 0 < \alpha < 1, & \text{with probabilty } \lambda(k_t) \\ 0 & \text{otherwise} \end{cases}$$

Where we further assume that $\lambda(k_t) = \gamma e^{-\gamma k_t}, \quad 0 < \gamma < 1$, such that $\lambda'(k) < 0$, $\lambda(0) = \gamma$, $\lim \lambda(k_t) = 0$ as $k \to \infty$, and $\lim k\lambda(k) = 0$ as $k \to \infty$. The realization of period t

[3] In what follows we will omit subscripts or superscripts unless we deem it necessary to avoid confusion.

production, $f(k_t)$, takes place at the beginning of period $t+1$[4]. Note that γ is the upper bound of the value of $\lambda(k_t)$. We further assume that upon utilization of the production process, the capital good is fully depreciated.

In order to create externalities we assume that neither the individuals nor commercial banks are aware of the aforementioned relationship between λ and k. They all take the level of λ as given. This assumption allows us to introduce systemic risk in the model in which there is a wedge between the actual risk the system is exposed to and the perceived risk by individuals.

There is a default free financial asset that potentially circulates in our economy, money (nominal cash balances), m_t, which is exclusively issued by the CB and bears no nominal interest. There are two additional nontradable financial assets in the economy that allow the individuals to store value: young individuals inherit financial intermediaries' equity, s_t, that entitles them to a share of the financial intermediaries' profits (dividends) when they become old. We assume that a fraction δ of the periodical profits is paid out as dividends to the shareholders (who are the old individuals) and the rest remains as retained earnings. δ is a shareholders' choice variable and is determined such that given various constraints the periodical dividends are maximized. In each period t an old individual holds an equal share ($1/N$) of each of the bank's shares. We assume that there are I identical financial intermediaries (commercial banks).

Young individuals can also deposit their financial savings, d_t, at the banks. These deposits bear a nonnegative one period nominal interest rate, i_{dt}. They are

[4] The uncertainty here is not related to the financing of the production cost but rather a physical characteristic of the production process. For example, the greater complexity and limited flexibility of larger project may increase the likelihood of production failure.

subject to some risk that is realized when the bank becomes insolvent, but it is bounded for there exists a partial deposit insurance (see details below).

In addition, to bridge between their available resources, and consumption and investment decisions, young individuals can borrow and get one-period, loans from banks, l_t, that bear a non-negative, one period nominal interest rate, i_{Lt}. In order to simplify the analysis we assume that the commercial banks follow a restriction that loans are granted to individuals only for the purpose of financing physical investments, as part of its risk management policy.

If an individual, when old, fails to repay her loan (realized with zero output), her bank deposits are automatically taken as collateral and are used to meet her obligations. On the other hand, her cash balances and dividends receipts remain available for her consumption[5]. To avoid corner solutions in the individual's asset portfolio choice, we assume there are transaction costs, ψ, involved in holding money balances (as opposed to other assets), which are proportional to the level of real money balances, $\psi = \psi_m \frac{m}{p}$ with $\psi_m > 0$, where p is the price of the consumption good.

Since the realization of period t production takes place at the beginning of period t+1, individuals' choice of period t variables can not be contingent on the realization of λ, that is, c_{1t}, c_{2t}, m_{1t}, m_{2t}, k_t, d_t, l_t, are all non-contingent. Since the choice of some of these variables depends on period t expectations of p_{t+1}, the latter cannot be contingent on the realization of λ too. On the other hand period t+1 consumption choices are all contingent on the realization of the production.

[5] This default arrangement is assumed for simplicity. Conceptually we could model an arrangement that takes account of the individuals' assets, but in return to a much more complicated model. i.e. use the stock holding as collateral.

In what follows we assume that there exists a separating equilibrium for our model economy such that the patient individuals (type 1) use the bank deposits and money in order to smooth their consumption, while the impatient individuals use the investment in the physical capital and money for the same purpose. Later on we prove these characteristics.

The household budget constraints of young and old individuals in periods t and t+1 are specified for depositors, denoted j=1, and for investors, j=2, as follows.

i) For the young individuals:

(3a) $$c_t + \frac{m_{1t}}{p_t}(1+\psi_{1t}) + \frac{d_t}{p_t} = w, \quad \text{(for depositors)},$$

Where p_t is the price of the consumption good in period t.

(3b) $$c_t + k_t + \frac{m_{2t}}{p_t}(1+\psi_{2t}) - \frac{l_t}{p_t} = w, \quad \text{(for investors)},$$

with the banks' imposed restriction $\frac{l_t}{p_t} \leq k_t$.

ii) For old individuals who have deposits with the bank, j=1, and the latter has not failed (with probability[6] 1-q_{t+1}):

(3c) $$c_{t+1} = \frac{m_{1t}}{p_{t+1}} + I\frac{s_t^j}{\sum_j s_t^j}\delta\frac{\Pi_{t+1}}{p_{t+1}} + \frac{(1+i_{dt})}{p_{t+1}}d_t$$

Where p_{t+1} is the *expected* price of period t+1, and q_{t+1} is the conditional probability in period t of the realization of the systemic risk in period t+1. Such realization entails banking insolvency and deposit insurance activation.

[6] See equation (8) for the determination of q_{t+1}.

iii) For old individuals who have deposits with the bank, j=1, and the latter has failed (with probability q_{t+1}):

$$(3d)\qquad c_{t+1} = \frac{m_{1t}}{p_{t+1}} + I\frac{s_t^j}{\sum_j s_t^j}\delta\frac{\Pi_{t+1}}{p_{t+1}} + \theta\frac{(1+i_{dt})}{p_{t+1}}d_t$$

Where θ (a policy variable) is the share of deposits that is recovered after activating the CB deposits insurance at period t+1. (For a discussion of θ see below). Both θ and q_{t+1} are known prior to the individual choices at time t.

iv) For old individuals who successfully produce the consumption good, j=2 (with probability $\lambda(k_t)$):

$$(3e)\qquad c_{t+1} = f(k_t) + \frac{m_{2t}}{p_{t+1}} + I\frac{s_t^j}{\sum_j s_t^j}\delta\frac{\Pi_{t+1}}{p_{t+1}} - \frac{(1+i_{Lt})}{p_{t+1}}l_t,$$

Where by assumption in each period t the share of stock holding is $\frac{s_t^j}{\sum_j s_t^j} = \frac{1}{N_{t-1}}$.

v) The old individual who failed in their production, j=2, and thus defaulted on their loans (with probability 1- $\lambda(k_t)$):

$$(3f)\qquad c_{t+1} = \frac{m_{2t}}{p_{t+1}} + I\frac{s_t^j}{\sum_j s_t^j}\delta\frac{\Pi_{t+1}}{p_{t+1}}.$$

Note that there is no collateral, which the bank can recover ex-post in this case.

Next we multiply equations (3c)-(3f) by their respective probabilities and then consolidate constraints (3c) with (3d), and (3e) with (3f) to get the following two period t+1 budget constraints:

(3g) $$c_{t+1} = \frac{m_{1t}}{p_{t+1}} + I\frac{s_t^j}{\sum_j s_t^j}\delta\frac{\Pi_{t+1}}{p_{t+1}} + (1-(1-\theta)q_{t+1})\frac{(1+i_{dt})}{p_{t+1}/p_t}\frac{d_t}{p_t}$$ (for depositors),

(3h) $$c_{t+1} = \frac{m_{2t}}{p_{t+1}} + I\frac{s_t^j}{\sum_j s_t^j}\delta\frac{\Pi_{t+1}}{p_{t+1}} + \lambda(k_t)(f(k_t) - \frac{(1+i_{Lt})}{p_{t+1}/p_t}\frac{l_t}{p_t})$$ (for investors)

Where period t+1 consumption choices in (3g) and (3h) are all in *expected* value form.

Given $\{s_t, \Pi_{t+1}, p_t, p_{t+1}, i_{dt}, i_{Lt}, \theta, q_{t+1}, \delta, \psi_m, \lambda\}$ and the function $f(k_t)$, depositors choose $\{c_t, c_{t+1}, m_t, k_t, l_t\}$ to maximize (1a) subject to (3a) and (3g), and investors choose $\{c_t, c_{t+1}, m_t, d_t\}$ to maximize (1a) subject to (3b) and (3h).

b. Financial Intermediaries: Commercial Banks

There are *I* financial intermediaries in the economy. Each of which accepts one-period deposits, d_t, that pays a nominal interest rate, i_{dt}. We assume that the deposit market is perfectly competitive so each individual bank and depositors are price taker. On the other hand banks extend loans where we assume that the loan market is imperfectly competitively. They extend one-period loans to investors, l_t, at an interest rate, i_{Lt} they set, given the perceived risk imbedded in the investments.

Each financial intermediary makes use of its equity capital, FK_t that is accumulated from past shareholder's endowments and past retained earnings. The banks pay out dividends to their shareholders who are all the old individuals in each period. They each receive 1/*N* of the dividend payments. For simplicity we assume that shareholders hold their shares when they are old (receiving dividends) and at the end of the period transfer them to their offspring when they become old.

The equity capital can be used as sources for financial intermediation as well. Each bank chooses the share, δ, of their profits that are to be distributed to their shareholders as dividends. As is aforementioned, a share (1- δ) of their profits will be retained by the intermediaries and will augment the stock of equity capital.

Financial intermediaries can either borrow from the CB a one-period monetary loan, l_{mt}, which the CB supplies perfectly elastically at a nominal monetary policy rate i_{mt}, or they can deposit reserves at the CB for one period and earn the same rate of return. They can use this borrowing source for the financial intermediation but the amount borrowed is limited to the total reserves they required to hold at the CB.

Financial intermediaries are subject to two financial stability regulations: (i) they must comply with the CB imposed reserve requirement at a rate of rr_t, maintained in the form of deposits at the CB. We assume that the required reserve ratio is such that the implied constraint on the financial intermediary is binding at all time, i.e. total reserves equal required reserves, $RR_t = rrD_t$ where D_t is the total deposits at the bank. (ii) they have to maintain a required capital ratio - *expected* end-of-period equity capital[7], E_tFK_{t+1} to total assets at time *t*, AS_t, of κ percents.

The first of this requirement coupled with the CB monetary loans arrangement enable the CB to expand or contract the supply of liquidity to the banks and to the economy. Setting rr_t affects the total commercial bank's reserves RR_t, and the monetary loans arrangement increases the potential outstanding commercial banking loans to individuals from a maximum of $L_t=(1-rr_t)D_t+FK_t$ to the maximum amount of $L_t=D_t+FK_t$. The capital ratio requirement aims at containing the exposure of commercial banks to credit risk as well as being a pillow to absorb losses.

[7] Note that in period *t*, the financial intermediary has no control over the existing stock of financial capital, FK_t, and thus we enter the end-of-period FK_{t+1} into the capital constraint of time *t*.

The resource constraint (balance sheet) of the commercial bank before the realization of the uncertainty is

(4a) $AS_t \equiv L_t^i + RR_t^i = D_t^i + FK_t^i + l_{mt}$

Where $RR_t = rr_t D_t$ and $l_{mt} \leq rr_t D_t$.

When the systemic risk is realized and the bank becomes insolvent, the CB activates the deposit insurance where it pays off depositors through the commercial banks such that for each bank the following resource constraint is satisfied

(4b) $\lambda(k_t)(1+i_{Lt})L_t^i + RR_t^i = \theta(1+i_d)D_t^i + (1+i_{mt})l_{mt}$

Where θ is the fraction of total deposits that is insured. Note that in a realization of systemic risk, the total (period t) financial capital of the commercial bank is depleted. Following a period in which commercial banks become insolvent, they continue on to the next period operating then as a new financial intermediary[8].

We assume that the commercial banks are all identical. Given that a systemic risk is realized with probability q, the *conditional* expected period t+1 profit when the realization of the systemic risk has not yet occurred is given by

(5a) $E_t \prod_{t+1}^{1-q} = \lambda(k_t) i_{Lt+1} L_t^i - i_{dt} D_t^i - i_{mt} l_{mt}$.

Similarly, the *conditional* expected period t+1 profit/loss when the realization of the systemic risk occurs (with probability 1-q) and the bank becomes insolvent is given by

(5b) $E_t \prod_{t+1}^{q} = \lambda(k_t) i_{Lt} L_t^i - i_{dt} \theta D_t^i - i_{mt} l_{mt}$.

[8] Note that in our model all assets and obligations have a one-period duration. Alternatively, we can assume that a new bank is established every period.

We assume here that even when there is a realization of systemic risk and the deposit insurance has been activated, still due to the "haircut" of the depositor return the commercial bank may realizes positive profits that are then distributed to the shareholders[9].

So the *unconditional* expected period t+1 profit is then

(5c) $$E_t \prod_{t+1} = \lambda(k_t) i_{Lt} L_t^i - (1-(1-\theta)q_{t+1}) i_{dt} D_t^i - i_{mt} l_{mt}$$

We assume for simplicity that the commercial banks seek to maximize the banks' period t+1 expected dividends payment, which they receive in all states of nature in which the bank' profits are positive. Accordingly, in each period t the commercial bank maximizes the expected dividends payment, $\delta_t E_t \Pi_t$, where the expected profit is the unconditional (5c), and subject to the following constraints (5d)-(5h).

The maximum leverage constraint, which is set by the bank's management and is given by

(5d) $$\frac{l_t}{p_t w} \leq \tau .$$

We refer to this constraint as a risk-management constraint. The risk-neutral bank management imposes this constraint to contain the exposure to credit risk such that a vicious cycle[10] would not emerge[11].

[9] Another way to see it is that this surplus will be returned to period t+1 old individuals who bear the segniorage payments.

[10] A cycle in which following a growth of the economy borrowers demand for loans increases, the banks exposure to credit risk increase both due to the expansion of the loans but also because of the assumed increase of the credit risk itself. Consequently, the probability of systemic crisis increases in time of rapid growth.

[11] One could perceive the rate of τ to be less restrictive (higher) the greater is the proportion of deposits insured by the CB, but for simplicity we leave it independent.

We further assume that there is a policy ratio: a minimum capital requirement and is applied to FK_{t+1} of period t+1 relative to the total financial assets of period t, AS_t. Note that FK_{t+1} is a state and predetermined variable at period t+1 and depends merely on period t action. Therefore a reference to FK_{t+1} rather than to FK_t in this policy ratio limits the analysis of the commercial banks to considerations of the current period only. The minimum capital requirement constraint is given by

(5e) $$\frac{E_t FK^i_{t+1}}{AS^i_t} \geq \kappa$$

There is a limit on the amount a financial intermediary can borrow from the CB in the form of monetary loans. The constraint is

(5f) $$l^i_{mt} \leq RR^i_t .$$

Assuming that the CB has priority on commercial bank's balance assets in time of default, actually makes the CB monetary loans fully secured by bank reserves at the CB. For simplicity we require a strict equality in the following reserve requirement constraint

(5g) $$RR^i_t = rrD^i_t .$$

Finally, banks accumulate financial capital according to the following dynamic process:

(5h) $$E_t FK_{t+1} = FK_t - (1-\lambda(k_t))(1+i_{Lt})L_t + (1-\delta_t)E_t \Pi_t$$

Where the second term on the right side of (5h) is the total period t loans written off and the last term is the retained earnings. Note that in order to maintain the optimal equity capital, FK_{t+1}, the intermediary must adjust its dividends policy at period t following realizations of the credit risk.

Thus the financial intermediary in period t chooses i_{Lt}, l_{mt}, FK_{t+1}, and δ_t to maximize its expected dividends payment subject to (4a), (5d)-(5h). Since all commercial banks are assumed to be identical we will refer in the analysis to a representative bank.

c. Central bank

The CB pursues two goals: reducing the deviations of the inflation from its target, and maintaining financial stability. The targeted inflation rate is determined exogenously. Inflation can deviate from its target due to shocks and to bring it back the CB adjusts its monetary (policy) interest rate i_{mt} on its monetary loans or deposits extended to commercial banks. The CB sets a perfectly elastic supply of money balances at its interest rate. The public demand for cash balances determines the equilibrium quantity of money balances.

To safeguard financial stability the CB provides a safety net in the form of partial deposits insurance, which is financed by seigniorage revenues (SR) that the CB collects from issuing cash and imposing reserve requirements.

We assume that the CB deposit insurance is activated only when there is a negative systemic realization that poses a financial risk on the whole banking system to make it insolvent. In this framework the CB guarantees to pay back a share θ, $0 \le \theta \le 1$, of each individual's deposit at the commercial banks. Given an expected inflation rate, this structure provides (if θ<1) certainty dominance to holding cash over banks' deposits. Of course it may also give rise to an interest rate differential between the two financial assets. The proportion of the deposit that is insured is predetermined[12].

The CB accumulates seigniorage revenue in our model from three sources: i) the CB imposes reserve requirements, *rr*, on banks' deposits that are held at the CB and bear no interest; ii) the individuals demand and hold nominal money balances; iii) commercial banks demand and receive monetary loans from the CB. Let M_t be the aggregate quantity of money held by the households in period *t*, and $rr_t D_t$ be the aggregate reserves financial intermediaries hold at the CB. The accumulated SR at the CB, given that last period the deposit insurance has not been activated, is

$$
\begin{aligned}
SR_t &= \frac{M_t + rr_t D_t - (M_{t-1} + rrD_{t-1})}{p_t} + \frac{i_{mt} L_{mt}}{p_t} + \frac{p_{t-1}}{p_t} SR_{t-1} \\
&= \frac{N(m_{1t} + (1+i_{mt}) rrd_t + m_{2t})}{p_t} - \frac{M_{t-1} + rrD_{t-1}}{p_t} + \frac{p_{t-1}}{p_t} SR_{t-1}.
\end{aligned}
\tag{6}
$$

The CB net worth is increased by the flow of $SR_t - SR_{t-1}$ and is depleted when deposit insurance is activated.

In addition the CB also sets minimum capital adequacy ratio, which is aimed at reducing the vulnerability of the banking system to realization of credit risk and to reduce the probability of needing to use the deposit insurance.

d. Markets and Policy Goals

The following markets operate in our economy: the consumption good market, the money market, the market for bank deposits and the loan market and the capital good market. In the framework of the monetary policy, the CB supplies through its monetary loan/deposit tool just enough financial sources for the commercial banks to

[12] The choice of θ could reflect two opposing forces, which are at the background of the model. A higher θ enhances financial stability by reducing the correlation of shocks to deposits and a systemic shock, while at the same time it enhances risk taking by the commercial banks (moral hazard).

meet the individuals' demand for money (as is reflected in their supply of deposits) at its predetermined policy rate, i_{mt}. Commercial banks are perfectly competitive in the deposit market and thus accept all deposits supplied by the individuals at the market deposit rate i_{dt}, where the latter is determined in accordance with the policy rate. On the other hand, commercial banks are oligopolies at the loan market, thus given the demand for loans and the monetary policy rate, it sets its loan rate, i_{Lt} at which it satisfies the individuals' demand for loans.

Investors determine their demand for stock of physical capital based on the expected real return (which is derived from the nominal i_{Lt} and the expected inflation). This will determine the supply of output. The expected inflation should be determined so that the consumption good market is equilibrated. In this framework, the CB policy is to determine its policy rate, the reserve requirements and the minimum capital ratio such that the expected inflation is in its target and the financial institutions are stable (in the sense that is specified earlier).

e. Equilibrium Conditions

In equilibrium all markets must clear and therefore we have

(7)
$$N_{1t}c_{1t}^{y} + N_{2t}c_{2t}^{y} + N_{1t-1}c_{1t}^{o} + N_{2t-1}c_{t}^{o} + N_{2t}k_{t} + N_{1t}\frac{m_{1t}^{y}}{p_{t}}\psi_{1t} + N_{2t}\frac{m_{2t}^{y}}{p_{t}}\psi_{2t} + SR_{t} - \frac{p_{t-1}}{p_{t}}SR_{t-1} = N_{t}w + N_{2}y_{t} + \sum_{i=1}^{I}\frac{\Pi_{t}^{i}}{p_{t}}$$

Where N_1 patient individuals deposit in commercial banks and the N_2 impatient individuals invest in the physical technology.

In equilibrium the perceived probability of commercial bank failure q_{t+1} by the individuals should be consistent with the fundamentals that determine bank bankruptcy. Hence it must satisfy the following

$$(8) \qquad q_{t+1} = H\{(1+i_{Lt})\lambda(k_t)L_t^i + RR_t - (1+i_{dt})D_t^i - (1+i_{mt})l_m \leq 0\},$$

Where H is the cumulative distribution of the default on loans granted by the bank a period ago. The expression $(1+i_{Lt})\lambda(k_t)L_t^i + RR_t$ is the nominal value of the commercial bank's total assets, expected to be realized in period t+1, while $(1+i_{dt})D_t^i + (1+i_{mt})l_m$ is the nominal value of its total liabilities (to the individuals and the CB), expected to be realized in period t+1. When the latter exceeds the former the addition to the commercial bank equity capital is negative. Consequently, the smaller is the difference between the two the larger is q_{t+1}, which implies that the function H is monotonic with $H' < 0$.

Substituting the resource constraint (4a) and the conditional expected profit when the systemic risk has not occurred (5a) into (8) yields the following

$$(8a) \qquad q_{t+1} = H\{FK_t + E_t\Pi_{t+1}^{1-q} - (1-\lambda(k_t))L_t\}$$

The expression within the curly brackets indicates whether the commercial banks have enough equity capital in addition to next period conditional expected profit to compensate for the expected loan defaults, provided the systemic risk has not yet realized[13]. The greater is this expression the smaller is q_{t+1}. Also we note that since FK_t is predetermined in period t, qt+1 is determined by the conditional expected next period profits of banks and the expected loan defaults.

[13] This is the reason for using $E_t\Pi_{t+1}^{1-p}$ in (8a).

In order to fulfill its deposit insurance obligations, the CB needs to generate sufficient SR and/or to restrain commercial banks' exposure to credit risk. Formally it sets the following incentive compatible constraint

(9) $$\sum_{i=1}^{I}(\theta(1+i_{dt})\frac{D_t}{p_t}-(\lambda(k_t)(1+i_{Lt})\frac{L_t}{p_t}+\frac{RR_t}{p_t}-(1+i_{mt})\frac{l_{mt}}{p_t}))\leq SR_t ,$$

That is, the SR accumulated up to period t should be no less than the sum (over all banks) of the absolute value of the banks' net worth in times of systemic risk, (the left hand side of (9)).

3. Equilibrium characteristics

a. Individuals

We begin with the first order conditions characterizing the various individuals in our economy. Let v_{ct} denotes the marginal utility with respect to c_t, and let Ξ_{1t} and Ξ_{2t} be the Lagrange multipliers of the budget constraints of the young and the old individuals of generation t, respectively. Recall that investors take the probability λ as given. From the first-order conditions (FOC) characterizing the investors we get the following:

(10a) $$\frac{v_{c_t}}{\beta_2}=\frac{\Xi_{1t}}{\Xi_{2t}}=\lambda(k_t)f_k ,$$

Where f_k is the marginal productivity of capital. The marginal rate of substitution in consumption equals the expected marginal productivity of capital. We further get

(10b) $$\lambda(k_t)f_k=\lambda(k_t)\frac{1+i_{Lt}}{p_{t+1}/p_t}\equiv R_{Lt} ,$$

I.e. the expected real interest rate on loans equals the expected marginal productivity of capital.

Since there is a positive probability for realizing zero produced output, the investor may hold money balances for precautionary motive[14], that is, the marginal utility goes to infinity when the consumption goes to zero. So from the FOC with respect to the money balances we get that if indeed money balances are held we have

(10c) $$\frac{\Xi_{1t}}{\Xi_{2t}} = \frac{p_t}{p_{t+1}} \frac{1}{1+2\psi_{2t}} \quad \text{with } \psi_{2t} = \psi_m \frac{m_{2t}}{p_t}.$$

Combining (10a)-(10c) yields

(10d) $$R_{Lt} = \frac{p_t}{p_{t+1}} \frac{1}{1+2\psi_{2t}} \text{ or } \lambda(k_t)(1+i_{Lt}) = \frac{1}{1+2\psi_{2t}}.$$

From the first-order conditions characterizing the depositors, we get the following:

(11a) $$\frac{\nu_{c_t}}{\beta_1} = \frac{\Xi_{1t}}{\Xi_{2t}} = (1-(1-\theta)q_{t+1})\frac{1+i_{dt}}{p_{t+1}/p_t} \equiv R_{dt},$$

I.e. the marginal rate of substitution in consumption equals the expected real return on deposits at the banks. If money is held then we have

(11b) $$\frac{\Xi_{1t}}{\Xi_{2t}} = \frac{p_t}{p_{t+1}} \frac{1}{1+2\psi_{1t}} \quad \text{with } \psi_{1t} = \psi_m \frac{m_{1t}}{p_t}.$$

Such that combining (11a) with (11b) yields

(11c) $$R_{dt} = \frac{p_t}{p_{t+1}} \frac{1}{1+2\psi_{1t}} \text{ or } (1-(1-\theta)q_{t+1})(1+i_{dt}) = \frac{1}{1+2\psi_{1t}}.$$

If the depositors hold money balances, then the expected real return on deposits equals the real return on money balances adjusted for the transaction cost.

[14] Recall that holding commercial bank liabilities could not be of help when the return on the investment is zero (no output).

From (10b) after rearranging terms and solving for the inflation rate we get the following equilibrium condition

(11d) $$\frac{p_{t+1}}{p_t} = \frac{1 + i_{Lt}}{f_{kt}} .$$

This equilibrium condition guarantees the satisfaction of the Fisherian relationship between the nominal interest rate, i_{Lt}, the real (gross) rate f_k and the rate of inflation. That is, the inflation in our model is determined in accordance with the asset portfolio selection framework. This approach to modeling inflation is in line with Sims (2009).

These equilibrium conditions imply the following results:

Result 1. *If the following probabilities $\lambda(k_t)$ and $1-(1-\theta)q_{t+1}$ are of similar magnitudes, and if there exists an equilibrium for our economy with $L_t > 0$, $D_t > 0$, then it is a separating equilibrium where the patient individuals (of type 1) deposit funds in the banks and do not invest in the physical capital, while the impatient individuals (type 2) invest in the physical capital and do not have deposits at the banks. (*See proposition 1 in the appendix).

b. Financial Intermediaries

In this section we derive the FOC that characterize the representative financial intermediary choices. For that we use the resource constraint (4a) to eliminate AS_t and D_t in the expected profit function (5c) and use as well constraints (5d)-(5h) to set the Lagrangian for the representative commercial bank as follows

$$
\begin{aligned}
\Psi = {} & \delta_t[\lambda(k_t)i_{Lt}L_t - (1-(1-\theta)q_{t+1})\frac{i_{dt}}{1-rr}(L_t - FK_t - l_{mt}) - i_{mt}l_{mt}] \\
& + \varphi_{1t}(\tau p_t Nw - L_t) + \varphi_{2t}(E_t FK_{t+1} - \frac{\kappa}{1-rr}(L_t - rr(FK_t + l_{mt}))) \\
& + \varphi_{3t}(rr(L_t - FK_t) - \frac{1}{1-rr}l_{mt}) \\
& + \varphi_{4t}(FK_t - (1-\lambda(k_t))(1+i_{Lt})L_t + (1-\delta_t)E_t\Pi_{t+1} - E_t FK_{t+1})
\end{aligned} \tag{12}
$$

where $\varphi_j, j = 1,2,3,4,$ are the Lagrange multipliers associated with constraints (5d), (5e), (5f) and (5h), respectively, *N* is the number of individuals who borrow from the commercial bank (the investors).

Now we can derive the FOC for the maximization of the expected dividends payments of the representative commercial bank. For convenience we begin with the derivative of the Lagrangian with respect to the payout ratio δ and get

(13a) $E_t\Pi_{t+1} - \varphi_{4t}E_t\Pi_{t+1} = 0.$

So if $0 < \delta < 1$ such that (13a) is binding, then $\varphi_{4t} = 1$, all *t*, where φ_{4t} is the shadow price in terms of the expected profit of the financial capital accumulation constraint[15].

Next we derive the FOC with respect to expected period *t*+1 financial capital, E_tFK_{t+1}. Note that both (5c) and (5f) restrict E_tFK_{t+1} and they are in fact linear in it, so the case where they are both binding is a special case. In this case we get

(13b) $\varphi_{2t} = \varphi_{4t}$

where φ_{2t} is the shadow price of the minimum capital requirement constraint[16].

We can now derive from the FOC the pass-through from the CB monetary interest rate to the deposit rate. This equilibrium relationship is given by

[15] This result that $\varphi_{4t} = 1$ is a straightforward consequence of constraint (5h), relaxing the constraint is done by increasing the retained earnings that is a fraction of the expected profit.

[16] The financial capital accumulation (5f) is always binding, while the minimum capital ratio (5c) may not be binding, in which case banks hold financial capital in excess of the required amount.

(13c) $(1-(1-\theta)q_{t+1})\frac{i_{dt}}{1-rr} = i_{mt} - \kappa\frac{rr}{1-rr} + \frac{\varphi_{3t}}{1-rr}$.

Next we derive the pricing of the interest rate on loans, given the deposit interest rate and get

(13d)
$$(\lambda(k_t)-(1-\lambda(k_t))(1+\frac{1}{\eta_t})i_{Lt} =$$
$$(1-(1-\theta)q_{t+1})\frac{i_{dt}}{1-rr} + \varphi_{1t} + \frac{\kappa}{1-rr} - rr\varphi_{3t} + (1-\lambda(k_t))$$

where $\eta_t = \frac{i_{Lt}}{L_t}\frac{\partial L_t}{\partial i_{Lt}}$ is the interest rate elasticity of the demand for loans.

We can combine (13c) and (13d) to eliminate (1-(1-θ)q_{t+1}) and have the transmission mechanism from the CB i_{mt} to the market i_{Lt}.

(13e) $(\lambda(k_t)-(1-\lambda(k_t))(1+\frac{1}{\eta_t})i_{Lt+1} - (1-\lambda(k_t)) = i_{mt+1} + \kappa + (\frac{1}{1-rr} - rr)\varphi_{3t}$

Note that the stochastic element in our model is the produced output, and it is modeled as a binomial distribution with probability λ. So we have that the *var*(λ) (the variance of λ) is λ(1-λ) where most likely λ > (1-λ). For λ > (1-λ) we have that *var*(λ) is a negative monotonic function of the difference λ - (1-λ). Thus if the second order effect of k_t on λ(k_t) is small and given the monetary policy rate i_{mt}, we have from (13c) that a reduction in *var*(λ) results in a fall in i_{Lt}. We get this result of a positive relationship between risk (output uncertainty) and the interest rate on loans even though the financial intermediaries are assumed to be risk neutral.

Note that the set of conditions (13c)-(13d) together with the constraints (4a), (4b), (5d)-(5h) and given the CB interest rate i_{mt}, can be used to solve for the choice variables i_{Lt}, L_{mt}, E_tFK_{t+1}, and δ as well as for i_{dt} and for the two Lagrange multipliers φ_{1t} and φ_{3t}.

Note from (13c) that if the deposit interest rate reached the zero bound, i_{dt}=0, i_{mt} ceases to be a policy instrument. Further lowering of the i_{mt} affects neither the deposit interest rate nor the loan interest rate and it degenerates into $i_{mt} = (\kappa rr - \varphi_{3t})/(1-rr)$. Note also, from (13d), that under such conditions, the way for the CB to affect i_{Lt} is by adjusting the reserves and capital requirements. In this situation, if a reduction in the lending rate is warranted to offset say a deflationary shock, then the viable monetary policy tools are ones, which in normal circumstances are financial stability instruments. This clearly demonstrates how inextricably interlocked are the tools of monetary policy and financial stability.

In the case where constraint (5f) is binding, i.e. the commercial bank can not rely on the CB monetary loans for further expansion unless it attracts additional public deposits, then changes in the perceived credit risk or in the probability of commercial bank bankruptcy, as well as in θ, could affect the interest rates on deposits even if i_{mt+1} remains constant[17] (see (13c)).

Finally we let the expected real dividends paid out by the banks to the representative old consumer be denoted by $\Gamma_{t+1} \equiv \delta \frac{E_t \Pi_{t+1}}{N_t p_{t+1}} I$ and without loss of generality we assume I=1 (there is one representative commercial bank). Note that we can combine the expression for the expected profits (5c) and the resource constraint for the bank (4a) to get the following expression for the expected dividends payments

[17] Thus while the recent relaxation of the collateral requirements by many CBs may have increased the pass-through from the KPR to deposit rates, but at a cost of putting the taxpayer money at greater risk and raising questions as to the extent of instrument independence that CB should have.

$$\Gamma_{t+1} = \delta_t \frac{p_t}{p_{t+1}} \{[\lambda(k_t) i_{Lt} - (1-(1-\theta)q_{t+1}) \frac{i_{dt}}{1-rr}] \frac{l_t}{p_t}$$

(14) $$+ [(1-(1-\theta)q_{t+1}) \frac{i_{dt}}{1-rr} - i_{mt}] \frac{l_{mt}}{Np_t}$$

$$+ (1-(1-\theta)q_{t+1}) \frac{i_{dt}}{1-rr} \frac{FK_t}{Np_t}\}$$

Where the optimal δ_t is chosen to have constraint (5h) satisfied with equality. There are two expressions in the RHS of (14) that appear in squared brackets. The first one can be analyzed using equilibrium condition (13d) and the second one can be analyzed using condition (13c). These analyses will be used to assess the effects of different shocks on Γ_{t+1}. In fact we can already derive a result regarding the use of the monetary loans by the commercial bank by substituting from (13c) to (14) and get

$$\Gamma_{t+1} = \delta_t \frac{p_t}{p_{t+1}} \{[\lambda(k_t) i_{Lt} - (1-(1-\theta)q_{t+1}) \frac{i_{dt}}{1-rr}] \frac{l_t}{p_t}$$

(14a) $$+ [-\kappa \frac{rr}{1-rr} + \frac{\varphi_{3t}}{1-rr}] \frac{l_{mt}}{Np_t}$$

$$+ (1-(1-\theta)q_{t+1}) \frac{i_{dt}}{1-rr} \frac{FK_t}{Np_t}\}$$

Result 2. *From (14a) it turns out that there is no partial use of the monetary loans the CB extends to the commercial banks. In fact, either there is no use at all of these loans or the banks utilizes all of its collaterals and* $l_{mt} = rrD_t$. (See Proposition 2 in the appendix).

Substituting $l_{mt} = rrD_t$ into the resource constraint of the commercial bank (4a) yields for all *t*

(14b) $L_t = D_t + FK_t$

For the determination of q_{t+1} we use the expected profit (5a) rather than (5c) (see (8a)), and similar to the derivation of (14) we use (5a) and (4a) to get

(14c)
$$E_t\{\frac{\Pi_{t+1}^{1-q}}{Np_{t+1}}\} = \frac{p_t}{p_{t+1}}\{[\lambda(k_t)i_{Lt} - \frac{i_{dt}}{1-rr}]\frac{l_t}{p_t} + [\frac{i_{dt}}{1-rr} - i_{mt}]\frac{l_{mt}}{Np_t} + \frac{i_{dt}}{1-rr}\frac{FK_t}{Np_t}\}$$

Which will be used later on.

c. Passthrough and effectiveness of the monetary policy

The point of this paper is that monetary policy is interconnected with financial stability. It turns out that the pass-through from the i_{mt} to i_{dt} depends, not only on whether constraint (5f) is binding or not, but also on the extent to which the required reserves rate and the minimum capital requirement ratio are used by the CB as policy instruments (see (13c) and (13d)). If, for example, in time of a trough, the CB implements expansionary monetary policy (by reducing its i_{mt}) but in addition raises the minimum capital requirement ratio κ for financial stability purposes, these effects on i_{dt} could set off each other (see (13c)). This case demonstrates clearly a possible conflict between the two goals of monetary policy.

Regarding the pass-through from the policy rate to the market rates, we note from (13d) that if the risk management relaxes its constraint on the leverage (increases τ), then φ_{1t} will decreases and the interest rate on loans will be (ceteris paribus) lowered, given the CB rate, i_{mt}.

Thus when there is financial instability the pass-through from the CB rate to deposit and lending rates is less than full; that is, monetary policy could become less effective[18]. From equation (13c) one can observe that a decision to increase the extent of deposit insurance, θ, also leads to greater effectiveness of monetary policy (as measured by the pass-through from i_{mt} to i_{dt})In the case of full deposit insurance, θ□1,

[18] These results are consistent with the development of the pass-through during the 2008-9 financial crisis.

the pass-through is $1/(1\text{-}rr)$ regardless of q_{t+1}, but a higher coverage rate requires more CB seigniorage, which in turn may necessitate higher reserve requirements, *rr*, which at least to some extent offsets the effect of larger θ on the pass-through.

d. Semi-Log linear consumer's preferences

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4. Interaction of monetary policy and financial stability

We now ready to establish the emerged conflict when in the implementation of the monetary policy (in pursuing inflation target) financial stability considerations are overlooked and vice versa. To that end we examine two shocks: a shock to productivity, which is translated in our model to a shock to inflation and a shock to financial stability. In each case we examine the CB reaction to the shock utilizing a particular policy tool and how this reaction affect the inflation and the financial stability goals

Suppose there is a shock to the total factor productivity in the production function (the parameter A in (2)). It can be verified from (11d) that this shock in our model is actually a shock to inflation. The shock is realized unexpectedly in period t before individuals take any actions, and we assume that our economy is in a steady-state equilibrium up to that period.

We first establish the condition under which the CB monetary rate, i_{mt+1} should be raised (lowered) for the expected inflation to be moderated (accelerated).

Result 3. *For the reduction (increase) in the CB monetary policy rate to generate an increase (decrease) in the expected inflation, the following condition has to be satisfied*

(17) $$-\frac{\partial \log(k_t)}{\partial \log(1+i_{Lt+1})} > \frac{1}{1-\alpha}.$$

(See Lemma 1 in the appendix).

We note that condition (17) can also be expressed in terms of the elasticity of the real investment with respect to the *real* interest rate on loans in which case condition (17) is equivalent to[19]

(17a) $$-\frac{\partial \log(k_t)}{\partial \log(r_{Lt})} > \frac{1}{1-\alpha}\frac{r_{Lt}}{1+r_{Lt}}, \text{ where } 1+r_{Lt} \equiv \frac{1+i_{Lt}}{p_{t+1}/p_t}.$$

In order to study the effect of a technology shock on the economy we first examine the effect of the implied monetary policy reaction following a technology shock on the monetary transmission mechanism in our model. The latter is reflected by the effect of a change in i_{mt} on the expected market interest rates.

It should be noted that absence monetary policy reaction, a positive shock to productivity pushes upwards the demand for k_{t} thus lowering $\lambda(k_{\mathrm{t}})$ and by (13d) yielding a larger i_{Lt}. Therefore, in order to study the effectiveness of the monetary policy, we have to compare the equilibrium following the shock and the CB policy reaction to an equilibrium that would have realized absence any policy reaction. The next result refers to this latter comparison.

Result 4. *Following a positive shock to the productivity, the CB lowers i_{mt+1} to maintain the inflation at its target. The loan rate i_{Lt+1} is reduced but the expected return on deposits $(1-(1-\theta)q_{t+1})i_{dt}$ increases. The effectiveness of the monetary policy transmission mechanism is partially worn out.* (See proposition 3 in the appendix).

[19] With the real interest rate on loans of 5% and α=0.32 we have that the elasticity of the demand for k_{t} with respect to the real rate should be greater than 0.07 which is consistent with empirical findings

We now turn to the consequences of the shock and the CB policy reaction to it on the financial stability stance of the banking sector.

Result 5. *If condition (17) is satisfied such that following a positive productivity shock in period t the CB lowers its rate, i_{mt+1} to maintain the expected inflation at its pre-shock rate. Then both 1-$\lambda(k_t)$ and $(1-\lambda(k_t))l_t$ increase, and the effects on q_{t+1} and on SR_t are ambiguous.* (See proposition 4 in the appendix).

We could, however, say more on the transmission of risk in our economy from the credit risk (increase in $\lambda(k_t)$) to the systemic risk q_{t+1}, provided the CB holds its rate at its pre-shock rate. Formally, in Lemma 2, we show that if θ is not too small and if the direct effect of $\lambda(k_t)$ on the demand for commercial bank loans is non-negative[20]

$\frac{\partial l_t}{\partial \lambda} \geq 0$ and the elasticity of the demand for loans with respect to λ satisfies

$\frac{\lambda}{l_t}\frac{dl_t}{d\lambda} < \frac{\lambda}{1-\lambda}$, then a decrease) in $\lambda(k_t)$ will consistently with (8a) result in an increase of the probability q_{t+1} and furthermore the SR_t will be reduced, provided that the CB holds i_{mt} constant. (See proposition 5 in the appendix).

Next we examine the effects of a shock to $\lambda(k_t)$ (decreasing the parameter γ in the definition of $\lambda(k_t)$) that is interpreted as a shock to credit risk. We consider at first a response that includes changing the capital requirements to fully offset the increase in $\lambda(k_t)$ and gets q_{t+1} to be even reduced.

Result 6. *Assume that constraint (5d) is not binding and there is a negative shock to $\lambda(k_t)$. In reaction the CB maintains i_{mt+1} at its pre-shock rate, while increases the minimum capital requirement κ enough to increase i_{Lt} and to lower $(1-(1-\theta)q_{t+1})i_{dt}$, such that the demand for investment k_t falls and $\lambda(k_t)$ increases back to its pre-shock*

[20] This is plausible since higher λ reflects a greater probability of success in the production, which attracts more physical investment and hence larger demand for bank loans.

level. If condition (17) is satisfied, the expected inflation will fall below its target. If further the effect of the increase in κ on the expected profits is nonnegative or negative but small enough, then q_{t+1} gets smaller compared with its pre-shock value. For large enough rr the revenue SR_t will get smaller. (See proposition 6 in the appendix).

According to proposition 5 a negative shock to $\lambda(k_t)$ absence any CB reaction results under certain conditions in a reduction of the SR_t. So next we explore the effects of a reaction in which the CB reduces the *rr* following a negative shock to $\lambda(k_t)$ in order to increase the SR_t back to its pre-shock level.

Result 7. *Assume there is a negative shock to $\lambda(k_t)$ and that the presumptions of proposition 5 hold. Thus there is a decrease in SR_t. In order to increase SR_t back to its pre-shock level the CB could lower the reserve requirement rr. If further the decrease in rr raises the expression*[21] $(\frac{1}{1-rr} - rr)\varphi_{3t}$, *it is more likely that i_{Lt} will be increased and under condition (17) the expected inflation will be moderated to below the target.* (See proposition 7 in the appendix).

5. Concluding Remarks

We developed in the paper an overlapping generations monetary model in which there exists reciprocity between the implementation of monetary policy to achieve inflation target and of macroprudential policy to maintain financial stability. Policy considerations that are relevant for one type of a policy appear to influence the

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[21] Note that raising *rr* has opposing effects on the expression $(\frac{1}{1-rr} - rr)\varphi_{3t}$. On the one hand $(\frac{1}{1-rr} - rr)$ increases with *rr*, but on the other hand raising *rr* decreases the shadow price of constraint (5f) as is reflected in the lower Lagrange multiplier φ_{3t}.

considerations of the other to the extent that c*oordination* is needed to avoid (possibly) substantial loss in one of the policy goals.

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References

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Appendix

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