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Deposit insurance pricing and monetary policy transmission

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Abstract

This paper provides a theoretical model that examines the effect of deposit insurance pricing on monetary policy transmission. An increase in the key policy rate benefits bank deposits when the deposit insurance premium is lower than the fair value. This leads firms to withdraw from the capital market and boosts their demand for bank lending. Thus, a lower than the fair value deposit insurance premium strengthens the monetary policy transmission on bond returns and bank interest rates. In contrast, a fair valuation of risks ensures the neutrality of the deposit insurance on the interest rate pass-through.

Keywords: Deposit insurance; Monetary policy transmission; Bank imperfect competition

JEL classification: E52; G21; G22

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1 Introduction

This paper studies the monetary policy implications of the misvaluation of risks and the mispricing of deposit insurance. It finds that the gap between the deposit insurance premium and its fair value distorts the effect of deposit insurance on monetary policy transmission. We advocate that a risk-based deposit insurance pricing contributes to the effectiveness of monetary policy, in addition to promoting financial stability through a reduction of bank risk-taking.

We find that a differential between the deposit insurance premium and its fair value changes the relative perception of risks of firm bonds and bank deposits. This in turn modifies households' arbitrage between bank deposits and firm bonds and affects firms' reliance on bank lending, ultimately distorting the extent of monetary policy transmission. We also show that the distortion widens when the coverage of deposit insurance is extended. An important policy implication is that setting a deposit insurance premium at its fair value makes the deposit insurance pricing as well as a shift in its coverage neutral for the monetary policy transmission.

We take a novel approach in studying the effect of deposit insurance on monetary policy transmission using a monopolistic competition framework. Our model builds on Grimaud and Rochet (1994) who develop a monopolistic competition model based on the spatial competition contribution of Salop (1979). This approach explicitly takes into account the differentiation of banking services. Grimaud and Rochet show that monopolistic competition weakens the monetary policy transmission, i.e. a change in the policy rate is transmitted less than one-to-one to bond returns and lending rates. We extend their model by introducing uncertainty in firms' return on investment and a deposit insurance mechanism. Firms face a risk of failure leading banks to be subject to a default risk. Depositors are covered by a deposit guarantee scheme, for which banks must pay an insurance premium. We allow the actual deposit insurance premium paid by financial institutions to differ from the fair value. We find that the introduction of uncertainty and the adoption of a Deposit Insurance Scheme (DIS) affect the monetary policy transmission. This effect adds to the distortion of the transmission mechanism of the monetary policy caused by bank services differentiation, as shown by Grimaud and Rochet.

Our model also builds on Andries and Billon (2010), who study the relationship between deposit insurance, state ownership and monetary policy. They show that banks with a larger state share in their ownership are more able to circumvent the effect of a monetary policy tightening on their lending due to their ability to raise additional volume of deposits. In their model, the distortion in the monetary policy transmission comes from the households' arbitrage between deposits held with state-owned banks and private banks, since they rule out the capital market. We extend the model of Andries and Billon by allowing firms to issue bonds on the capital market. This feature coupled with the presence of a DIS implies households' trade-off between bank deposits and firm bonds, which affects monetary policy transmission.

Our paper is related to the recent literature on the deposit channel of monetary policy developed by Drechsler et al. (2017). According to this channel, in a context of imperfect competition, an increase in the policy rate widens the interest rate spread applied on deposits and lowers the amount of deposits. This is explained by an increase in the liquidity premium that makes the detention of cash or deposits relatively more expensive and favors households' investment in bonds. The mechanism of our theoretical model operates through the deposit channel of monetary policy. The latter is affected by the presence of a deposit insurance, unless it is fairly priced. From an empirical point of view, our paper suggests that establishing a relationship between deposit insurance and interest rate pass-through is a way to identify the deposit channel of monetary policy.

Our paper contributes to the literature on deposit insurance, which explores its design (Demirgüç-Kunt and Kane 2002; Demirgüç-Kunt and Huizinga 2004; Anginer and Bertay 2019), its pricing (Pennacchi 1987; Laeven 2002; IADI 2020), the modalities of its implementation and its potential consequences on bank risk-taking (Keeley 1990; Hovakimian et al. 2003; Anginer et al. 2014; Oosthuizen and Zalla 2022) and on financial stability (Demirgüç-Kunt and Detragiache 2002). In contrast to this literature that studies the deposit insurance through the lens of financial stability, our paper explores the effect of deposit insurance on monetary policy transmission.[1] The study of this relationship is particularly relevant when considering that central banks are involved in the decision-making process of some DIS features, such as the coverage level and scope. According to the Deposit insurance coverage level and scope survey conducted by the International Association of Deposit Insurers (IADI) in June 2020, 36.5% of deposit insurers report that their decision-making process regarding the coverage level involves the central bank (IADI 2021).[2] In addition, 7.5% of deposit insurers report that the process is initiated by the central bank, the government or the congress. Finally, according to the 2020 IADI Annual Survey, 15% of deposit insurers report that they are central bank administered. Thus, one can legitimately consider that central banks would benefit from being knowledgeable about the potential adverse effect of deposit insurance on monetary policy transmission.

Our paper adds to the literature on monopolistic competition in the banking system. Chiappori et al. (1995) use a similar approach to Grimaud and Rochet (1994) to analyze the impact of deposit regulation in an imperfect competition environment. They argue that deposit rate regulation favors the emergence of tied sale contracts, which in turn leads to cross-subsidization between credit and deposit activities. Regulation on deposit interest rates allows banks to lower the interest rates on loans and weakens the transmission of monetary policy impulses. Our paper shows that, in addition to industrial strategies coupled with regulation, financial stability policies like deposit insurance affect the monetary policy effectiveness.

Matutes and Vives (1996) consider a banking system that exhibits horizontal differentiation and risk of failure. Depositors form expectations about bank failure probabilities and a coordination problem among them may lead to the outcome of no banking. The

[1] Previous attempts have been made by Opiela (2008) and Lin (2015). Opiela (2008) shows, based on Polish data, that banks with a partial deposit guarantee experience a decrease in their loan growth following a contractionary monetary policy. On the contrary, banks benefiting from a full deposit guarantee are able to counteract this policy by raising uninsured time deposits to support their loan growth. Once the full protection of deposits is removed, the difference between the two bank groups in loan response to monetary policy vanishes. Using Taiwanese data, Lin (2015) finds that an expansion of deposit insurance coverage reduces the effect of open market operations on bank loans. Lin concludes to the ineffectiveness of monetary policy during periods of full protection of deposits.

[2] The survey responses cover 53 jurisdictions located in Europe, Africa, Latin America, Asia-Pacific, North-America and Caribbean.

introduction of a DIS avoids this potential collapsing equilibrium and increases welfare. Cordella and Yeyati (2002) analyze the monitoring effort of banks collecting deposits and financing risky projects. They show that a risk-based deposit insurance or public disclosure of financial information improves the monitoring efforts of banks. Our paper stresses that deposit insurance has important implications for the conduct of monetary policy on top of those for moral hazard, bank-risk taking and financial stability. Although this paper draws attention to the potential consequences of a deposit insurance mispricing, it does not intend to question the benefits of a DIS in maintaining public confidence in the banking system and ensuring financial stability.

Our paper considers the potential for the deposit insurance premium to differ from the fair value. Theoretically, a fair premium should include both an actuarially-fair premium, which compensates for insurers expected losses, and a systematic risk premium (Jokivuolle and Pennacchi 2019). Although the risk of bank failures is highly correlated and non-diversifiable during financial crises, the systematic risk is not taken into account in the pricing of the DIS. Indeed, in practice, deposit insurance agencies set the deposit insurance premium so as to reach a given target ratio of deposit insurance funds to eligible or covered deposits (Adema et al. 2019). Moreover, the actual deposit insurance premium does not systematically reflect the actuarially-fair value. In addition, during economic expansions, the increase in the banks' risk-taking and in the corresponding fair premium is not entirely reflected into the actual deposit insurance premium whose purpose is to match the target ratio. As a result, the fair premium is expected to be higher than the actual premium. Conversely, in times of economic downturns, we expect the fair premium to lie below the actual premium. The empirical literature report both an underpricing (Laeven 2002) and an overpricing (Marcus and Shaked 1984) of deposit insurance.

This paper is organized as follows. Section 2 presents the theoretical model. Section 3 solves the equilibrium values. Sections 4 and 5 examine the transmission on the equilibrium values of bank loans, deposits and bonds, as well as on their corresponding interest rates of a change in the key interest rate and of a shift in the deposit insurance coverage respectively. The last section concludes.

2 The model

This model extends that of Grimaud and Rochet (1994) in which households, firms and banks are located in a geographical space which can be interpreted as a characteristic space of bank products. Thus, the "trip to the bank" reflects an imperfect matching between household and firm preferences and bank products' characteristics. We add to this model several features, namely uncertainty concerning firms' investment project returns and the presence of a deposit insurance. In our model, households have a unit of cash endowment which is either deposited within a bank or invested in bonds on the capital market. Deposit insurance is provided by a DIS for which banks pay a premium. We assume that the mandate of the Deposit Insurance Agency (DIA) consists in a *pay-box* system, meaning that it solely aims to reimburse depositors in case of bank default (Adema et al. 2019; IADI 2021).[3] Firms are subject to risky projects than can be financed either by bond issuance or bank lending. With a probability of success p, bonds return a yield and firms reimburse their loans. In case of firms' bankruptcy, which occurs with a probability $(1-p)$, firms fail to repay interests on loans. This leads to bank failure, as firm and bank probability of bankruptcy is alike. Thus, banks cannot pay back to households the interests on their deposits, and households can recover only a part of their interests from the DIS.

2.1 Households

A continuum of households are uniformly distributed along a circle, whose total length is normalized to one. Each household is endowed with an amount ω, which is either deposited within a bank with a return rate of r_D, or invested on the capital market in bonds issued by firms with a net return of $r_B - \delta$. r_B is the interest rate on bonds and δ denotes the transaction costs which are proportional to the amount invested on the capital market. Households recover the return on bonds with a probability p of firm success. When depositing their endowment within a bank, households face a transportation

[3] According to the 2022 IADI Annual Survey, 25% of deposit insurers have a pay-box mandate (IADI 2023).

cost of ax, where $a > 0$ and x are the transportation cost parameter[4] and the distance from the bank to the depositor respectively. Households recover the interests on their deposits with a probability p, and a share $\phi \in [0, 1]$ of deposit interests from the DIS in case of bank failure occurring with a probability of $(1 - p)$. Households are indifferent between bank deposits and bonds when $r_D\omega (p + (1 - p) \phi) - a\hat{x} = (pr_B - \delta) \omega$. Solving for $\hat{x}$ gives the distance between the bank and the marginal depositor:

$$\hat{x} = \frac{\omega}{a} [r_D (p + (1 - p) \phi) - (pr_B - \delta)] . \tag{1}$$

Using (1), we compute the households' deposit supply to a bank, which equals $2\hat{x}\omega$:

$$D = \frac{2\omega^2}{a} [r_D (p + (1 - p) \phi) - (pr_B - \delta)] . \tag{2}$$

Eq. (2) shows that households' deposit supply is decreasing with the transportation cost parameter a.

2.2 Firms

A continuum of firms are uniformly distributed along a circle. Firms finance their inelastic investment κ either through bank credit L, at an interest rate r_L, or by issuing bonds B on the capital market.[5] Firms face a proportional transportation cost of by when borrowing from banks. The parameter $b > 0$ reflects an imperfect matching between a firm's funding requirements according to its business sector and the bank specialization within this sector. The parameter b can also be interpreted as a degree of differentiation of loan characteristics, such as the duration of the loan, the loan early repayment conditions or the required collateral (Bensaid and De Palma 1995). y is the distance between the bank and the borrower. A firm will be indifferent between bank credit and bond issuance if $pr_L\kappa + b\hat{y} = (pr_B + \delta) \kappa$. Solving for $\hat{y}$ provides the distance between the bank and the

[4]While this parameter can literally be interpreted as a transportation cost incurred by customers to visit a branch, it can also reflect the degree of product differentiation related to bank services, such as ATMs, online banking, see for instance Cordella and Yeyati (2002).

[5]Corporate bonds are an important financing source for firms, see Crouzet (2021) for the United States and Holm-Hadulla and Thürwächter (2021) for the euro area countries.

marginal borrower:

$$\hat{y} = \frac{\kappa}{b}\left[p\left(r_B - r_L\right) + \delta\right], \tag{3}$$

which allows to compute the firms' loan demand toward a bank $2\hat{y}\kappa$:

$$L = \frac{2\kappa^2}{b}\left[p\left(r_B - r_L\right) + \delta\right]. \tag{4}$$

Eq. (4) shows that firms' loan demand is decreasing with the transportation cost parameter b.

2.3 Banks

There are N banks evenly located along a circle that collect deposits D from households and supply loans L to firms. Banks face a bankruptcy risk related to the uncertainty concerning the firms' loan repayment. Households' deposits are insured by a DIS, for which banks pay an insurance premium per unit of deposits equal to $\tau p r_D$, where $\tau = c\phi(1-p)/p$. This specification for the banks' contribution to the DIS follows Cordella and Yeyati (2002). τ is the flat-rate premium and the parameter c denotes the deviation of τ from the level of fair premium ($\tau^* = \phi(1-p)/p$). When $c = 1$, banks are charged a fair deposit insurance premium. If $c < 1$, the flat-rate premium paid by banks is lower than the insurance payout received by customers from the Deposit Guarantee Fund (DGF) in case of bank failure. If $c > 1$, the flat-rate premium charged to banks is greater than the customers payout when bank defaults.

If we assume that the DIS is designed according to a risk-based approach, we can interpret $c \neq 1$ as a mispricing of actual risks of banks' loan portfolios and thus a misvaluation of banks' creditworthiness when setting the deposit insurance premiums. Alternatively, c might mirror the DIS willingness to influence the bank risk-taking behavior.[6]

Banks earn profit from both deposit and lending activities. Banks face an additive

[6]However, since the probability of success is given by the state of nature, the model does not capture changes in bank risk-taking following a shift in τ.

management cost function $C(D, L) = \gamma_D D + \gamma_L L$. The profit reads:

$$\pi = [\rho - pr_D(1+\tau) - \gamma_D] D + (pr_L - \rho - \gamma_L) L. \tag{5}$$

where ρ is the interest rate on the interbank market and is exogenous. For the sake of simplicity, we assume that the pass-through of changes in the monetary policy rate to the interbank market interest rate is complete. Consequently, throughout the paper, we will refer to a change in the monetary policy rate and the interbank market interest rate interchangeably.

The bank chooses the interest rate on deposits r_D and on loans r_L in order to maximize its profit. Substituting (2) and (4) in (5), differentiating with respect to r_D and r_L and rearranging yields:

$$r_D = \frac{1}{2}\left[\frac{\rho - \gamma_D}{p(1+\tau)} + \frac{pr_B - \delta}{p(1+\tau^*)}\right], \tag{6}$$

$$r_L = \frac{1}{2}\left[\frac{1}{p}(\rho + \gamma_L + \delta) + r_B\right]. \tag{7}$$

For later use, we compute the households' deposit supply and the firms' loan demand functions conditional on r_B:

$$D = \frac{\omega^2}{a}\left[\frac{(\rho - \gamma_D)(1+\tau^*)}{(1+\tau)} - (pr_B - \delta)\right]. \tag{8}$$

$$L = \frac{\kappa^2}{b}(pr_B - \rho - \gamma_L + \delta). \tag{9}$$

3 Monetary policy and deposit insurance premium

This section examines the transmission of a change in the key policy rate on the equilibrium values of bonds, bank deposits and loans, as well as on their corresponding interest rates, which are calculated in the appendix. The efficiency of the monetary policy transmission is affected by the pricing of the deposit insurance premium.

3.1 Effect on bank lending, deposits and bonds

Lemma 1 investigates the effect of a change in the interest rate on refinancing operations ρ on the equilibrium values of bonds, bank deposits and loans.

Lemma 1 *The sign of the effect of a change in ρ on B^*, D^* and L^* depends on the magnitude of the parameter c, such as:*

$$
\begin{array}{ll}
(i) & \dfrac{\partial B^*}{\partial \rho} \geq (<) 0 \Leftrightarrow c \geq (<) 1, \\
(ii) & \dfrac{\partial D^*}{\partial \rho} \geq (<) 0 \Leftrightarrow c \leq (>) 1, \\
(iii) & \dfrac{\partial L^*}{\partial \rho} \geq (<) 0 \Leftrightarrow c \leq (>) 1.
\end{array}
$$

Proof. Differentiating Eq. (A.3), (A.5) and L^* with respect to ρ yields:

$$\frac{\partial B^*}{\partial \rho} = -N\psi^2 \frac{(\tau^* - \tau)}{(a+b)(1+\tau)}, \tag{11a}$$

$$\frac{\partial D^*}{\partial \rho} = \frac{\partial L^*}{\partial \rho} = \psi^2 \frac{(\tau^* - \tau)}{(a+b)(1+\tau)}. \tag{11b}$$

The last equality in (11b) follows from the equilibrium condition $L^* = D^*$. Notice that the signs of Eq. (11) are ambiguous and depend on the sign of $\tau^* - \tau = 1 - c$. The fact that $c \geq (<) 1 \Leftrightarrow \tau^* - \tau \leq (>) 0$ proves Lemma 1. ■

The core idea of Lemma 1 is that the transmission of a shift in the key policy rate ρ on bonds (B^*), bank deposits (D^*) and loans (L^*) is subject to three regimes according to the deviation of the flat rate deposit insurance premium from the fair premium. For instance, when τ is lower than τ^* (i.e. $c < 1$), the premium does not appropriately account for the risk profile of the bank's loan portfolio.[7] In this case, for a given increase in the key policy rate ρ, the drop in the households' demand for bonds will exceed in absolute terms the rise in the firms' bond supply, which results in a decrease of the equilibrium volume of bonds B^*, see part (i) in Lemma 1.

For a given level of ψ, the mechanism described above implies part (ii) of Lemma 1,

[7] Laeven (2002) finds an underpricing of deposit insurance in a wide range of countries, essentially in developing countries.

i.e $\partial D^*/\partial \rho > 0$. To meet firms' financing needs, banks are encouraged to collect more deposits and customers will increase their deposit supply to banks, as r_D^* increases with ρ. Therefore, a rise of ρ will increase the equilibrium volume of bank deposits. From the bank's perspective, the risks taken on the loan portfolio are partly subsidized by the DIS compared to a fair premium scenario.[8] The shift of the financial surplus from the bond market to bank deposits is explained by a lower opportunity cost of risk borne by households, as the DIS supports a more than proportional level of risk.

A change in the key policy rate ρ increases (decreases) the equilibrium volume of deposits D^* if, and only if, the transmission of monetary policy impulses on the expected return on deposits exceeds (lies below) that on return on bonds. Formally, substituting (A.2) and (A.4) into (2) and differentiating with respect to ρ yields:

$$\frac{\partial D^*}{\partial \rho} = \frac{2\omega^2}{a} \left[\frac{\partial r_D^*}{\partial \rho} (1 + \tau^*) - \frac{\partial r_B^*}{\partial \rho} \right] p.$$

It is straightforward that:

$$\frac{\partial D^*}{\partial \rho} \geq (<) 0 \Leftrightarrow \frac{\partial r_D^*}{\partial \rho} (1 + \tau^*) \geq (<) \frac{\partial r_B^*}{\partial \rho}.$$

Part (iii) of Lemma 1 simply follows from the fact that, in our simple model, all deposits are lent to firms.

Conversely, when $c > 1$ the Lemma 1 can be interpreted symmetrically.[9] Intuitively, the overpricing of risks by the DIS drives financial surplus from bank deposits to the bond market.

Finally, when τ is equal to τ^* (i.e. $c = 1$), the flat-rate deposit insurance premium is equivalent to a fair premium, which ensures that risks are fairly valued by the DIS. In this case, the relative opportunity cost of risk in the banking sector and in the bond market is not affected by a change in ρ.[10]

[8] As explained by Hovakimian et al. (2003) p. 178, "[r]isk-shifting is subsidized whenever the value of the explicit and implicit deposit guarantees a country's banks enjoy exceeds the implicit and explicit premiums the insurer imposes on them".

[9] Marcus and Shaked (1984) find an overpricing of deposit insurance by the FDIC for 1979 and 1980.

[10] Note that:

3.2 Efficiency of interest rate pass-through

In our model, agents make their allocation choices based on expected returns. At the equilibrium, firms make an arbitrage based on a comparison between r_B^* and r_L^*, as the same probability p applies to both returns. Households consider r_B^* and $\tilde{r}_D^* = r_D^*(1+\tau^*)$ that occur with the same likelihood p.

The efficiency of interest pass-through is computed by differentiating (A.2), $\tilde{r}_D^*$ and (A.6) with respect to ρ:

$$\frac{\partial r_B^*}{\partial \rho} = \frac{a}{p(a+b)} + \frac{b}{p(a+b)}\frac{(1+\tau^*)}{(1+\tau)} \tag{12a}$$

$$\frac{\partial \tilde{r}_D^*}{\partial \rho} = \frac{1}{2}\left[\frac{a}{p(a+b)} + \frac{a+2b}{p(a+b)}\frac{(1+\tau^*)}{(1+\tau)}\right] \tag{12b}$$

$$\frac{\partial r_L^*}{\partial \rho} = \frac{1}{2}\left[\frac{2a+b}{p(a+b)} + \frac{b}{p(a+b)}\frac{(1+\tau^*)}{(1+\tau)}\right]. \tag{12c}$$

Eq. (12) reveals that an increase in the key policy rate ρ raises the interest rates r_B^*, r_L^* and $\tilde{r}_D^*$. In addition, the interest rate pass-through is affected by the DIS as described in the following proposition:

Proposition 1 *When $c > (<)1$, the DIS weakens (strengthens) the efficiency of the pass-through of a change in ρ on r_B^*, $\tilde{r}_D^*$ and r_L^*.*

Proof. First, we refer to the case where $\phi = 0$ as the benchmark interest rate pass-through, by evaluating (12) :

$$\left.\frac{\partial r_i^*}{\partial \rho}\right|_{\phi=0} = \frac{1}{p}, \qquad i = B, D, L. \tag{13}$$

$$\frac{\partial B^F}{\partial \rho} = -\left.\frac{\partial B^H}{\partial \rho}\right|_{\tau=\tau^*}$$

i.e. when the change in the households demand for bonds is evaluated at $c = 1$. This equality is also ensured by the equivalence between $\partial B^H/\partial \rho$ and $-N\partial D/\partial \rho$ (computed by differentiating (8) with respect to ρ) and between $\partial D/\partial \rho$ and $\partial L/\partial \rho$ (computed by differentiating (9) with respect to ρ) respectively.

Evaluating (12) at $\tau^* - \tau < 0$ shows that :

$$\left.\frac{\partial r_i^*}{\partial \rho}\right|_{\tau > \tau^*} < \left.\frac{\partial r_i^*}{\partial \rho}\right|_{\phi = 0} \qquad i = B, D, L. \tag{14}$$

which proves the first statement of Proposition 1.

Evaluating (12) at $\tau^* - \tau > 0$ gives:

$$\left.\frac{\partial r_i^*}{\partial \rho}\right|_{\tau < \tau^*} > \left.\frac{\partial r_i^*}{\partial \rho}\right|_{\phi = 0} \qquad i = B, D, L. \tag{15}$$

and completes the proof. ∎

Proposition 1 shows that the transmission of monetary policy is conditional on the gap between the flat-rate deposit insurance premium and the fair premium according to three regimes.

If the flat-rate deposit insurance premium is greater than the fair premium, the pass-through of a change in the interest rate on refinancing operations on interest rates on bonds, bank deposits and loans is distorted downward. This is explained by a lower shift in absolute terms in households' demand for bonds than would occur in the case of no DIS. This leads to an increase in the equilibrium volume of bonds and a drop in the equilibrium volume of bank deposits and loans, as shown in Lemma 1. These adjustments are reflected in a lower increase of r_B^*, $\tilde{r}_D^*$ and r_L^* than would happen in the absence of a DIS.

If the flat-rate deposit insurance premium is lower than the fair premium, the interest rate pass-through is strengthened. Following an increase in the key policy rate, the households' demand for bonds reacts more strongly than would prevail in the absence of a DIS, leading to an over-reaction of r_B^*, $\tilde{r}_D^*$ and r_L^*.

The last case is a special regime which is summarized by the following proposition:

Proposition 2 *A flat-rate deposit insurance premium priced at its fair value ensures the neutrality of the DIS for the interest rate pass-through.*

As shown in Lemma 1, with $\tau = \tau^*$ the households' trade-off between bonds and bank deposits is not affected by a marginal change in ρ. All returns are thus equally modified by $1/p$, as stated in Eq. (13).

Propositions 1 and 2 have important policy implications. The deposit insurance *per se* and the modalities of its implementation are important not only from a financial stability but also from a monetary policy perspective. This result is in line with that of Cecchetti and Krause (2001) who empirically show that *the adoption* of an explicit DIS enhances the monetary policy efficiency.[11] Their empirical result can be considered as a special case of our model when $\tau < \tau^*$ and would be consistent with the natural presumption that risks are usually undervalued at macroeconomic level.[12]

If we consider the gap between τ^* and τ as a misvaluation or a mispricing of risks, our proposition states that a fair risk pricing in the deposit insurance premium ensures the neutrality of the DIS on monetary policy transmission.

However, in the event of risks' misvaluation in the pricing of the deposit insurance, our results suggest that monetary policy is likely to further alter the business cycle. Let us first consider the case of a procyclical monetary policy. In the upward phase of the business cycle, the deposit insurance is likely to be underpriced and following the predictions of our model, the monetary policy transmission is enhanced. Thus, an expansionary monetary policy would exacerbate the growth stage of the business cycle. In the downward phase of the business cycle, the deposit insurance is likely to become overpriced and, according to our model, the monetary policy is weakened. Thus, a restrictive monetary policy would accentuate the downturn of the business cycle.

Let us now suppose that monetary policy is countercyclical and the same pattern of deposit insurance mispricing over the business cycle applies. During upswings of the cycle, a restrictive monetary policy would be strengthened. In contrast, during downswings of the cycle, a stimulative monetary policy would be enhanced. To sum up, given the considered pattern of the deposit insurance pricing, the stabilizing effect on the business cycle of a countercyclical monetary policy is more pronounced.

The above discussion assumes a passive behavior of DIAs. However, in practice, DIAs

[11]Note that in Cecchetti and Krause (2001), monetary policy efficiency refers to output and price stability while our model focuses on interest rate pass-through. However it is reasonable to surmise that reducing output and price volatility is achieved through a more effective interest rate pass-through.

[12]This presumption is confirmed empirically by Yoshino et al. (2013) for the case of Japan.

might be tempted, in period of excessive risk taking, to increase the pricing of the deposit insurance to prevent moral hazard and excessive bank risk-taking. An overpriced deposit insurance has the drawback of weakening the monetary policy transmission and entails an adverse effect on contractionary monetary policy that would follow the same objective of preventing economic overheating. Similarly, an overpriced deposit insurance during the downturn of the business cycle would limit the transmission of an expansionary monetary policy. Overall, an overpricing of the deposit insurance over the business cycle would mitigate the stabilizing effect of the monetary policy on the business cycle.

To sum up, an appropriate evaluation of risks is crucial not only for financial stability considerations but also for a proper conduct of monetary policy. This stresses the importance of a risk-based pricing of deposit insurance to ensure the neutrality of DIA's policy in relation to monetary policy.

4 Monetary policy and deposit insurance coverage

In practice, countries extend the deposit insurance coverage to foster confidence in the financial system. It is thus essential to study how a shift in deposit insurance coverage affects the transmission of monetary policy impulses onto bank lending, deposits and bonds and onto their corresponding interest rates.

4.1 Effect on bonds, bank deposits and loans

This section investigates how the system presented in Eq. (11) is affected by a change in the deposit insurance coverage. Its main results are outlined in the following Lemma:

Lemma 2 *A shift in ϕ affects the monetary policy transmission on B^*, D^* and L^**

conditional on the magnitude of the parameter c, such as:

$$
\begin{aligned}
&(i) \qquad \frac{\partial^2 B^*}{\partial\rho\partial\phi} \geq (<) 0 \Leftrightarrow c \geq (<) 1, \\
&(ii) \qquad \frac{\partial^2 D^*}{\partial\rho\partial\phi} \geq (<) 0 \Leftrightarrow c \leq (>) 1, \\
&(iii) \qquad \frac{\partial^2 L^*}{\partial\rho\partial\phi} \geq (<) 0 \Leftrightarrow c \leq (>) 1.
\end{aligned}
$$

Proof. Differentiating Eq. (11) with respect to ϕ gives:

$$\frac{\partial^2 B^*}{\partial\rho\partial\phi} = \frac{-N\psi^2\chi}{(a+b)(1+\tau)^2}, \tag{17a}$$

$$\frac{\partial^2 D^*}{\partial\rho\partial\phi} = \frac{\partial^2 L^*}{\partial\rho\partial\phi} = \frac{\psi^2\chi}{(a+b)(1+\tau)^2}, \tag{17b}$$

where $\chi = \left[\frac{\partial\tau^*}{\partial\phi}(1+\tau) - \frac{\partial\tau}{\partial\phi}(1+\tau^*)\right]$. The signs of Eq. (17) depend on the sign of χ. Substituting the values of τ^*, τ, $\partial\tau^*/\partial\phi$ and $\partial\tau/\partial\phi$ shows that $\chi = 1 - c$ and that $\chi \geq (<) 0 \Leftrightarrow c \leq (>) 1$. ■

Lemma 2 shows that an extension of the deposit insurance coverage amplifies the monetary policy transmission on equilibrium values of bonds, bank deposits and loans. For instance, when $\tau < \tau^*$, an increase in ϕ strengthens the adverse effect of ρ on B^*. More precisely, an extension of the deposit insurance coverage leads to a reduction in households' demand for bonds following an increase in ρ.[13] Since firms' bond supply does not depend on τ and τ^*, this ends up with an even lower value of B^* compared to part (i) in Lemma 1.

Parts (ii) and (iii) in Lemma 2 simply follow from the fact that at the equilibrium $D^* = \frac{1}{N}(\psi - B^*)$ and $D^* = L^*$.

[13] This can be shown formally by differentiating Eq. (A.1a) with respect to ρ and ϕ:

$$\frac{\partial^2 B^H}{\partial\rho\partial\phi} = -\frac{N\omega^2\chi}{a(1+\tau)^2},$$

which sign is negative if $c < 1$.

4.2 Efficiency of interest rate pass-through

An important implication of Lemma 2 is that an extension of the deposit insurance coverage amplifies the distortion of the interest rate pass-through presented in Proposition 1. The intuition behind this result is that a change in the equilibrium volumes of bonds and bank deposits (and thus of bank loans) following a shift in the key policy rate is amplified (upward or downward according to c) relative to the change described in Eq. (11). Since these volume effects are translated into interest rate effects, the same conclusion applies for the effect of the deposit insurance coverage on interest rate pass-through. This result is summarized in the following proposition:

Proposition 3 *When $c > (<)1$, an extension of the deposit insurance coverage ϕ weakens (strengthens) the efficiency of the pass-through of a change in ρ on r_B^*, $\tilde{r}_D^*$ and r_L^*.*

Proof. Differentiating Eq. (12) with respect to ϕ yields:

$$\frac{\partial^2 r_B^*}{\partial\rho\partial\phi} = \frac{b\chi}{p(a+b)(1+\tau)^2}, \tag{18a}$$

$$\frac{\partial^2 \tilde{r}_D^*}{\partial\rho\partial\phi} = \frac{(a+2b)\chi}{2p(a+b)(1+\tau)^2}, \tag{18b}$$

$$\frac{\partial^2 r_L^*}{\partial\rho\partial\phi} = \frac{b\chi}{2p(a+b)(1+\tau)^2}. \tag{18c}$$

The signs of Eq. (18) depend on the sign of χ. $\chi > (<)0 \Leftrightarrow c < (>)1$. ■

When the flat-rate deposit insurance premium is lower than the fair premium, an improvement in the deposit insurance coverage strengthens the monetary policy transmission. An increase in the extent of the deposit insurance coverage conduces households to deposit their endowment within the bank rather than invest it into relatively riskier bonds on the capital market. This trade-off in favor of bank deposits raises the rate of return on bonds constraining firms to withdraw from the capital market and boosts their demand for bank lending. This leads to a contraction of the capital market, making firms more bank dependent. This result suggests that when an economy goes through a crisis and the deposit insurance pricing does not appropriately reflect bank risks, an extension of the deposit insurance coverage is likely to enhance the effect of an expansionary monetary policy.

When the deposit insurance premium is priced at its fair value, the following proposition applies:

Proposition 4 *A flat-rate deposit insurance premium priced at its fair value ensures that a shift in the deposit insurance coverage ϕ does not affect the interest rate pass-through.*

Proposition 4 extends the neutrality condition of the DIS for the interest rate pass-through to the case of deposit insurance coverage differentials. We can easily show that substituting $\tau = \tau^*$ in Eq. (12) removes the effect of the deposit insurance coverage on interest rate pass-through. This directly follows from Lemma 2, which shows that the equilibrium volumes of bonds, bank deposits and loans are unresponsive to a change in ρ in conjunction with an extension of the deposit insurance coverage. With a fair deposit insurance premium, the households' trade-off between the expected return on bonds and the one on bank deposits is not affected by a change in coverage because banks bear all the costs of risk-taking through the DIS. In this case, there is no tax or subsidy effect, contrary to the statement of Proposition 3.

5 Conclusion

This paper provides a theoretical contribution to the literature on deposit insurance and monetary policy transmission. It builds on the theoretical model of Grimaud and Rochet (1994), in which banks operate in a monopolistic competition environment. We extend their model through the introduction of uncertainty in firms' risky investment project returns and the inclusion of a DIS.

We show that the gap between the fair premium and the flat-rate deposit insurance premium affects the monetary policy transmission on bank deposits, loans and bonds and their corresponding interest rates. More precisely, when the gap is positive, savings are channeled to bank deposits at the expense of bonds and the interest rate pass-through on bond yields and lending rates is strengthened. Conversely, when the gap is negative, a more attractive bond market brings in household savings and the interest rate pass-through is weakened. As a corollary, we find that a flat-rate deposit insurance premium priced at the fair premium value ensures the neutrality of the DIS for the interest rate pass-through. This result implies that the deviation of the deposit insurance premium from its fair value should be considered not only from a financial stability view but also from a monetary policy perspective.

Also, the magnitude of the bank interest rate pass-through is influenced by the DIS through the extent of the deposit insurance coverage. An increase in the extent of the deposit insurance coverage amplifies the distortion in the monetary policy transmission on bond returns, bank deposit and lending rates.

These results have important policy implications. If we consider the case of the euro area, the combination of a single monetary policy and multiple DIAs enhances the cross-country heterogeneity of the monetary policy transmission. This calls for a coordination of deposit insurance policies across member states.

In addition, a procyclical monetary policy naturally exacerbates the fluctuations of the business cycle. Our model implies that this phenomenon is even more pronounced when the deposit insurance premium is below its fair value, since in this case we show that monetary policy transmission is strengthened. The procyclical effect vanishes when the deposit insurance premium is priced at its fair value. Finally, an overvaluation of risks that would translate into a higher level of deposit insurance premium compared to its fair value would mitigate the procyclicality of monetary policy.

Appendix

This appendix solves the equilibrium values of interest rates in the economy. Eqs. (6) and (7) show that interest rates on loans and deposits are conditional on the interest rate on bonds. The equilibrium on the capital market determines the share of endowment ω invested in bonds and the corresponding equilibrium return r_B^*. The remaining is invested in bank deposits that are transformed into loans, at r_D^* and r_L^* respectively.

Capital market

We substitute profit maximizing interest rates (6) and (7) into Eqs. (1) and (3) respectively. We then define the households' demand for bonds as $B^H = \omega\,(1 - 2\hat{x}N)$ and the firms' supply of bonds as $B^F = \kappa\,(1 - 2\hat{y}N)$.

$$B^H = \omega \left\{ 1 - \frac{N\omega}{a} \left[\frac{(\rho - \gamma_D)\,(1+\tau^*)}{(1+\tau)} - (pr_B - \delta) \right] \right\}, \tag{A.1a}$$

$$B^F = \kappa \left[1 - \frac{N\kappa}{b} \left(pr_B - \rho - \gamma_L + \delta \right) \right]. \tag{A.1b}$$

Equilibrium in the capital market requires equality between B^H and B^F. Note that equilibrium in the market for goods and services ensures equality between financial surplus and funding needs, i.e. $\omega = \kappa = \psi$. The equilibrium value of r_B is characterized by:

$$\begin{aligned} r_B^* = \;& \rho \left[\frac{a(1+\tau) + b\,(1+\tau^*)}{p\,(a+b)\,(1+\tau)} \right] + \frac{a}{p\,(a+b)}\gamma_L - \frac{b}{p\,(a+b)}\frac{(1+\tau^*)}{(1+\tau)}\gamma_D \\ & - \frac{(a-b)}{p\,(a+b)}\delta. \end{aligned} \tag{A.2}$$

Eq. (A.2) reveals that the return on bonds is affected by the DIS. Substituting the equilibrium value of the return on bonds r_B^* into the bonds demand or supply function (A.1) gives:

$$
\begin{aligned}
B^{*} =& \psi \left\{ 1 - N\psi \left[\rho \frac{(\tau^{*} - \tau)}{(a+b)(1+\tau)} \right] - \frac{1}{(a+b)} \gamma_{L} - \frac{(1+\tau^{*})}{(a+b)(1+\tau)} \gamma_{D} \right. \\
& \left. + \frac{2}{(a+b)} \delta \right\} .
\end{aligned} \tag{A.3}
$$

Deposit market

Substituting (A.2) into the profit-maximizing interest rate on deposits (6) and rearranging yields:

$$
\begin{aligned}
r_{D}^{*} =& \frac{1}{2} \left\{ \rho \left[\frac{a(1+\tau) + (a+2b)(1+\tau^{*})}{p(a+b)(1+\tau)(1+\tau^{*})} \right] + \frac{a}{p(a+b)(1+\tau^{*})} \gamma_{L} \right. \\
& \left. - \frac{(a+2b)}{p(a+b)(1+\tau)} \gamma_{D} - \frac{(a-b)}{p(a+b)(1+\tau^{*})} \delta \right\} .
\end{aligned} \tag{A.4}
$$

Using (A.3), we define the equilibrium value of deposits held by households:

$$
D^{*} = \frac{1}{N} (\psi - B^{*}) . \tag{A.5}
$$

Loan market

Substituting (A.2) into the profit-maximizing interest rate on loans (7) and rearranging yields:

$$
\begin{aligned}
r_{L}^{*} =& \frac{1}{2} \left\{ \rho \left[\frac{(2a+b)(1+\tau) + b(1+\tau^{*})}{p(a+b)(1+\tau)} \right] + \frac{2a+b}{p(a+b)} \gamma_{L} - \frac{b}{p(a+b)} \frac{(1+\tau^{*})}{(1+\tau)} \gamma_{D} \right. \\
& \left. + \frac{2b}{p(a+b)} \delta \right\} .
\end{aligned} \tag{A.6}
$$

At the equilibrium, the volume of loans supplied by banks is equal to the amount of bank deposits owned by households, i.e. $L^{*} = D^{*}$.

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