Economics Working Paper Series

2014/023
(revised in February 2015)

Financial Shocks, Loan Loss Provisions and Macroeconomic Stability

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January 2015

Abstract

This paper studies the interactions between loan loss provisioning rules, business cycle fluctuations and monetary policy in a model with nominal price rigidities, a borrowing cost channel and endogenous credit default risk. We show that an empirically relevant backward-looking provisioning rule induces financial accelerator mechanisms and results in financial, price and macroeconomic instability. Forward-looking provisioning systems, set to cover for expected losses over the whole business cycle, reduce significantly procyclicality in prices and output, and in addition moderate the (otherwise optimal) anti-inflationary response in the monetary policy rule. The optimal policy response to financial shocks calls for a combination of forward-looking provisions and a mildly credit augmented monetary policy rule.

JEL Classification Numbers: E32, E44, E52, E58, G28

Keywords: Loan Loss Provisions, Procyclicality, Borrowing Cost Channel, Basel III, Forward-Looking Provisions, Monetary Policy.

*We are grateful to Raffaele Rossi for helpful comments. All remaining errors are our own.

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1 Introduction

The global financial crisis of 2007-2009 followed by the Great Recession has made it clear how volatility in financial markets can quickly translate into severe real macroeconomic effects. These adverse consequences have led to a substantial shift in the policy debate, which now places a vital role on various macroprudential policies aimed at preventing the build-up of financial imbalances, strengthening the banking sector's loss-absorbing capacity, and mitigating procyclicality in the financial system.

In general, countercyclical bank capital buffers have been the core instrument of interest among policy makers and academic researchers investigating macroprudential policy. The new regulatory Basel III accords, set to be fully implemented by 2018, intend to enforce banks to raise the quality of their assets, and hold countercyclical capital buffers set as a fraction of up to 2.5% of risk-weighted assets. The countercyclical evolution of bank capital buffers should in turn be related to credit growth or the loan to GDP ratio, both viewed as good indicators of systemic risk (see Basel Committee on Banking Supervision (2011)). A number of recent contributions which have studied the performance of countercyclical bank capital regulation in Dynamic Stochastic General Equilibrium (DSGE) models include Angelini, Neri and Panetta (2014), Angeloni and Faia (2013) and Kannan, Rabanal and Scott (2012), among others. These papers conclude that a combination of countercyclical regulation and a credit augmented monetary policy rule is optimal in terms of promoting overall macroeconomic and financial stability.[1]

Notably less attention in the theoretical literature has been given to the role of loan loss provisions despite the recent calls of the Basel Committee for the transition from backward-looking provisioning systems (incurred-loss approach) towards a more forward-looking (statistical or dynamic) provisioning regime (expected-loss approach). In practice, the provisioning system in most industrialized countries is still backward-looking and tied by the International Accounting Standards (IAS) 39, which require banks to set specific provisions related to identified credit losses (such as past due payments (usually 90 days) or other default-like events). These specific provisions are therefore said to be backward-looking and are driven mainly by recognized nonperforming loans.[2]

By contrast, forward-looking provisioning schemes should motivate banks to set provisions in a timely manner before credit risk materializes and during upswing phases, and allow the financial sector to better absorb losses by drawing upon these provisions in the wake of a negative credit cycle. Specifically, dynamic provisions should smooth out the evolution of total loan loss provisions, thus reducing the need of financial intermediaries to increase costly loan loss reserves during economic downturns. The Bank of Spain has introduced such statistical provisioning for loan loss reserves since 2001 in order to dampen excess procyclicality in credit growth. Under this system, banks must make provisions according to the latent risk over the business cycle, or the historical information regarding credit losses for different types of loans. By anticipating better the expected losses inherent in a loan portfolio, statistical provisions should provide additional buffers and mitigate procyclicality. While the dynamic provisioning regime in Spain allowed banks to enter the financial crisis in a more robust shape, it is less clear what kind of effect it had on the real estate bubble

[1] Similar policy implications are obtained in Rubio and Carrasco-Gallego (2014), where macroprudential policy is defined as a rule on the loan-to-value ratio (LTV) rather than a countercyclical rule on bank capital requirements.

[2] Under the guidelines of the Generally Accepted Accounting Standards (GAAP) in the United States, loan loss provisions should be related to identified nonperforming loans, *and* also set at a sufficient level to cover for associated expected credit losses recognized at the specific time of the balance sheet. Therefore, the GAAP is also primarily backward-looking and ex-post by design.

this country experienced in the previous decade (see Saurina (2009), Caprio (2010) and Jiménez, Ongena, Peydró and Saurina (2012)).[3]

Two theoretical frameworks which examine the effectiveness of loan loss provisioning regimes are Bouvatier and Lepetit (2012a) and Agénor and Zilberman (2013). The former develop an analytical partial equilibrium model with monopoly banking, and show that statistical provisions, defined by accounting rules to cover for expected losses, can eliminate procyclicality in lending standards induced largely by specific provisions. The latter use a standard medium-scale calibrated DSGE model and illustrate that forward-looking provisioning systems can help mitigate financial and real sector volatility, even more so when implemented together with a credit-gap augmented monetary policy rule. These results stem mostly from an empirically justified stock-flow formulation for loan loss reserves, and more precisely from the value of the persistence parameter relating current loan loss reserves to past reserves.

This paper contributes to the debate on the performance of loan loss provisions by examining the interaction between loan loss provisioning rules, business cycle fluctuations and monetary policy in a DSGE model with nominal price rigidities, a borrowing cost channel, collateralized lending and endogenous nonperforming loans (risk of default). Contributing to the theoretical models described above, within our framework we capture endogenously the two main stylized facts characterizing the behaviour of loan loss provisions: a) the negative correlation between output and provisions (Cavallo and Majnoni (2001), Laeven and Majnoni (2003) and Bikker and Metzemakers (2005);[4] b) the highly countercyclical relationship between the loan loss provisions to loan ratio and the economic activity (Clerc, Drumetz and Jaudoin (2001), De Lis, Pagés and Saurina (2001) and Pain (2003)). Moreover, the commercial bank's lending rate decision is directly linked to what we refer to as the provisioning cost channel; because provisions are costly and deducted from the bank's income statement, higher loan loss provisions relative to loans amplify a rise in the loan rate following adverse financial shocks. As the loan rate is endogenously linked to the risk of default through the risk premium channel, raising more provisions during a downturn can also lead to higher financial risk and to additional procyclicality in borrowing costs (see Jin, Kanagaretnam and Lobo (2011), who document a strong positive relationship between loan loss provisions and the probability of bank failures for financially weak banks between 2007-2010).[5,6] Overall, backward-looking provisions in this model are shown to exacerbate procyclicality in the financial system, in line with the cross-country analysis performed by Bouvatier and Lepetit (2012b) and the partial equilibrium results of Bouvatier and Lepetit (2012a).

[3] As noted in Wezel, Chan-Lau and Columba (2012), several countries in Latin America have also introduced dynamic loan provisioning systems in recent years, but their experience is still premature to provide robust conclusions. For further discussion of the literature see Agénor and Zilberman (2013).

[4] Cavallo and Majnoni (2001), for example, empirically examine the policies of large commercial banks in various countries with regards to their provisioning practices. These authors find that bankers create significantly less provisions during economic expansions compared to recessions. Laeven and Majnoni (2003) and Bikker and Metzemakers (2005) also show that provisions are much higher when GDP growth is low, reflecting increased credit risk associated with deteriorating economic conditions.

[5] Bank failures, in turn, are often positively related to the fraction of nonperforming loans (see Demirguc-Kunt and Detragiache (2005)).

[6] Contributing to Agénor and Zilberman (2013), in our model the loan rate, the fraction of nonperforming loans and the loan loss provisions to loan ratio are all endogenously related such that the provisioning cost channel has also a direct meaningful effect on financial risk.

We illustrate that adjusting loan loss provisions to account for the latent losses over the cycle (forward-looking provisions), can largely offset the rise in specific (backward-looking) provisions during a downturn as well as mitigate considerably the rise in borrowing costs associated with deteriorating economic conditions. Firms in our model must partly borrow from the commercial bank in order to finance their labour costs. Therefore, monetary policy, nonperforming loans and loan loss provisioning rules, all which dictate the loan rate behaviour, translate into changes in the firms' marginal costs, price inflation and output through the borrowing cost channel. Such type of short term borrowing costs have been utilized and empirically examined in the literature since the contribution of Ravenna and Walsh (2006). These papers include Chowdhury, Hoffmann and Schabert (2006), Tillmann (2008) and De Fiore and Tristani (2013), among others. Using the borrowing cost channel to describe part of the linkages between the financial market conditions and the real economy, we demonstrate that following adverse financial shocks, forward-looking provisioning rules can be very effective in promoting both price and output stability.[7,8] A credit augmented monetary policy rule, on the other hand, is shown to produce demand driven inflation and is only successful in enhancing overall welfare when supported by a full forward-looking provisioning regime. In this case, the central bank can afford to reduce its anti-inflation response in the policy rule as dynamic provisioning regimes effectively contain cost-side inflationary pressures. From the policy perspective we advocate that accounting rules on loan loss provisions alter the optimal conduct of monetary policy, and have a non-negligible effect on the dynamics of financial, real and nominal variables.

This paper therefore contributes to the existing literature on loan loss provisions, which largely uses empirical and/or partial equilibrium frameworks to examine the role of provisioning practices in shaping the financial cycle. We go a step further and highlight the importance of loan loss provisioning rules in explaining also the behaviour of real business cycles and inflation, as well as their optimal interaction with simple monetary policy rules.

The remainder of the paper is structured as follows. Section 2 describes the model. We keep the presentation relatively brief, given that several ingredients are described in Agénor and Aizenman (1998) and its New Keynesian counterpart framework developed in Agénor, Bratsiotis and Pfaifer (2014). Instead, we focus on how the model presented here departs from these papers, especially with respect to the commercial bank's balance sheet, loan loss provisioning regimes, financial risk shocks, credit augmented monetary policy and optimal policy analysis. Section 3 provides a discussion on the parameter calibration, whereas Section 4 simulates the model following financial shocks to the value of collateral received by the commercial bank in times of credit default. In Section 5 we examine simple and implementable optimal policy rules which minimize a micro-founded welfare

[7] In a recent contribution which abstracts from credit default risk, De Paoli and Paustian (2013) also use the borrowing cost channel (loans for working-capital needs) to study the optimal interaction between macroprudential regulation (defined by a cyclical tax on the borrowing of firms) and monetary policy under discretion and commitment. We instead focus on optimal simple implementable rules, with monetary policy defined by a Taylor rule, and the macroprudential regulation conducted via accounting rules on loan loss provisions.

[8] The majority of the literature on financial regulation uses credit lines to finance house purchases and investment in physical capital. We instead pursue a different approach and introduce loans to finance labour costs. This modeling viewpoint is also motivated by recent evidence which suggests that variations in working-capital loans following adverse financial shocks can have persistent negative effects on the economic activity (see Fernandez-Corugedo, McMahon, Millard and Rachel (2011) who estimate the cost channel for the U.K economy). This result, therefore, requires the examination of macroprudential policies when firms rely on external finance to support their production activities.

loss function. Section 6 concludes.

2 The Model

Consider an economy consisting of six types of agents: households, a final good (FG) firm, a continuum of intermediate good (IG) firms, a competitive commercial bank, a government, and a central bank. At the beginning of the period and following the realization of aggregate shocks, the representative bank receives deposits from households, and sets the loan rate according to a break even condition. The risk in our model stems from the possibility of IG firms defaulting on their loans as their production is subject to idiosyncratic productivity shocks, which are unobservable when the loan contract is agreed. The loan rate decision is made in light of this risk, along with the value of collateral the bank expects to receive in case of default, and the deduction of loan loss provisions from the bank's income statement. Provisioning rules are set by the central bank, and can be either backward- or forward-looking. In the former case, provisions are triggered by the contemporaneous fraction of nonperforming loans (risk of default), which, in turn, is endogenous to the real economic activity and financial conditions. Forward-looking (statistical or dynamic) provisions, by contrast, take into account both identified risk, as before, and expected losses over the whole business cycle. Thus, provisions are smoothed over the cycle and are less affected by the current state of the economy and cyclical risk. For a given loan rate, the IG firms decide on the level of employment, prices and loans, with the latter used to partly fund wage payments to households. The intermediate goods are then all combined by the FG firm, who produces a homogeneous final good. At the end of the period, the idiosyncratic shocks are realized and the bank seizes collateral from defaulting firms. The collateral is then handed over to the household as a lump-sum transfer, which ensures depositors get their full return. We now turn to a more detailed description of the behaviour of each agent in this economy.

2.1 Households

There is a continuum of households of measure 1, who consume, hold deposits and supply labour to IG firms. The objective of the representative household is to maximize the following utility function,

$$U_t = \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \left\{ \frac{C_t^{1-\varsigma}}{1-\varsigma} - \frac{H_t^{1+\gamma}}{1+\gamma} \right\}, \tag{1}$$

where $\mathbb{E}_t$ is the expectations operator conditional on the information available in period t, and $\beta \in (0,1)$ the discount factor. The term C_t denotes consumption at time t, while ς stands for the inverse of the intertemporal elasticity of substitution in consumption. The expression H_t represents the time-t hours devoted for labour, with γ denoting the inverse of the Frisch elasticity of labour supply.

Households hold real bank deposits, D_t, which bear a gross interest rate of R_t^D. Hence, total gross repayments from holding deposits in period $t-1$ (adjusted to real terms in period t) is given by $R_{t-1}^D D_{t-1} \frac{P_{t-1}}{P_t}$, with P_t denoting the price of the final good

At the start of period t, each household chooses the level of deposits, and supplies labour to the IG firms, for which it earns a factor payment of $\frac{W_t}{P_t} H_t$ (where W_t is the nominal wage).

At the end of period t, households receive all profits from IG firms ($J_t^{IG} = \int_0^1 J_{j,t}^{IG} dj$) and the commercial bank (J_t^B) in the form of lump-sum transfers. Moreover, households also pay a lump-sum tax given by T_t (in real terms).[9]

The household's budget constraint reads as,

$$C_t + D_t \leq R^D_{t-1} D_{t-1} \frac{P_{t-1}}{P_t} + \frac{W_t}{P_t} H_t + \int_0^1 J^{IG}_{j,t} dj + J^B_t - T_t. \tag{2}$$

Each household maximizes (1) with respect to (2). Combining the first order conditions with respect to C_t, D_t and H_t (taking interest rates, prices and wages as given) yields,

$$C_t^{-\varsigma} = \beta \mathbb{E}_t \left(C_{t+1}^{-\varsigma} R^D_t \frac{P_t}{P_{t+1}} \right), \tag{3}$$

$$H_t^{\gamma} C_t^{\varsigma} = W^R_t. \tag{4}$$

Equation (3) is the standard Euler equation which dictates the optimal consumption path. Equation (4) determines the optimal labour supply, where the marginal rate of substitution between leisure and consumption ($H_t^{\gamma} C_t^{\varsigma}$) equals to the real wages ($W^R_t \equiv W_t/P_t$).

2.2 Final Good Firm

A perfectly competitive representative FG firm assembles a continuum of intermediate goods ($Y_{j,t}$ with $j \in (0,1)$), to produce final output (Y_t) using the standard Dixit-Stiglitz (1977) technology, $Y_t = \left(\int_0^1 Y_{j,t}^{\frac{\lambda_p - 1}{\lambda_p}} dj \right)^{\frac{\lambda_p}{\lambda_p - 1}}$, where $\lambda_p > 1$ denotes the constant elasticity of substitution between the differentiated intermediate goods. The FG firm chooses the optimal quantities of intermediate goods ($Y_{j,t}$) that maximize its profits, taking as given both the prices of the intermediate goods ($P_{j,t}$) and the final good price (P_t). This optimization problem yields the demand function for each intermediate good given by $Y_{j,t} = Y_t \left(\frac{P_{j,t}}{P_t} \right)^{-\lambda_p}$. Finally, imposing the zero profit condition yields the usual definition of the final good price, $P_t = \left(\int_0^1 P_{j,t}^{1-\lambda_p} dj \right)^{\frac{1}{1-\lambda_p}}$.

2.3 Intermediate Good Firms

A continuum of IG producers, indexed by $j \in (0,1)$, operate in a monopolistic environment and are subject to Calvo (1983)-type nominal rigidities in their price setting. Each IG firm j uses the homogeneous labour supplied by households, and faces the following linear production function,

$$Y_{j,t} = Z_{j,t} N_t, \tag{5}$$

where N_t and $Z_{j,t}$ are the amount of labour employed and the total productivity shock experienced by firm j, respectively. Moreover, the shock $Z_{j,t}$ follows the process,

$$Z_{j,t} = A_t \varepsilon^F_{j,t}. \tag{6}$$

[9] Households also receive profits from the final good firm, but these profits are equal to zero in equilibrium as noted below.

The term A_t denotes a common economy wide technology shock which follows the $AR(1)$ process, $A_t = (A_{t-1})^{\varsigma^A} \exp(\alpha_t^A)$, where ς^A is the autoregressive coefficient and α_t^A a normally distributed random shock with zero mean and a constant variance. The expression $\varepsilon_{j,t}^F$ represents an idiosyncratic shock with a constant variance distributed uniformly over the interval $(\underline{\varepsilon}^F, \bar{\varepsilon}^F)$.[10]

The IG firm must partly borrow from a representative commercial bank in order to pay households wages in advance. Specifically, let $L_{j,t}$ be the amount borrowed by firm j, then the (real) financing constraint is equal to,[11]

$$L_{j,t} = \kappa W_t^R N_t. \tag{7}$$

with $\kappa \in (0, 1)$ determining the fraction of wage bill that must be financed at the beginning of the period.[12]

Financing labour costs bears risk and in case of default the commercial bank expects to seize a fraction χ_t of the firm's output $(Y_{j,t})$, with $\chi \in (0, 1)$ denoting the steady state value of this fraction.[13] The term χ_t is assumed to follow the $AR(1)$ shock process, $\chi_t = (\chi_{t-1})^{\varsigma^\chi} \exp(\alpha_t^\chi)$, where ς^χ denotes the degree of persistence and α_t^χ is a random shock with a normal distribution and a constant variance. A shock to effective collateral (χ_t) represents a financial (credit) shock in this model, as it affects directly the value of collateral the bank can seize in case of default as well as the credit risk at the firm level.

In the good states of nature, where the firms do not default, each firm pays back the commercial bank principal plus interest on the loans granted. Consequently, and in line with the willingness to pay approach to debt contracts, default occurs when the expected value of seizable output $(\chi_t Y_{j,t})$ is less then the amount that needs to be repaid to the lender at the end of the period. Specifically,

$$\chi_t Y_{j,t} < R_t^L L_{j,t}, \tag{8}$$

where R_t^L denotes the gross interest rate on loans granted to IG firms. Similar to Agénor and Aizenman (1998), we assume for simplicity that no IG firm defaults if the economy is at the good state of nature and the level of *collateralized* output is sufficiently high to cover for the loan repayment. It is worth noting that there exists states of nature in which the firm's output level exceeds the repayment to the commercial bank, and still the firm has an incentive to default. This occurs when $\chi_t Y_{j,t} < R_t^L L_{j,t} < Y_{j,t}$ for $\chi_t \in (0, 1)$, implying that the default condition depends on the fraction of output that can be seized by the commercial bank, net of state verification and enforcement costs. The upshot is that χ_t measures the degree of credit market imperfections.

Let $\varepsilon_{j,t}^{F,M}$ be the cut-off value below which the IG firm decides to default. Thus, using equations (5) and (6), the threshold condition can be defined as,

$$\chi_t \left(A_t \varepsilon_{j,t}^{F,M} \right) N_{j,t} = R_t^L L_{j,t}. \tag{9}$$

[10] We use the uniform distribution in order to generate plausible data-consistent steady state risk of default and loan rate spreads as explained in the parameterization section. This simple distribution also allows for a closed-form expression for credit risk. See also Faia and Monacelli (2007) who adopt a similar approach.

[11] For the purpose of this paper we abstract from net worth and firms financing loans via debt and equity (which is the case in Jermann and Quadrini (2012)). Instead, we follow the borrowing cost channel literature, initiated by Ravenna and Walsh (2006), by assuming that firms must borrow from the commercial bank to partly fund their production activity.

[12] We assume that the remainder of the wage bill, $(1 - \kappa)W_t^R N_t$, is financed through aggregate retained profits taken from the lump sum transfer to the household.

[13] Steady state values are denoted by dropping the time subscript.

Substituting equation (7) and solving the above for $\varepsilon_{j,t}^{F,M}$ yields,

$$\varepsilon_{j,t}^{F,M} = \frac{\kappa}{\chi_t A_t} R_t^L W_t^R. \tag{10}$$

Therefore, the threshold value is related to aggregate credit shocks, the funding costs and real wages, and is identical across all firms. However, in our model, the loan rate *not* only depends on the risk free rate and the finance premium (as in Agénor, Bratsiotis and Pfajfar (2014)), but *also* on credit risk shocks and the loan loss provisions to loan ratio. Given the uniform properties of ε_t^F, we can write a closed-form expression for the probability of default (or the fraction of nonperforming loans),

$$\Phi_t = \int_{\underline{\varepsilon}^F}^{\varepsilon_t^{F,M}} f(\varepsilon_t^F) d\varepsilon_t^F = \frac{\varepsilon_t^{F,M} - \underline{\varepsilon}^F}{\bar{\varepsilon}^F - \underline{\varepsilon}^F}. \tag{11}$$

We assume a two stage pricing decision problem during period t. In the first stage, each IG producer minimizes the cost of employing labour, taking its (real) effective costs ($R_t^L W_t^R$) as given. This minimization problem yields the real marginal cost,[14]

$$mc_{j,t} = \frac{\left[1 + \kappa\left(R_t^L - 1\right)\right] W_t^R}{Z_{j,t}}. \tag{12}$$

In the *second stage*, each IG producer chooses the optimal price for its good. Here Calvo (1983)-type contracts are assumed, where a portion of ω_p firms keep their prices fixed while a portion of $1 - \omega_p$ firms adjust prices optimally given the going marginal costs and the loan rate (set at the beginning of the period). The firm's problem is to maximize the following expected discounted value of current and future real profits subject to the demand function for each good, and taking the marginal costs as given. Formally that is,

$$\max_{P_{j,t+s}} \mathbb{E}_t \sum_{s=0}^{\infty} \omega_p^s \Delta_{s,t+s} \left[\left(\frac{P_{j,t+s}}{P_{t+s}}\right)^{1-\lambda_p} Y_{t+s} - mc_{t+s} \left(\frac{P_{j,t+s}}{P_{t+s}}\right)^{-\lambda_p} Y_{t+s} \right], \tag{13}$$

where $\Delta_{s,t+s} = \beta^s \left(C_{t+s}/C_t\right)^{\varsigma}$ is the total discount factor.[15]

Denoting P_t^* as the optimal price level chosen by each firm at time t, and using the definition of the total discount factor, the first order condition of the above problem with respect to P_t^* yields

[14] Below we show that the bank sets the loan rate based on the IG firm's default decision and threshold default value. Therefore, the risk of default has also a direct effect on the IG firms marginal costs through its endogenous impact on the cost of borrowing. In other words, firms internalize the possibility of default in their optimal pricing behaviour once they borrow at the going lending rate.

[15] The IG firms are owned by the households and therefore each firm's discount value is $\beta^s \left(\frac{C_{t+s}}{C_t}\right)^{\varsigma}$. Intuitively, $\left(\frac{C_{t+s}}{C_t}\right)^{\varsigma}$ is the marginal utility value (in terms of consumption) of a one unit increase of IG firms profits in period t.

the optimal relative price equation,[16]

$$\frac{P_t^*}{P_t} = \left(\frac{\lambda_p}{\lambda_p - 1}\right) \frac{\mathbb{E}_t \sum_{s=0}^{\infty} \omega_p^s \beta^s C_{t+s}^{-\frac{1}{\varsigma}} Y_{t+s} mc_{t+s} \left(\frac{P_{t+s}}{P_t}\right)^{\lambda_p}}{\mathbb{E}_t \sum_{s=0}^{\infty} \omega_p^s \beta^s C_{t+s}^{-\frac{1}{\varsigma}} Y_{t+s} \left(\frac{P_{t+s}}{P_t}\right)^{\lambda_p - 1}}, \tag{14}$$

with (P_t^*/P_t) denoting the relative price chosen by firms adjusting their prices at period t and $pm = [\lambda_p / (\lambda_p - 1)]$ representing the price mark-up.

Finally, using the aggregate price equation with the Calvo (1983) price rigidities, and log-linearizing equation (14) yields the familiar form of the New Keynesian Phillips Curve (NKPC),

$$\widehat{\pi}_t = \beta E_t \widehat{\pi_{t+1}} + \frac{(1-\omega_p)(1-\omega_p\beta)}{\omega_p} \widehat{mc_t}. \tag{15}$$

where the marginal cost is determined directly also by the cost of borrowing from the commercial bank (from equation 12).

2.4 Financial Intermediation

2.4.1 Balance Sheet and Loan Loss Reserves

Consider a perfectly competitive financial intermediary (a bank in short), who raises funds through deposits (D_t) in order to supply credit (L_t) to IG firms. The supply of credit is perfectly elastic at the prevailing loan rate and therefore the total amount of lending provided by the bank is given by equation (7). Moreover, the bank holds government bonds (B_t), a safe asset, which yields a gross return of R_t^B. As the loan portfolio takes into account expected loan losses, loan loss reserves (LLR_t) are subtracted from total loans, consistent with standard practice (see Walter (1991) and Bouvatier and Lepetit (2012a)). The representative bank lends to a continuum of firms and therefore its balance sheet in real terms can be written as,

$$L_t - LLR_t + B_t = D_t, \tag{16}$$

where $L_t \equiv \int_0^1 L_{j,t} dj$ is the aggregate lending to IG firms.

The bank must also satisfy regulation in the form of setting loan loss provisions (a flow), which are deducted from current earnings. As noted earlier, these provisions (defined in detail in the next section) can be based on either a backward- or a forward-looking system. Loan loss reserves (a stock) are assumed to be re-invested in each period into a safe asset such that $LLR_t = B_t$. This assures that loan loss reserves are a liquid asset and available to face losses (as in Bouvatier and Lepetit (2012a)).[17] Consequently, we do not need to specify the evolution of loan loss reserves in

[16] The sibscript j is dropped because all re-optimizing firms choose the same price so everything becomes time dependent.

[17] In practice, *variations* in loan loss reserves are equal to the flow of provisions plus unanticipated charged-off loans (subtracted from earnings) minus charged-off loans (Walter (1991)). Due to the intra-period nature of loans and rational expectations, we do not model charged-off loans given that there is no distinction between the fraction of nonperforming loans and the fraction of charged-off loans (both which are equal to the risk of default). To avoid

order to examine the direct effects of loan loss provisioning practices on the bank's intermediation activities. Using these results, the commercial bank's balance sheet boils down to,

$$L_t = D_t. \tag{17}$$

2.4.2 Provisioning Rules and Nonperforming Loans

Provisioning rules are set by the central bank. We consider two specifications of loan loss provisions, which depend directly on the fraction of problem loans: First, a *backward-looking* provisioning system, where loan loss provisions are driven by contemporaneous nonperforming loans and fit identified loan losses. Second, we examine a *forward-looking* provisioning system that requires the bank to make provisions related to current risk *and* expected losses over the whole business cycle. Loan loss provisions are defined as,

$$LLP_t^i = l_0 \Phi \left(\frac{\Phi_t}{\Phi} \right)^{1-\mu} L_t, \tag{18}$$

where l_0 is the steady state fraction of nonperforming loans ($\Phi \left(\frac{\Phi_t}{\Phi}\right)^{1-\mu} L_t$), which are covered by loan loss provisions in period t (also referred to as the coverage ratio). The term Φ is the steady state risk of default, and $\mu \in (0, 1)$ the degree of loan loss provisions smoothing under the forward-looking system. With $\mu = 0$ (no smoothing), $LLP_t^{BK} = l_0 \Phi_t L_t$, corresponding to the extreme backward-looking case (superscript BK). In contrast, the forward-looking provisioning system (superscript FW), is represented by setting $0 < \mu \leq 1$ such that $LLP_t^{FW} = l_0 \Phi^{\mu} \Phi_t^{1-\mu} L_t$. A larger μ implies a higher smoothing effect on loan loss provisions. In this way, during an economic expansion, where the short run value of nonperforming loans (Φ_t) is lower than the estimation of the latent risk over the whole cycle (Φ) and lending (L_t) is high, the bank can build up statistical provisions. Therefore, taking into account expected losses over the business cycle offsets the short-run impact of problem loans on total provisions, and allows the bank to deduce constant expected losses in each period when $\mu = 1$.[18] Note also that regardless of the provisioning regime, the steady state value of loan loss provisions is always $LLP = l_0 \Phi L$.

As we show later, the probability of default in this setup moves countercyclically with output (collateral) and therefore a rise in the fraction of nonperforming loans, associated with deteriorating economic conditions, results in an increase in loan loss provisions and the loan loss provisions to loan ratio. These results are consistent with the main stylized facts characterizing the evolution of specific loan loss provisions (see references provided in the introduction).

It is important to note that this paper adopts a positive approach to loan loss provisions and more generally to macroprudential policy. That is, we take as given the presence of empirically relevant regulatory loan loss provisions and examine how different accounting rules to these provisioning practices affect the economy and interact with standard and augmented monetary policy rules. However, unlike Angelini, Neri and Panetta (2014) for example, who also pursue a positive analysis in examining the interaction between bank capital requirements and monetary policy, the

a zero steady state value of provisions and to simplify the analysis, we assume that loan loss reserves are invested in a safe asset in each period. Loan loss provisions therefore only appear in the bank's income statement.

[18] Provisions in the forward-looking system therefore do not explicitly depend on the statistical prediction of nonperforming loans in period $t + 1$. Rules are specified in order to smooth provisions made by the bank over a whole business cycle (see also Bouvatier and Lepetit (2012a)).

policy objective in our model is micro-founded and based on the underlying economic and financial distortions.

2.4.3 Lending Rate Decision

The lending rate is set at the beginning of the period before IG firms engage in their production activity and prior to their labour demand and pricing decisions. As IG firms may default on their loans at the end of the period due to idiosyncratic shocks, the repayments to the commercial bank, for a given one period contract are uncertain. The bank expects to break even from its intermediation activity, such that the expected income from lending to a continuum of IG firms minus the new flow of loan loss provisions for the given period, is equal to the total costs of borrowing deposits from households. Specifically,

$$\begin{aligned} & \int_{\varepsilon_{j,t}^{F,M}}^{\bar{\varepsilon}^F} \left[R_t^L L_{j,t}\right] f(\varepsilon_{j,t}^F) d\varepsilon_{j,t}^F + \int_{\underline{\varepsilon}^F}^{\varepsilon_{j,t}^{F,M}} \left[\chi_t Y_{j,t}\right] f(\varepsilon_{j,t}^F) d\varepsilon_{j,t}^F - LLP_t^i \\ = \; & R_t^D D_t \end{aligned} \tag{19}$$

where $f(\varepsilon_{j,t}^F)$ is the probability density function of $\varepsilon_{j,t}^F$. The first element on the left hand side is the repayment to the bank in the non-default states while the second element is the expected return to the bank in the default states.[19] Finally, loan loss provisions (LLP_t^i) are an expense for the bank and are therefore deducted from its expected income statement.

Turning now to the derivation of the lending rate note that,

$$\begin{aligned} \int_{\varepsilon_{j,t}^{F,M}}^{\bar{\varepsilon}^F} \left[R_t^L L_{j,t}\right] f(\varepsilon_{j,t}^F) d\varepsilon_{j,t}^F \;\; \equiv \;\; & \int_{\underline{\varepsilon}^F}^{\bar{\varepsilon}^F} \left[R_t^L L_{j,t}\right] f(\varepsilon_{j,t}^F) d\varepsilon_{j,t}^F - \\ & - \int_{\underline{\varepsilon}^F}^{\varepsilon_{j,t}^{F,M}} \left[R_t^L L_{j,t}\right] f(\varepsilon_{j,t}^F) d\varepsilon_{j,t}^F, \end{aligned}$$

where $\int_{\underline{\varepsilon}^F}^{\bar{\varepsilon}^F} \left[R_t^L L_{j,t}\right] f(\varepsilon_{j,t}^F) d\varepsilon_{j,t}^F \equiv R_t^L L_{j,t}$. Hence, equation (19) can be written as,

$$\begin{aligned} & R_t^L L_{j,t} - \int_{\underline{\varepsilon}^F}^{\varepsilon_{j,t}^{F,M}} \left[(R_t^L L_{j,t} - (\chi_t Y_{j,t})\right] f(\varepsilon_{j,t}^F) d\varepsilon_{j,t}^F \\ = \; & R_t^D D_t + LLP_t^i. \end{aligned} \tag{20}$$

Using the bank's balance sheet (equation 17), substituting (9) for $\chi_t \left(A_t \varepsilon_{j,t}^{F,M}\right) N_{j,t} = R_t^L L_{j,t}$, and employing the value of output from the production function (5) gives,

$$\begin{aligned} & R_t^L L_{j,t} - \int_{\underline{\varepsilon}^F}^{\varepsilon_{j,t}^{F,M}} \left[\varepsilon_{j,t}^{F,M} - \varepsilon_{j,t}^F\right] \chi_t A_t N_{j,t} f(\varepsilon_{j,t}^F) d\varepsilon_{j,t}^F \\ = \; & R_t^D L_{j,t} + LLP_t^i. \end{aligned} \tag{21}$$

[19] In times of default, the collateral received by the bank is handed over to the household as a lump sum transfer such that deposits are insured. In addition, the return on loan loss reserves (which are invested in the safe asset) go back to the household also as a lump sum transfer and do not affect the determination of the loan rate.

Dividing by $L_{j,t}$, dropping the subscript j (given that the amount of labour and loans are the same for all firms), and applying the characteristics of the uniform distribution yields,

$$R_t^L = R_t^D + \frac{LLP_t^i}{L_t} + \left(\frac{\chi_t A_t}{\kappa W_t^R}\right) \frac{\left(\bar{\varepsilon}^F - \underline{\varepsilon}^F\right)}{2} \Phi_t^2. \tag{22}$$

Finally, substituting (10) and (11) in (22) gives the final loan rate equation,

$$R_t^L = \nu_t \left(R_t^D + \frac{LLP_t^i}{L_t}\right), \tag{23}$$

where the term $\nu_t \equiv \left[1 - \frac{\left(\bar{\varepsilon}^F - \underline{\varepsilon}^F\right)}{2\varepsilon_t^{F,M}} \Phi_t^2\right]^{-1} > 1$ is defined as the finance premium, which itself is also a positive function of the lending rate.

From equation (23), the loan rate is affected by various components: a) the direct *monetary policy cost channel* associated with changes in the deposit rate, equal to the refinance rate in the absence of required reserves policies and central bank borrowing; b) the *finance premium channel*, which is related to the fact that the bank expects to receive back only a fraction of its loans and seize collateral in case of default. The bank internalizes the positive risk of default and consequently charges a higher loan rate.

The contribution of this model is the additional effects loan loss provisioning rules have on the cost of borrowing and consequently on the financial system and real economy. A higher loan loss provisions to loan ratio (LLP_t^i/L_t), associated with a rise in identified credit losses, lowers the profitability of the bank and therefore requires an increase in the loan rate for the break-even condition to be satisfied. This can explain procyclicality in the credit markets generated by backward-looking provisioning systems (also the main result in Bouvatier and Lepetit (2012a, 2012b)). Moreover, through an internal propagation mechanism, the higher borrowing costs amplify the rise in nonperforming loans and produce further procyclicality in financial variables (see equations 10, 11 and 23). More precisely, backward-looking provisions in this model result in higher financial risk, supporting empirical findings by Jin, Kanagaretnam and Lobo (2011). We refer to this channel, through which loan loss provisions determine the loan rate and nonperforming loans, as the *provisioning cost channel*.

Finally, as the monetary policy cost, the finance premium and the provisioning cost channels all directly impact the lending rate dynamics, these channels ultimately affect the behaviour of the real marginal costs, inflation and output via the *borrowing cost channel*. In other words, this general equilibrium framework allows us to examine how accounting rules for loan loss provisions can translate into real macroeconomic effects.

2.5 Monetary Policy

The central bank sets the loan loss provisioning rules (as explained above) and in addition targets the short term policy rate (R_t^{cb}) according to the following Taylor (1993)-type policy rule,[20]

$$R_t^{cb} = \left[\left(R^{cb}\right) \left(\frac{\pi_t}{\pi^T}\right)^{\phi_\pi} \left(\frac{Y_t}{Y_t^n}\right)^{\phi_Y} \left(\frac{L_t/Y_t}{L/Y}\right)^{\phi_L} \right]^{1-\phi} \left(R_{t-1}^{cb}\right)^{\phi}, \tag{24}$$

where $\phi \in (0,1)$ is the degree of interest rate smoothing and $\phi_\pi, \phi_Y > 0$ coefficients measuring the relative weights on inflation deviations from its target (π^T) and the 'natural' output gap, respectively. The output gap is defined as deviations of output from its flexible price equilibrium (natural) level given by $Y_t^n = \left[\frac{Z_t^{1+\gamma}}{(pm)R_t^L}\right]^{\frac{1}{(\varsigma+\gamma)}}$. That is, the natural level of output (denoted by superscript n) is dependent on the borrowing cost channel, which, in turn, is driven by the monetary policy cost, provisioning cost and finance premium channels. The new term added to the standard Taylor rule is $\left(\frac{L_t/Y_t}{L/Y}\right)^{\phi_L}$, where ϕ_L measures the response of the policy rule to deviations in the credit to output ratio. These type of credit-augmented monetary policy rules ('leaning against the credit cycle') have been widely used in several other studies such as Benes and Kumhof (2011) and Angelini, Neri and Panetta (2014), among others.

2.6 Government

The government collects lump-sum taxes from households, and issues risk-free bonds, held only by the commercial bank in the form of loan loss reserves. Thus, the government's budget constraint in real terms is: $T_t + B_t = R_{t-1}^B B_{t-1} \frac{P_{t-1}}{P_t}$.

2.7 Market Clearing Conditions

In a symmetric equilibrium, households are identical and IG firms produce the same output ($Y_{j,t} = Y_t$ for all $j \in (0,1)$) and set equal prices ($P_{j,t} = P_t$ for all $j \in (0,1)$). The supply of loans by the commercial bank and the supply of deposits by households are assumed to be perfectly elastic at the prevailing interest rates and therefore markets for loans and deposits always clear. The goods market clearing condition is therefore: $Y_t = C_t$.[21]

3 Parameterization

The baseline parameterization of the model is summarized in Table 1. Parameters that characterize tastes, preferences, technology and the Taylor rule, are all standard in the literature. We therefore focus on in what follows on the parameters that are new and unique to this model.[22]

[20] With no required reserves policies and in the absence of central bank borrowing, the deposit rate, bond rate and policy rate are all equal ($R_t^{cb} = R_t^D = R_t^B$). The equality $R_t^{cb} = R_t^B$ ensures that the commercial bank has no incentive to borrow from the central bank in order to invest in government bonds.

[21] The lost output in case of default is already incorporated in the goods market clearing condition. This is because collateral in this model is given by the level of output (and thus consumption), which already is endogenously related to the probability of default

[22] In Table 1, LLP refers to loan loss provisions, and NPL to nonperforming loans.

Table 1: Benchmark Parameterization - Parameter Values

Parameter	Value	Description
β	0.99	Discount Factor
ς	1.00	Inverse of Elasticity of Intertemporal Substitution
γ	3.00	Inverse of the Frisch Elasticity of Labour Supply
λ_p	6.00	Elasticity of Demand for Intermediate Goods
ω_p	0.70	Degree of Price Stickiness
A	1.00	Average Productivity Parameter
κ	0.50	Strength of the Borrowing Cost Channel
$\bar{\varepsilon}^F$	2.00	Idiosyncratic Productivity Shock Upper Range
$\underline{\varepsilon}^F$	0.50	Idiosyncratic Productivity Shock Lower Range
χ	0.97	SS Fraction of Collateral Seized in Default State
l_0	1.00	LLP Coverage Ratio
μ	0.00	Smoothing Coefficient in Dynamic LLP Rule
ϕ	0.80	Degree of Persistence in Taylor rule
ϕ_π	1.50	Response of Policy Rate to Inflation Deviations
ϕ_Y	0.125	Response of Policy Rate to Output Gap
ϕ_L	0.00	Response of Policy Rate to Credit-GDP Deviations
ς^A	0.80	Degree of Persistence - Supply Shock
ς^χ	0.80	Degree of Persistence - Credit Shock

For illustrative purposes in the model dynamics section, we compare a backward-looking provisioning system ($\mu = 0$) with an advanced forward-looking system ($\mu = 0.8$). Moreover, the loan loss provisions coverage ratio (l_0) is calibrated at 1, meaning that loan loss provisions fully cover for nonperforming loans. This value, together with $\chi = 0.97$, $\kappa = 0.5$ and an idiosyncratic productivity range of $(0.50, 2.00)$, gives a loan loss provisions-loan ratio (matching the fraction of nonperforming loans) of 3.23% and a loan rate of 4.39%.[23] These values are within the range observed for industrialized countries. The response of the policy rule to deviations in the credit to output ratio (ϕ_L) is set to 0.025. With standard Taylor rule parameters ($\phi_\pi = 1.5$ and $\phi_Y = 0.125$), we conduct these initial counterfactual experiments in order to highlight the transmission channels of the additional new macroprudential rules in isolation, and before the examination of their optimal combination in the optimal simple policy rules section.

4 Model Dynamics

This section examines the cyclical behaviour of the macroeconomic and financial variables following an adverse financial shock to χ_t.[24]

Under this shock a comparison is made between the following three regimes:

[23] Reducing the steady state value of the probability χ, which is a key financial friction in this model, raises the cost of borrowing in the long run as well as amplifies the response of both financial and real variables following various shocks. Similarly, increasing the weight of the borrowing cost channel (κ) also exacerbates the response of key economic and financial variables.

[24] Results of supply shocks did not show significant differences across provisioning regimes and are not reported here to save space. In fact, Christiano, Motto and Rostagno (2014), and Jermann and Quadrini (2012) show that different types of financial shocks are the most important shocks driving real and financial variables.

- *The first* baseline policy regime examines a combination of a backward-looking provisioning system (BK) and a standard Taylor rule (STR) ($\mu = 0, \phi_L = 0$, solid blue line).

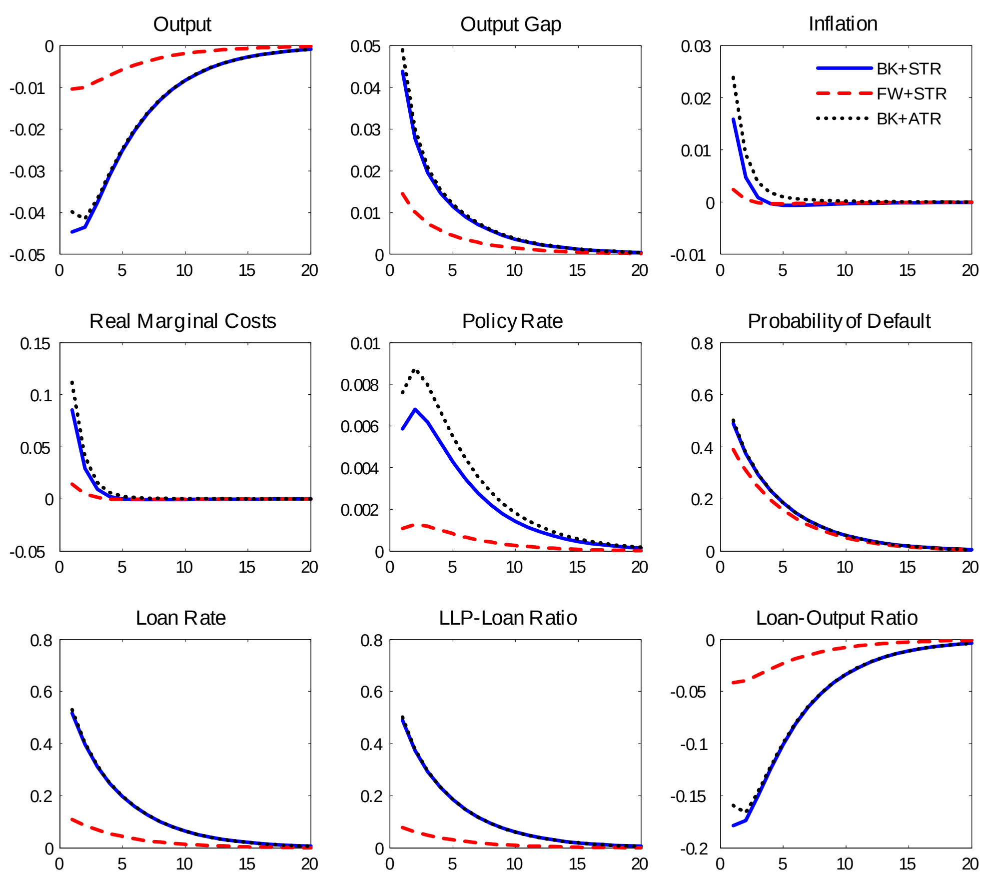
- *The second* regime combines a forward-looking provisioning system (FW) and a standard Taylor rule (STR) ($\mu = 0.8, \phi_L = 0$, dashed red line).

- *The third* regime combines a backward-looking provisioning system (BK) and an augmented Taylor rule (ATR) ($\mu = 0, \phi_L = 0.025$, dotted black line).

Financial Shock

Figure 1 shows the impulse response functions of the main variables of the model following a negative 1 standard deviation shock to χ_t.

Figure 1: Adverse Financial Shock



Note: Interest rates, inflation rate, the probability of default and the LLP-loan ratio are measured in percentage point deviations from steady state. The rest of the variables are measured in terms of percentage deviations.

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The direct effect of a negative financial shock is an immediate rise in nonperforming loans and consequently the loan rate through the finance premium channel. The hike in the lending rate, coupled with the rise in risk, raises the marginal costs, increases price inflation and lowers the level of output (collateral) via the borrowing cost channel. The decreasing levels of available collateral increases further the possibility of default by IG firms and propagates the worsening credit market conditions into the real economy. Furthermore, with standard Taylor rule parameters, higher prices lead the central bank to raise the policy rate, thus inducing an additional amplification effect on the loan rate through the monetary policy cost channel. However, by raising the policy rate, output deteriorates further, which, in turn, mitigates the rise in the output gap and inflation via the standard demand channel of monetary policy. Overall, given the nature of the adverse financial shock, the rise in the loan rate raises inflation, reduces output and amplifies the fall in both credit and the loan to output ratio.[25,26]

As raising regulatory loan loss provisions is costly for the bank, a backward-looking provisioning system magnifies the movement in the loan rate and nonperforming loans in relation to the case where provisions are absent. [27] As a result, inflationary pressures increase while the drop in output and the loan to output ratio is exacerbated.

These adverse procyclical effects of costly backward-looking provisioning systems highlight the importance of implementing a more forward-looking regime. With statistical provisioning systems, a higher weight is placed on the latent risk over the whole business cycle such that the commercial bank needs not to raise as much provisions in response to a negative shock hitting the banking system. Expected credit losses are taken more into account, and offset the immediate impact of current nonperforming loans on loan loss provisions and the loan rate. The fall in the lending rate attributed to the weaker provisioning cost channel produces an attenuating effect on nominal, real and financial variables through the borrowing cost channel described above.

A credit augmented Taylor rule *initially mitigates* the rise in the policy rate following a fall in the loan to output ratio, which moderates the decline in output and raises the output gap through an intertemporal substitution effect. Nevertheless, the higher output gap creates inflationary pressures via the standard demand channel of monetary policy, leading to a rise in the policy rate. Given our standard calibration values, the demand channel dominates the monetary policy cost channel such that the policy rate *overall rises* in response to the demand driven inflation. The higher cost of deposits raises the loan rate charged by the commercial bank, thereby adding to the rise in the IG firms' marginal costs and price inflation.

In conclusion, we show that moving towards a forward-looking provisioning regime reduces significantly procyclicality in key macro and financial variables. Further, a credit augmented Taylor rule can contribute to output stability but at the expense of higher volatility in borrowing costs and inflation. We now turn to examine the optimal interaction between monetary policy rules and forward-looking provisioning rules.

[25] See also Gilchrist, Schoenle, Sim and Zakrajsek (2014), who show that *aggregate* inflation rises following adverse financial shocks.

[26] Although not shown in the impulse response functions, real wages, employment and loans all decrease following the negative credit shock. Moreover, output and loans always move in the same direction, with the latter being the more volatile variable.

[27] This additional simulation without provisions is available upon request though it is straightforward to see why backward-looking provisions amplify procyclicality in financial and real variables.

5 Optimal Simple Policy Rules

This section provides an analysis of the optimal interaction between the monetary policy and provisioning rules outlined above. For this purpose, we use the parameter values used in the previous sections, with the central bank aiming to minimize a period average welfare loss function proportional to,

$$Loss_t = \frac{\lambda_p}{k_p} var(\widehat{\pi}_t) + (\varsigma + \gamma)\, var(\widehat{Y_t^g}), \tag{25}$$

where $k_p = (1 - \omega_p)(1 - \omega_p \beta)/\omega_p$, and $\widehat{Y_t^g} = \widehat{Y}_t - \widehat{Y_t^e}$ is the *welfare relevant* output gap. The term $\widehat{Y_t^e} = [(1 + \gamma)/\,(\varsigma + \gamma)]\,\widehat{Z_t}$ is the efficient level of output chosen by the social planner who can overcome all the nominal and financial frictions in this economy. As supply shocks are not considered for the purpose of this paper, the welfare relevant output gap is simply equal to cyclical output, $\widehat{Y_t^g} = \widehat{Y}_t$.[28] The above loss function is derived using a second order approximation of the household's utility function, just as in Woodford (2003) and Ravenna and Walsh (2006), who incorporate the monetary policy cost channel (without the additional frictions affecting the borrowing cost channel as in this paper). Similar to Ravenna and Walsh (2006), the presence of the borrowing cost channel creates a wedge between the natural and efficient level of output. Specifically, $\widehat{Y_t^e} - \widehat{Y_t^n} = [1/\,(\varsigma + \gamma)]\,\widehat{R_t^{L,n}}$, where $\widehat{Y_t^n}$ and $\widehat{R_t^{L,n}}$ denote the natural level of output and loan rate prevailing under flexible prices.[29]

The policy rules examined are: Policy I - Central bank responding to inflation and output gap in the Taylor rule (solving for ϕ_π and ϕ_Y and setting $\phi_L = \mu = 0$). Policy II - Central bank responding to inflation, output gap and the loan to GDP ratio (solving for ϕ_π, ϕ_Y and ϕ_L and setting $\mu = 0$). Policy III - A credit augmented Taylor rule and a forward-looking provisioning system (solving for ϕ_π, ϕ_Y, ϕ_L and μ). The optimal parameters which minimize the above loss function are searched within the following implementable ranges: $\phi_\pi = [1:5]$, $\phi_Y = [0:1]$, $\phi_L = [0:1]$ and $\mu = [0:1]$ with step of 0.01.

Table 2 shows the optimal simple policy rules and how the value of each policy rule changes with the introduction of additional policy instruments following the adverse financial shock considered in this model.

[28] We also do not examine the ex-post effects of the actual idiosyncratic productivity shock ($\varepsilon_{j,t}^F$), but only consider its uniform properties and how its threshold ($\varepsilon_{j,t}^{F,M}$) value moves in response to aggregate shocks hitting the economy at the beginning of the period. Therefore, $\widehat{Y_t^g} = \widehat{Y}_t$ in the absence of beginning of period supply and end of period idiosyncratic shocks still holds.

[29] The richer borrowing cost channel therefore does not change the *structure* of the loss function compared to standard new Keynesian models with only price rigidities. However, unlike Ravenna and Walsh (2006), where $\widehat{R_t^{L,n}} = 0$, in our model the presence of the various financial frictions also lead to deviations in $\widehat{R_t^{L,n}}$ and hence generate the wedge between $\widehat{Y_t^n}$ and $\widehat{Y_t^e}$ (see also Airaudo and Olivero (2013)).

Table 2: Optimal Simple Policy Rules

	Financial Shocks
Policy I	$\phi_\pi = 2.60$ $\phi_Y = 0.40$ $\phi_L = -$ $\mu = -$ $Loss = 0.0392$
Policy II	$\phi_\pi = 2.60$ $\phi_Y = 0.40$ $\phi_L = 0.00$ $\mu = -$ $Loss = 0.0392$
Policy III	$\phi_\pi = 1.20$ $\phi_Y = 0.30$ $\phi_L = 0.04$ $\mu = 1$ $Loss = 1.67 \times 10^{-4}$

Note: The value of the loss function is calculated following a 1 s.d. credit shock

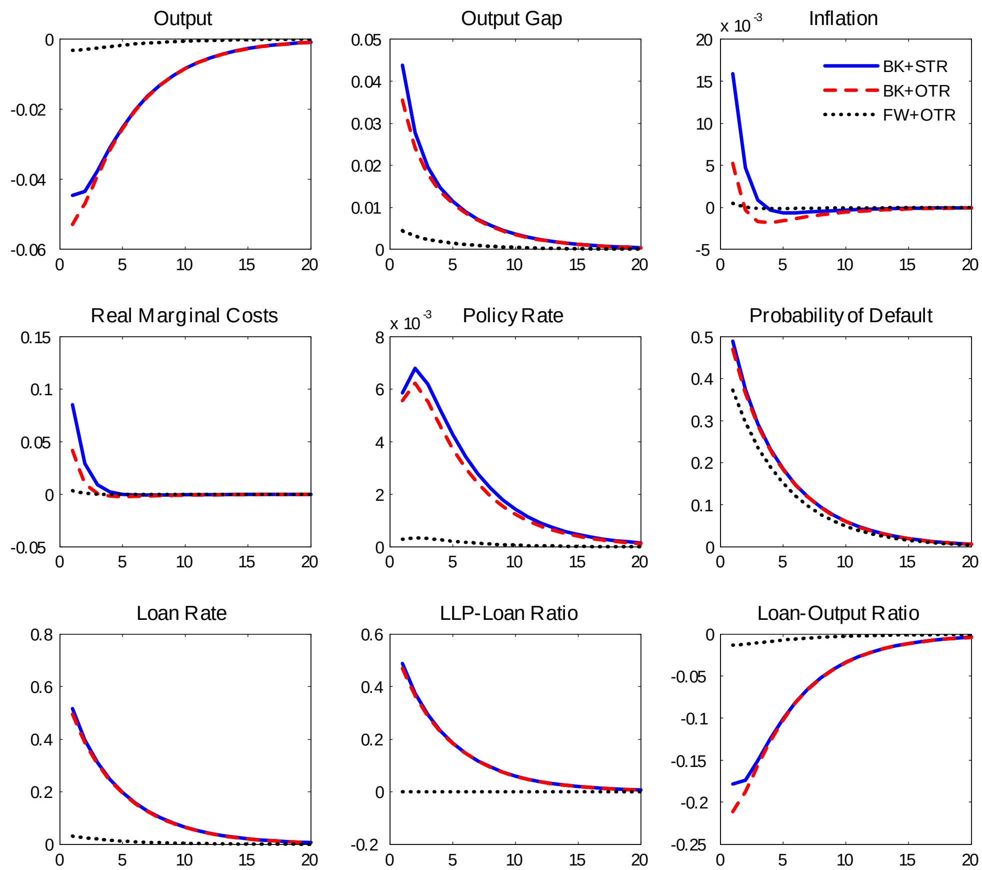
Policy I prescribes a relatively high, yet contained, weight on inflation and the output gap in the Taylor rule such that the refinance rate initially increases following adverse credit shocks. In this case, the 'natural' output gap is lowered (compared to a standard Taylor rule policy), which mitigates the inflationary pressures resulting from the borrowing cost channel. At the same time, the higher policy rate amplifies welfare output losses, but this has a smaller impact on overall welfare given that the policy maker places a much higher weight on inflation variance relative to output volatility in the micro-founded loss function. The upshot is that the fall in the 'natural' output gap and inflation create downward effects on the policy rate, which contributes further to price stability through the monetary policy cost channel.

In Policy II, we observe that a credit augmented Taylor rule does not promote overall welfare as it creates demand driven inflation despite mitigating output losses (see the simulations in previous section). However, Policy III shows that when a forward-looking provisioning rule is fully implemented, there is also a role for a 'leaning against the credit cycle' type of monetary policy. Under this policy mix, inflation is contained by the dynamic provisioning system, whereas output can be further stabilized by reacting modestly to a financial indicator in the Taylor rule. The central bank can also afford to respond *less* stringently to inflation as the forward-looking provisioning regime already targets directly the inflationary borrowing cost channel. To conclude, a combination of forward-looking provisions and a mildly credit augmented Taylor rule produces the best outcome in terms of minimizing welfare losses.

Figure 2 depicts the impulse response functions associated with optimal Policy I (identical to Policy II - both represented by the dashed red line and labelled as backward-looking provisions + optimal Taylor rule (BK+OTR)), and Policy III (represented by the dotted black line and labelled as FW+OTR) following a negative 1 standard deviation shock to χ_t. These policies are compared against the backward-looking provisions + standard Taylor rule (BK+STR) case illustrated by the solid blue line.[30] The impulse response functions illuminate and summarize the above discussion.

[30] Note that the BK+STR regime represented by the solid blue line in Figure 2 corresponds to the solid blue line

Figure 2: Adverse Financial Shock with Optimal Policy Rules



Note: Interest rates, inflation rate, the probability of default and the LLP-loan ratio are measured in percentage point deviations from steady state. The rest of the variables are measured in terms of percentage deviations.

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6 Concluding Remarks

This paper provides new insights on how macroprudential measures in the form of forward-looking loan loss provisions impact the financial system and real economy, as well as alter the optimal conduct of monetary policy. Key features of this framework include nominal price rigidities, a borrowing cost channel, collateralized lending, endogenous countercyclical risk of default (nonperforming loans), financial shocks and a distinction between backward- and forward-looking provisioning systems.

and the BK+STR policy in Figure 1.

Following financial shocks, we find that backward-looking provisions amplify the procyclical effects of the loan rate behaviour and more generally of the financial system. As the lending rate influences the marginal costs, backward-looking provisions exacerbate also the response of output and inflation through the borrowing cost channel. Nevertheless, switching to a more forward-looking provisioning system, as currently advocated by the Basel committee, considerably mitigates these adverse procyclical consequences on the financial sector and real economy. Additionally, statistical loan loss provisions significantly modify the transmission mechanism of monetary policy, and allow central banks to be more 'dovish' by focusing on financial market conditions with a smaller risk of generating demand side inflation. The upshot is that a dynamic provisioning regime combined with an augmented Taylor rule is optimal in terms of minimizing central bank welfare losses.

The conclusions drawn from this paper support the recent calls by the Basel committee to re-design accounting principles such that banks set discretionary provisions in a timely manner based on the expected-loss approach (see Basel Committee on Banking Supervision (2011,2012)). Indeed, the Basel Committee continues to work with the International Accounting Standards Board (IASB) on the expected-loss approach to loan loss provisions in order to reform the IAS 39 and the incurred-loss framework instigated by backward-looking provisions. Coordinating between these boards and central banks, by increasing transparency regarding the roles of each institutional body, can promote even further financial and macroeconomic stability.

A natural extension of this model would be to simultaneously account for countercyclical capital requirement regimes and statistical loan loss provisioning systems, and understand how such policy tools interact with one another. That is, if both tools can act to reduce financial and real sector volatility, do they exhibit complementarity or substitutability? Understanding the optimal interaction between accounting rules for loan loss provisions and countercyclical capital buffers is left for future research.

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