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Banking Crisis, Moral Hazard and Fiscal Policy Responses

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Abstract

This paper examines the role of fiscal policy as prudential instrument in preventing banking crisis in a framework where the government faces the tradeoff between the supply of public services and the stabilization of the banking system. We advocate that in a monetary union, the national governments without monetary autonomy should redesign their fiscal policy to prevent financial crises due to the moral hazard of banking entrepreneurs whose incentives are distorted by their expectations of ex-post bailout. We show that the government has incentive to bail out banks under both discretion and commitment if the banking sector is relatively influential. To prevent financial fragility, the pre-committed fiscal bailout policy should be time-consistent and incite banks to keep sufficient liquidity reserves and a low leverage ratio. Such policy could be efficiently complemented by public lending with a pre-announced interest rate that reduces banks' moral hazard incentives but not their normal risk-taking.

Key words: Banking crisis, capital ratio, over risk-taking, too big to fail, fiscal bailout, fiscal policy, government put, moral hazard, crisis resolution, public lending.

JEL Classification: E44, G01, G11, G28, H21, H32.

1 Introduction

One salient feature of the recent financial crises occurring since 2007 is, besides the large maturity mismatch in banks' balance sheet, the significant role of discretionary fiscal policies in banking bailouts (IMF, 2013). The weakness in the regulatory framework and in banks' risk management has been clearly revealed. Banking regulations (from Basel I to Basel II) have generally focused on incremental rules, which notably strengthen banks' capital and liquidity position. While more exigent regulations on banks' capital requirement and liquidity reserves might reinforce an individual bank's resilience to adverse idiosyncratic shocks, they do not eliminate the risk of banking crises and could even increase the systemic risk by being pro-cyclical.

The costs of a systemic banking crisis are so tremendous that the government can rarely just stand by idly when it occurs. Nevertheless, prior to the eruption of such crises, most countries do not possess a well-designed bailout policy, leading to uncertainty about the crisis resolution arrangements. This creates conditions for excessive and irreversible risk-taking by banking entrepreneurs expecting an *ex post* bailout, despite the rigorous implementation of incremental rules. When these banks with moral hazard fail, the fiscal authority might find itself incapable of sustaining large ex-post bailouts. The eurozone crisis has clearly demonstrated this. Countries such as Spain or Ireland have been drawn into the twin banking and sovereign debt crises following the implementation of unaffordable *ex post* banking bailouts. Honohan and Klingebiel (2003), using a cross-country database, show that accommodative policies (i.e., liquidity support, recapitalization, debtor bailouts) increase the fiscal costs of banking bailouts substantially. During the crisis of the Eurozone, the fiscal position of several member states turned out to be critical in the absence of national monetary sovereignty once their engagement in huge bailouts became evident. However, in a monetary union inherently flawed by the lack of coordination between fiscal and monetary policies, both the banking sector and the national budget become more vulnerable (Lane, 2012).

Successive waves of large-scale banking rescues since the recent global financial crisis has aroused the debate on the taxation of financial institutions as a crucial component

of financial regulatory reform (Claessens et al. 2010, Beck and Huizinga 2011, Matheson 2011, Llewellyn, 2012a,b, Mullineux 2014). In Europe, several proposals to introduce a new financial transaction tax have been published by the European Commission since September 2011. In a perfect Pigouvian world, taxation and regulation would be equivalent. Thus, in a banking system with all kinds of imperfections, taxation could be an important component of banking regulation. In effect, there are three rationales for imposing specific taxation on banks: first, it allows the government to recoup the costs of bailouts; second, the tax revenue is a counterpart to the expected subsidy received by too-big-to-fail banks during possible future bailouts; and finally, such taxation could create incentives for banks to improve their funding structure, to avoid over-borrowing and perhaps even to keep from becoming too big.

This paper aims to seek efficient and feasible policy reform to avoid the reoccurrence of financial crisis of the type that hit the Eurozone by taking into account three distinctive features of the financial regulation and macroeconomic policies that govern the Eurozone: (a) The rigorous implementation of incremental rules in the member states failed to discourage banks from excessive risk-taking; (b) The absence of monetary sovereignty emphasized the importance of fiscal policy in handling the vulnerability of banks; (c) The fiscal policy was not conceived to avoid bailout expectations and hence aggressive risk-taking of banks, while the absence of a clearly *ex ante* defined fiscal rescue plan impeded a quick establishment of normal financial order after the occurrence of the crisis. Moreover, to capture the fact that the financial sector in eurozone countries is relatively mature with skilled financial experts, we impute, following Farhi and Tirole (2012), the excessive risk-taking to the nature of banking entrepreneurs being profit-seekers, rather than the lack of human capital or sufficient effort to supervise their investments. Consequently, a latent collision exists between the objective of banking entrepreneurs and that of regulatory authority, since the former pursue the dividends on shares while the latter seeks maximizing social welfare. If *ex ante* well-defined crisis arrangements are not credibly announced, this collision can arouse the moral hazard incentive of eurozone banks to adopt a risky balance sheet given the hope of *ex post* bailouts, even though

monetary instruments are not available to national governments.

Based on above features, we advance the idea that the regulatory reform, notably for eurozone countries, needs to be strategic rather than incremental (i.e., capital or liquidity ratios). A strategic regulation implies enhancing the resilience of banks and lowering the cost of their failures. In contrast, incremental regulations focus on reducing the probability of bank failures while overlooking the costs of banking crises. A properly designed strategic regulation, that permits avoiding inefficient and unsustainable bailouts, can shield countries in a monetary union against twin banking and sovereign debt crisis due to *ex post* huge banking bailouts. We show that an appropriate fiscal policy embodying clearly defined crisis responses can achieve the goals of strategic regulation. Such a policy is particularly important for countries in a monetary union in which fiscal policy becomes the main device available to national governments to handle financial fragility.

We develop a simple framework based on Farhi and Tirole (2012) by allowing for fiscal interventions with or without commitment to investigate (i) how optimal regulation should be designed when monetary instruments are not available to national government and (ii) how moral hazard could be discouraged when risky activities appear highly lucrative to profit seeking banking entrepreneurs? Two types of bailout, i.e., one conducted through tax reduction, which is in effect akin to a direct liquidity injection, and the other through public lending, are examined in our framework.

Our results show that, given an independent and relatively stable monetary policy ensured at the level of the monetary union, a pre-committed fiscal policy, including a well-defined bailout program, can impel banks to voluntarily keep a relatively safe investment structure corresponding to the objective of incremental regulations, and thus strengthen the financial resilience and avoid inefficient *ex post* bailouts. As a result, a policy reform conforming to the spirit of strategic regulation can, in general, prevent the moral hazard problem caused by banks' bailout expectation and could significantly reduce the cost of eventual intervention.

According to our model, there is a critical threshold for the relative weight of the banking sector, above which the latter is "too influential to fail" and the government's

policy commitment can be vulnerable to risky investments undertaken by banks. On the other hand, there is a switching point for bank capital relative to economic fundamentals, below which banks succumb to the moral hazard and tend towards over risk-taking, and *vice versa*. This raises the time consistency problem for the fiscal policy as an apparatus of strategic regulation since the government facing an influential banking sector taking too much risk will abandon its commitment to no bailout. To deal with the moral hazard problem in such a situation, a pre-announced bailout through public lending should be included as a supplementary component to a pre-committed fiscal policy. Our results show that, by adding extra but not excessive lending costs to banks' risky investments, public lending can effectively change the beliefs of banking entrepreneurs about future outcomes, and thus rule out their moral hazard incentive at the planning stage.

In the light of our results, we may consider that the banking crisis in the Eurozone is a result of the discretionary and 'bailout-prone' fiscal policy that tends to protect banks in the event of a crisis. What the Eurozone needs is a time-consistent and well-conceived fiscal policy with a credibly pre-committed fiscal bailout policy in the absence of national monetary sovereignty.

Relationship to the literature

Our paper is related to a number of studies on banking crises and the taxation of financial activity. The fragility of the banking sector, in particular the issue of maturity mismatch, has been emphasized by a line of research following the seminal contribution of Diamond and Dybvig (1983), e.g., Rodrick and Velasco (1999), Radelet and Sachs (2000), Chang and Velasco (2001) and Allen and Gale (2009). As them, we also view the lack of synchronization between payments and receipts as a major factor that weakens banks' balance sheet. While these authors underline the connection between the occurrence of banking crises and the role of monetary policy, we focus on the role of fiscal policy in managing a crisis situation that could happen in a monetary union. Given that the common monetary policy could not be used to deal with national financial meltdown during a banking crisis, the existence of such a union could be put into question. To avoid this scenario, the impact of the fiscal policy on the stability of the banking system must

be taken into account seriously from the beginning of its conception. This constitutes the principal concern of this paper.

A number of empirical studies on the taxation of banking activity mainly have confirmed the effectiveness of tax rate policy in affecting the profitability and the stability of the banking system. Albertazzi and Gambacorta (2010) show that the taxation of banks' profit is equivalent to the taxation of loans and as such it exerts a substantial impact on the composition of banking revenues. Chiorazzo and Milani (2011) show that if banks are able to shift their tax burden forward, the taxation of banking activities could affect the loss provisions, with negative implications for the stability of the banking system. We share the idea of these authors and investigate in our theoretical model the feasibility and efficiency for a fiscal authority to apply tax rate policy as an apparatus of strategic regulation.

A strand of literature considers that taxation could be superior to incremental regulation in coping with the systemic risk externality in the financial sector (Keynes 1936, Stiglitz 1989, Cooley et al. 2009, Adrian and Brunnermeier 2011, Goodhart 2011, Acharya et al. 2012, Masciandaro and Passarelli 2013). Reflecting private agents' marginal costs of reducing risk, a well-designed non-linear tax scheme could yield any desired progressive impact. Our model contributes to the literature on the taxation of financial activity by evaluating the effect of financial transaction taxes on the investment decision and risk-taking of the banking sector.[1] We assume that the government sets tax rates on banks' risky investments. Such taxes could reduce the level of risky investment and might thus improve the stability of the banking sector.

The active role of the government in financial crisis management has been explored by several theoretical and empirical studies (Reinhart and Rogoff 2011, Bolton and Jeanne 2011, Laeven and Valencia 2012, Kollman et al. 2013, and IMF 2013). However, focusing on the impact of fiscal bailouts on the stability of the banking sector, they do not consider how these bailouts could be optimally designed prior to the crisis. We investigate the issue

[1] Several financial transaction taxes are directly or indirectly related to the banking sector, e.g., securities transaction tax, currency transaction tax, capital levy tax, bank transaction tax, real estate transaction tax. Recently, a number of countries, including France and Germany, have imposed different forms of financial transaction tax to enhance the stability of the financial system (Matheson, 2011).

of optimal bailout measure through evaluating two intervention mechanisms, i.e., the tax reduction and the public lending, conducted by the fiscal authority, in terms of social cost and debtor moral hazard. In this respect, our paper is close to the spirit of Corsetti et al. (2006) and Hryckiewicz (2014) that analyze the trade-off between government intervention and resulting moral hazard. They show that public lending is generally costly in terms of social welfare, although desirable for avoiding financial meltdowns. In contrast, our paper shows that a well-defined pre-committed lending policy can eliminate the moral hazard incentive and is welfare-improving by reducing the riskiness of banks' balance sheet and decreasing the cost of intervention. We suggest that there is no one-fits-all bailout measure, and the design of optimal bailout needs to consider the cost of intervention, the risk of moral hazard, and the fundamentals of the economy. In addition, the role of the pre-committed penalty tax imposed on banks' profits from risky investments is similar to that of a penalty on risk-shifting and gambling behaviors of banks considered by Boyd and Hakenes (2014). We show that the existence of a high enough pre-committed tax rate can fully eliminate banks' moral-hazard incentive, thus reinforce the stability of the banking system without inducing any social cost.

Analyzing the effect of the fiscal policy on banks' risk-taking decision and the latent moral hazard problem due to bailout expectations, our paper is related to Chari and Kehoe (2013). In a model of financial fragility, they show that the government cannot commit itself to not bailing out firms *ex post* and hence *ex ante* regulation of firms is desirable. There are important differences with our paper: First, instead of arising from the effort-withholding of bank managers, the moral hazard in our paper results from the nature of bank managers as profit seekers that maximize dividend on shares. Second, Chari and Kehoe consider that the unique purpose of taxation is to finance bailouts while we consider that taxes are levied to fund projects of public services or reduced to bail out distressed financial institutions during a banking crisis. In our paper, the trade-off between these two objectives determines the choice of optimal tax rates by the government. Third, Chari and Kehoe show that the government is more tempted to make *ex post* bailouts when the scale of troubled investment is larger, while our model shows

that the *ex post* bailout incentive is high when the relative weight of banking sector regarding economic fundamentals exceeds a country specific critical threshold and the banking sector is under-capitalized. Last, Chari and Kehoe suggest an *ex ante* regulation to limit the size of individual firms in order to reduce the incentive to *ex post* bail out while we focus on the efficiency of a pre-announced bailout through public lending in restraining the moral hazard incentives of an influential banking sector. Our model shows that a well-designed fiscal policy can avoid the time inconsistency problem and can be an instrument of strategic regulation whose proper implementation helps to achieve the objective of incremental regulations.

Focusing on the optimal fiscal policy design and fiscal bailout, our study is complementary to Farhi and Tirole (2012), who analyze the impact of the central bank's put, i.e., an accommodative interest rate policy in the event of a crisis, on the risk-taking behavior of financial institutions, and show that an interest rate policy under commitment could avoid the moral hazard and reduce the leverage of banks when the risky asset is not extremely attractive. In a framework based on Farhi and Tirole, we study the impact of the government's put, i.e., the effects of discretionary or pre-committed fiscal bailout policy on banks' activity and on the social welfare of a small country within a monetary union. Our model shows that national fiscal authorities can favorably influence the leverage choice and thus the risk-taking of the banking sector by adopting appropriate fiscal and bailout policies with commitment, even in the case in which banks' risky project is highly lucrative.

The remainder of this paper is organized as follows. Section 2 sets up the basic framework and shows the effectiveness of taxation in reducing banks' risk-taking. Section 3 examines the government's choice of tax rates while ignoring the bailout in crisis times. Section 4 considers a fiscal bailout via tax reduction under commitment or discretion. Section 5 studies the design of public lending policy to deal with the interplay between the fiscal policy and the moral hazard in the banking sector. Section 6 concludes.

2 Basic framework

The economic environment corresponds to that of a small country in a monetary union. Its government has abandoned monetary sovereignty by joining the union and has only a certain degree of fiscal autonomy. Focusing on the effects of fiscal policy, we assume that monetary policy is stable and the gross interest rate R is equal to 1 in each period.

There are three dates, denoted by t_0, t_1, and t_2, respectively. Banks are managed by identical risk neutral banking entrepreneurs and each of them is endowed with a capital K at t_0. Subject to limited liability, banks carry out their investment of scale I in a constant-returns-to-scale production technology that accrues a safe cash flow γ (< 1) at t_1 for each unit invested at t_0, independently of the states of the economy. The project is risky, since the safe return γ at t_1 is not enough to cover the investment cost and the return at t_2 is state contingent. The shocks impacting the projects of different banks are assumed to be perfectly correlated. A project delivers ρ_1 at t_2 in addition to γ in the good (or normal) state that is realized with probability α, and yields no pay-off at t_2 in the bad (or adverse) state that is realized with probability $1 - \alpha$. A project can yield ρ_1 at t_2 in the adverse state, if a unit of fresh resources is reinvested in it at t_1. Since no new investment can be started at t_1, the scale of continuation or reinvestment J cannot exceed the scale of initial investment I, i.e., $J \in [0, I]$. In the adverse state, J primarily depends on bank's liquidity availability at t_1. If the refinancing is not in place, the non-performing asset will be liquidated at t_1. For simplicity, we assume that the liquidation yields no revenue.

For each maturing project, only a part of return ρ_0 ($\rho_0 < 1 < \rho_1$) is pledgeable to risk-neutral investors (consumers). Consequently, $\rho_1 - \rho_0$ is the rate of profit for banking entrepreneurs when risky projects succeed. The assumption $\rho_0 < 1$ is imposed to avoid the case in which banks will not have a liquidity shortage in the adverse state.[2]

The government sets the tax rates on banks' risky investments and collects taxes at

[2] Given that each unit of troubled investment needs one unit of fresh resource, for $\rho_0 \geq 1$, banks can always obtain enough collateralized loans backed by their future revenue to ensure full-scale continuation investment. This implies that banks' balance sheet is riskless and no banking crisis will occur.

t_0 and t_1 to invest in short-term public projects.[3] Public projects initiated at t_0 deliver public services to consumers at t_1 and those started at t_1 provide public services at t_2. Let τ_i be the tax rate at date t_i, $i = 1, 2$, and without loss of generality, we assume that the tax rates are constant in the normal state, such that $\tau_1 = \tau_2$. Given the gross interest rate being $R = 1$, setting a constant tax rate τ_i at each date is equivalent to setting an overall rate $\tau = \tau_1 + \tau_2$ at either t_0 or t_1. Consequently, a tax rate reduction at t_1 could be substituted by an alternative solution whereby the government raises all taxes at t_0 and bails out banks with a liquidity injection at t_1.

The risky project should be lucrative enough to attract banks to invest all their endowment (K). We therefore establish the following condition

$$\rho_1 > 1 + \frac{(1+\alpha)(\gamma+\alpha-1)}{1-\alpha}. \tag{1}$$

There are a large number of risk-neutral consumers who have an endowment at the initial date and are indifferent to the dates of consumption. At t_0, they invest their endowment in safe asset and/or debt issued by banks. We assume that this endowment is large enough to support banks' investment at both dates (t_0 and t_1). The gross rate of return from a safe asset is given by $R = 1$. The risk-neutral consumers invest (part of) their endowment in bank debt, if its average gross rate of return is no less than the rate of return from safe assets.

Taking account of taxes, to effectuate an investment of scale I , the bank needs to raise $(1 + \tau_1)I - K$ from consumers at t_0 by issuing state-contingent debt. In the good state, the bank returns $(\rho_0 + \gamma - \tau_2)I$ to consumers but only δI with $\delta \leq \gamma - \tau_2$ in the bad state. Provided that the expected rate of return to banks' debt is 1, the borrowing capacity of banks at t_0 is limited by the expected present value of future returns that is

[3] Focusing on the impact of the fiscal policy on banks' investment decision and the time-consistency problem of such a policy, we limit our analysis to the flat tax rate on banks' investment instead of an income tax for two reasons: first, an income tax imposed on risk-neutral consumers is uninteresting from the viewpoint of policy analysis, as in this simple model consumers obtain an average gross rate of return equal to 1 both from state-contingent deposits and from the safe asset; second, a tax on banks' income depending on the realization of aggregate shocks hampers the analysis of the time-consistency problem.

pledgeable to consumers. In equilibrium, we have

$$(1+\tau_1)I - K = \alpha(\rho_0 + \gamma - \tau_2)I + (1-\alpha)\delta I. \tag{2}$$

When condition (2) holds, a bank's borrowing capacity reaches the ceiling, thus any additional debt will be unsustainable. Condition (2) shows that the amount of short-term debt the bank can issue at t_0 increases with the payment to investors in the adverse state δ, and the investment scale I. To ensure that the bank's investment is finite, we assume that

$$1 - \alpha\rho_0 - \gamma > 0. \tag{3}$$

Condition (3) implies that the maximum pledgeable return to consumers from a unit of risky project is always smaller than the cost of the initial investment. Setting this condition can guarantee that the bank's borrowing capacity is bounded by the investment scale, which is itself limited by (and proportional to) the bank's capital.

We can rewrite (2) to obtain the investment scale in the risky project as follows:

$$I = \frac{K}{\beta + \tau}, \tag{4}$$

where $\beta \equiv (1 - \alpha\rho_0 - \gamma) + (1-\alpha)\eta$, with $\tau \equiv \tau_1 + \tau_2$ being the sum of tax rates for the two periods and $\eta \equiv \gamma - \tau_2 - \delta$ being the liquidity reserve ratio chosen by banks. The composite parameter β measures the riskiness or the illiquidity of the project: a larger β refers to a larger expected liquidity gap and thus a higher degree of risk. For a given τ_2, a higher payment to consumers δ implies a lower η. Equation (4) shows that the investment scale increases with banks' capital and the probability of success, but decreases with the liquidity reserve ratio and the tax rate. Clearly, a higher η reinforces banks' liquidity position in the adverse state, but implies a lower δ and hence a lower investment scale. Thereby, the bank may choose a liquidity reserve ratio as low as possible to increase the investment at t_0. Provided that condition (3) holds, we can easily determine that $\beta > 0$

in any circumstances. We rewrite (4) as:

$$l \equiv \frac{I}{K} = \frac{1}{\beta + \tau}. \tag{5}$$

From (5), it is straightforward to see that l, i.e., the financial leverage ratio, is determined by the riskiness of banks' investment and the tax rate. In financial terms, l is a good index to measure the adequacy of bank capital. However, some key elements concerning economic fundamentals are ignored by l. We will show in section 4 that the capital level sufficient to avoid the moral hazard problem is determined by the economic fundamentals of a country.

The tax rate is a key factor that affects η and l simultaneously. Given that the liquidity reserve ratio (η) and the leverage ratio (l) adopted by banking entrepreneurs depend on tax rates (τ), the financial regulation concerning these ratios could be inefficient and reduced to soft budget constraints if τ are not credibly pre-committed by the government.

The scale of continuation investment J is determined by the total liquidity available to banks at t_1. In crisis times, banks, to refinance troubled projects, can use their liquidity reserves ηI and can issue new debt against the future pledgeable income $\rho_0 J$ from the projects refinanced at t_1 and maturing at t_2. Banks' borrowing constraint at t_1 is:

$$J \leq \eta I + \rho_0 J. \tag{6}$$

Provided that $\rho_0 < 1$, the resource obtained from issuing new short-term debt $\rho_0 J$ is not enough to cover the cost of full-scale continuation investment ($J = I$). Therefore, to implement full-scale reinvestment, the amount of banks' liquidity reserves is crucial. A higher η lowers investment scale but ensures a more comfortable liquidity condition for banks in crisis times. Using $\eta \equiv \gamma - t_2 - \delta$, we can rewrite condition (6) as

$$J = \min\{\frac{\gamma - \tau_2 - \delta}{1 - \rho_0}, 1\} I. \tag{7}$$

Condition (7) captures the fact that a lower second-period tax rate τ_2 increases the scale

of reinvestment in the adverse state. We assume that banking entrepreneurs have no alternative use for extra liquidity and will keep the minimal liquidity reserve required in the adverse state. The interval for the liquidity reserve ratio is then $\eta \in [0, 1-\rho_0]$. Full-scale reinvestment can be implemented when the liquidity ratio is such that $\eta = 1-\rho_0$.

Banking entrepreneurs will choose a safe balance sheet by limiting the quantity of short-term debt and keeping a sufficient liquidity reserve (i.e., $\eta = 1-\rho_0$), if doing so delivers a higher profit than taking from a risky balance sheet. Using (4) and (7), we write banks' objective function as follows:

$$\pi(\eta) = (\rho_1 - \rho_0)[\alpha I + (1-\alpha)J] = \frac{(\rho_1 - \rho_0)\left[\alpha + (1-\alpha)\frac{\eta}{1-\rho_0}\right]}{1+\tau-\alpha\rho_0-\gamma+(1-\alpha)\eta}K. \tag{8}$$

It is straightforward to show that banks' profits π rise with the liquidity reserve ratio η if $1+\tau-\gamma-\alpha > 0$ and *vice versa*. Thereby, if the condition

$$1+\tau > \gamma+\alpha \tag{9}$$

is satisfied, the first-order condition of banks' optimization problem implies that they will choose a safe balance sheet corresponding to $\eta = 1-\rho_0$, and there will be no aggregate liquidity shortage disregarding the states of the economy.

We have two possible scenarios compatible with (9): one with $\gamma+\alpha < 1$ and the other with $\gamma+\alpha > 1$. It is noticeable that, in the absence of taxation, banks will keep a sufficient liquidity reserve only if the risky projects have a moderate expected return as shown in Farhi and Tirole (2012). Since the latter analyze the effect of monetary policy on banks' risk-taking, the only case that they can consider is that in which $\gamma+\alpha < 1$.

When $\gamma+\alpha < 1$, the role of the fiscal policy in stabilizing the banking system is modest in the sense that condition (9) is always verified regardless of the level of taxation, implying that the latter does not affect banks' choice of liquidity reserve ratio. However, a higher level of taxation could reduce the financial leverage of banks according to (5). In fact, $\gamma+\alpha < 1$ stands for the case in which the yield from the project is relatively low with respect to its riskiness. Therefore, banking entrepreneurs, instead of

over-accumulating short-term debt, will always keep enough liquidity reserves to ensure a full-scale reinvestment in the adverse state.

However, the second scenario, $\gamma+\alpha > 1$, implies that the high return from the project overwhelms its riskiness. Banking entrepreneurs thus have a strong incentive to adopt a risky balance sheet by setting $\eta = 0$ and loading up as much short-term debt as possible to invest more in risky projects. In this situation, if the tax rate satisfies (9), i.e.,

$$\tau \geq \tau_{\min} \equiv \gamma + \alpha - 1, \tag{10}$$

banking entrepreneurs will abandon their risky balance sheet. This is because, in the absence of taxes, $\gamma + \alpha > 1$, risky projects are appealing, but the taxes could reduce their attractiveness since we could have $\gamma + \alpha - \tau < 1$. Thus, an appropriate fiscal policy can be an efficient prudential instrument that could be used to impel banks to keep enough liquidity reserve even in the case in which the risky project is exceedingly lucrative ($\gamma + \alpha > 1$). We are primarily interested in the second scenario, and from now on, we concentrate on the case in which the condition $\gamma + \alpha > 1$ holds.[4]

However, the government cannot set a tax rate higher than

$$\tau_{\max} \equiv \rho_1 - (1 - \gamma + 1 - \alpha). \tag{11}$$

If $\tau > \tau_{\max}$, any investment will yield a loss for banking entrepreneurs, i.e. $\pi(\tau) - K < 0$. In addition, condition (1) ensures that $\tau_{\max}$ is non-negative for $\gamma + \alpha > 1$.

We summarize the above results in the following proposition:

Proposition 1 *Considering $\gamma + \alpha$ as a measure of attractiveness of the risky asset, with γ being its rate of safe return and α its probability of success, we have:*

- *(1a) if $\gamma + \alpha \leq 1$, i.e., the riskiness is high relative to the yields, banks will adopt a safe balance sheet, regardless of the fiscal policy;*

[4] The fiscal policy has a role in affecting banks' resource allocation, when $\gamma + \alpha < 1$, depending on its nature i.e., pre-committed or discretionary. To limit the scope of the paper, we focus on the case where $\gamma + \alpha > 1$. In fact, the implication of the results obtained for $\gamma + \alpha > 1$ can be used to deduce the influence of the fiscal bailout policy when $\gamma + \alpha < 1$, knowing that the expectation of fiscal bailouts increases the attractiveness of the risky asset.

- *(1b) if $\gamma + \alpha > 1$, i.e., the riskiness is dominated by the yields, banks will choose a safe balance sheet only when the tax rate (τ) is such that $\tau \geq \tau_{\min} \equiv \gamma + \alpha - 1$.*

The case (1b) of proposition 1 immediately leads to the following corollary:

Corollary 1 *The tax rate policy can be used as an efficient instrument to fight against the excessive risk-taking of banks through reducing the attractiveness of risky assets. Given both the liquidity reserve ratio (η) and the leverage ratio (l) being dependent on the tax rate (τ), the incremental regulation on η and l could be inefficient and reduced to soft budget constraints, if the tax rate policy (τ) is not credibly pre-committed by the government.*

It is to notice that when the risky asset is highly attractive, i.e., the case (1b) of proposition 1, a credibly pre-committed tax rate policy can incite banks to keep sufficiently high liquidity reserves and capital ratios. By playing an important role in stabilizing the banking system, the tax rate policy can be considered as an efficient instrument of strategic regulation.

3 Fiscal policy ignoring the potential bailout

We start with the simplest case in which the tax rates are constant and non-state-contingent, and do not distinguish policy regimes (i.e., commitment *versus* discretion). More precisely, when the government makes the taxation decision, it takes into account the probability of the adverse state while disregarding crisis resolution arrangements.

Consumers are indifferent to the dates of consumption and their utility is given by[5]

$$U(\zeta, \tau) = \begin{cases} C + \theta\tau I(\tau), & \text{if } \tau \geq \widehat{\tau} \\ C + \theta\tau I(\tau) - \zeta, & \text{if } \tau < \widehat{\tau} \end{cases} \tag{12}$$

The utility of consumers results from the consumption of private goods C and public services.[6] The utility from the consumption of the latter is a linear function of their

[5] Given the gross rate of interest $R = 1$, the date of consumption does not impact the utility of risk-neutral consumers. For them, the expected return from a risky project is the same as that from the saving technology; hence, the consumption of private goods is not affected by the investment scale.

[6] The utility function (12) is similar to the one in Hasman and Samartín (2011). They introduce a

cost and is equal to $\theta\tau I$, with $\theta > 0$. Given condition (3), we can easily verify that the investment $I(\tau)$ is relatively inelastic with respect to the tax rate τ such that a reduction in the tax rate will induce a decrease in the fiscal revenue $\tau I(\tau)$ and thus the supply of public services.[7] There is a minimum demand for public services, implying a corresponding threshold tax rate $\widehat{\tau}$. When the tax rate is below $\widehat{\tau}$, consumers will suffer a deadweight utility loss $\zeta > 0$ due to an excessively insufficient supply of public services. Such a loss is explained by the fact that lowering the public services to a level below consumers' minimum demand impairs their consumption structure and some public services cannot be substituted by private goods.

The threshold tax rate $\widehat{\tau}$ is country-specific and can vary greatly across countries. We assume henceforth that $\widehat{\tau} > \tau_{\min}$.[8] To avoid the case in which the threshold tax rate is sky-high, making thus the taxation impractical, we assume that, for our economy, it always satisfies the following condition

$$\frac{1}{2}\widehat{\tau} < \frac{\alpha + \gamma - 1}{1 - \alpha}. \tag{13}$$

Condition (13) ensures that the threshold tax rate $\widehat{\tau}$ is compatible with the profitability of banking entrepreneurs' investment and that the government has enough tax revenue to fill the liquidity gap in the event of a crisis. Condition (1) ensures that $\widehat{\tau} < \tau_{\max}$.

The government sets an 'optimal' two-period tax rate at t_0 to maximize the social welfare and stabilize the banking system. Its optimization problem is

$$\begin{aligned} \max_{\tau} W &= U(\zeta, \tau) + \phi J(\tau), \\ \text{s.t.} \quad \tau &\geqslant \tau_{\min} \end{aligned} \tag{14}$$

threshold for the consumption of private goods, while we consider a minimum demand for public services. Further, this utility function is also close to that in Farhi and Tirole (2012). They measure consumers' utility loss directly when the government bails out the banking sector, while we compare the consumers' utility in the case in which the bailout is implemented with the one in the case of no bailout.

[7] The investment is relatively inelastic with respect to the tax rate when $\beta > 0$. Provided condition (3), we can easily check that $\beta > 0$ holds in any circumstances.

[8] In fact, if $\widehat{\tau} < \tau_{\min}$, a tax rate policy setting $\tau \geqslant \tau_{\min}$ becomes very costly in terms of social welfare. The government is in an either-or situation: it chooses either the safety of the banking system or a higher level of social welfare.

where ϕ (≤ 1) is the relative weight associated with the scale of continuation investment J and measures the influence of the banking sector in the whole economy. In the good state, we have $J = I$ as there is no problem for refunding; in the adverse state, $J \leq I$, depending on the bank's liquidity availability. The objective function (14) is a weighted average W of consumers' consumption $U(\zeta, \tau)$ and banks' continuation investment scale J. The introduction of the term $\phi J(\tau)$ into (14) is extensively justified by Farhi and Tirole (2012) who suggest that a higher reinvestment scale improves the utility of banking entrepreneurs, lenders and workers. Given that $U(\zeta, \tau)$ increases while $\phi J(\tau)$ decreases with τ, the social welfare function (14) captures well the conflict of interest between consumers and banks induced by the taxation of risky investment.

The realization of the dual objective of the government is subject to $\tau \geqslant \tau_{\min}$ implied by condition (10). The satisfaction of this constraint implies that the government's fiscal policy could discourage banks from excessive risk-taking.

The social welfare W is a step function depending on τ. For $\tau \in [\tau_{\min}, \widehat{\tau}]$, $W \mid_{\tau_{\min} \leq \tau < \widehat{\tau}} = C + \theta\tau I(\tau) - \zeta + \phi J(\tau)$, and for $\tau \geq \widehat{\tau}$, $W \mid_{\tau \geq \widehat{\tau}} = C + \theta\tau I(\tau) + \phi J(\tau)$. The optimal fiscal policy (i.e., 'optimal' tax rate) is set over two distinct intervals of τ, i.e., $\tau \in [\tau_{\min}, \widehat{\tau}]$ and $\tau \geq \widehat{\tau}$, by evaluating W over these two intervals. If condition (10) is verified, i.e., $\tau \geq \tau_{\min}$, banks will keep a sufficiently high liquidity reserve ratio such that $\eta = 1 - \rho_0$ in the adverse state. Consequently, full-scale refunding (i.e., $J = I$) is ensured for both intervals of τ. Using the definition of $I(\tau)$ and β, we rewrite $W \mid_{\tau \geq \widehat{\tau}}$ and $W \mid_{\tau_{\min} \leq \tau < \widehat{\tau}}$ as

$$W \mid_{\tau \geq \widehat{\tau}} = C + \frac{(\phi + \theta\tau)K}{\beta + \tau} \quad \text{and} \quad W \mid_{\tau_{\min} \leq \tau < \widehat{\tau}} = C - \zeta + \frac{(\phi + \theta\tau)K}{\beta + \tau},$$

respectively. We have $\frac{\partial W|_{\tau \geq \widehat{\tau}}}{\partial \tau} < 0$ and $\frac{\partial W|_{\tau_{\min} \leq \tau < \widehat{\tau}}}{\partial \tau} < 0$, if

$$\phi > \theta\beta. \tag{15}$$

Condition (15) implies that the government is more prone to set a moderate tax rate if the banking sector is relatively important, i.e., ϕ is relatively large. It is more easily verified when the investment is less risky (β is lower), the productivity of the public

sector (θ) is lower and the utility of the banking sector has a greater weight in the social welfare function (ϕ is higher).[9] Hereafter, we assume that (15) is always verified given the importance of the banking system in the modern economy, so that the social welfare decreases with τ within both intervals of τ. Therefore, it is straightforward to see that only corner solutions of τ exist (see Figure 1), i.e., $\tau = \tau_{\min}$ maximizes $W\mid_{\tau_{\min}\leq\tau<\widehat{\tau}}$ in the interval $\tau \in [\tau_{\min}, \widehat{\tau}]$ and $\tau = \widehat{\tau}$ maximizes $W\mid_{\tau\geq\widehat{\tau}}$ in the interval $\tau \geq \widehat{\tau}$.

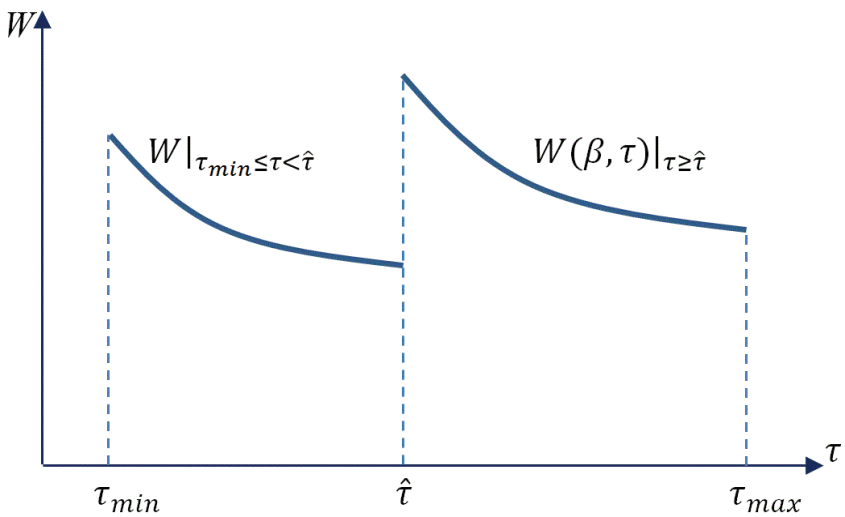

Figure 1: The social welfare function for intermediate values of ϕ.

To determine the optimal overall tax rate for the two periods, we now compare the social welfare obtained respectively in the two intervals of τ given above. It is easy to see that the policy maker sets the 'optimal' tax rate at $\tau^* = \widehat{\tau}$ if $\Delta W \equiv W\mid_{\tau=\widehat{\tau}} - W\mid_{\tau=\tau_{\min}} > 0$. Let $\Delta_1 = \widehat{\tau} - \tau_{\min}$. The condition $\Delta W > 0$ is equivalent to

$$\phi < \theta\beta + \frac{\zeta(\beta + \widehat{\tau})(1 - \rho_0)}{\Delta_1 K} \equiv \Phi_1. \tag{16}$$

From the definition of ΔW, we observe that the welfare gap depends negatively on Δ_1 and ϕ. The social welfare is highest at $\tau = \widehat{\tau}$ if the weight of the banking sector is such that $\phi \in [\theta\beta, \Phi_1]$. In this interval of ϕ, the social welfare is a decreasing function of the

[9] Otherwise, two cases need to be distinguished. For $\phi < \theta\beta$, i.e., the size of the banking sector is small, the government should set a maximum tax rate corresponding to the ceiling $\tau_{\max}$ given by (11). For $\phi = \theta\beta$, there are infinite optimal solutions of τ.

tax rate in two intervals, i.e., $\tau \in [\tau_{\min}, \widehat{\tau}]$ and $\tau \in [\widehat{\tau}, \tau_{\max}]$. Due to the deadweight utility loss of consumers induced by insufficient provision of public services when $\tau < \widehat{\tau}$, the welfare obtained for $\tau = \widehat{\tau}$ is higher than when setting $\tau = \tau_{\min}$, i.e. the welfare gain for consumers from setting a higher tax rate overcompensates the loss of stakeholders of the banking sector. It is noticeable that for $\phi > \Phi_1$, it is optimal for the government to set $\tau = \tau_{\min}$ since the gain from a higher investment scale induced by a lower tax rate always dominates the utility loss of consumers due to less public services. However, this case corresponds to the one in which the government does not have a room of maneuver in the event of a crisis and will not be examined in the following.

When condition (16) is satisfied, the policy maker, who does not consider the potential banking bailout in the event of a crisis, will set $\tau^* = \widehat{\tau}$ as the optimal overall two-period tax rate. Given that the government is assumed to maintain a constant tax rate in the two periods, the 'optimal' tax rate for each period is $\tau_1 = \tau_2 = \frac{1}{2}\widehat{\tau}$. It is identical to the tax rate in the case of no fiscal bailout. The social welfare when $\tau^* = \widehat{\tau}$ is given by:

$$W \mid_{\tau=\widehat{\tau}} = C + \frac{(\theta\widehat{\tau} + \phi)K}{1 + \widehat{\tau} - \alpha\rho_0 - \gamma + (1-\alpha)\eta}. \tag{17}$$

A lower tax rate, such as $\tau^* = \tau_{\min}$, will improve the social welfare when condition (16) is not satisfied. This is more likely when the continuation investment scale has a larger weight (i.e., ϕ is higher) in the social welfare function (14), the banking sector is less vulnerable (i.e., with more capital K), projects are less risky (β is smaller), consumers' deadweight utility loss caused by a reduction in public services when $\tau^* < \widehat{\tau}$ is smaller (i.e., ζ is lower) and their utility gain from the consumption of public goods is lower (i.e., θ is smaller). From now on, we focus on the case in which both conditions (15) and (16) always hold, i.e., $\phi \in [\theta\beta, \Phi_1]$. The following proposition summarizes the above results.

Proposition 2 *Ignoring the potential bailout, the government will set the tax rate, according to the relative weight of the banking sector ϕ in the social welfare function, at*

- *(2a) the maximum feasible level, i.e., $\tau^* = \tau_{\max}$, if $\phi < \theta\beta$;*
- *(2b) the minimum feasible level, i.e., $\tau^* = \tau_{\min}$, if $\phi > \Phi_1$;*

- *(2c) the threshold tax rate below which consumers suffer a deadweight utility loss, i.e.,* $\tau^* = \widehat{\tau}$*, if* $\phi \in [\theta\beta, \Phi_1]$.

The implication of proposition 2 is straightforward. The extremely high (low) tax rate, i.e., case (2a) (case (2b)) in proposition 2, implies a welfare transfer from banks (consumers) to consumers (banks) and is set when the banking sector has a relatively low (high, respectively) weight. In case (2c), the banking system is moderately influential so that the government will avoid welfare transfer between these two sectors in normal times by setting $\tau^* = \widehat{\tau}$. In this case, the benefit for the banking sector generated by a tax rate lower than $\widehat{\tau}$ will be dominated by the loss for consumers, whereas the welfare gain induced by more public services made possible by a tax rate higher than $\widehat{\tau}$ will be dominated by the welfare loss due to a reduction in banks' investment scale.

4 Fiscal response to the crisis

Banking regulation, failing to fully eliminate crises, has usually focused on lowering their likelihood. When a banking crisis is inevitable, policy makers generally react in urgency instead of making much effort to conceive a well-defined bailout policy that stabilizes the banking sector while reducing the social cost of the crisis. In the absence of monetary sovereignty, pre-committed fiscal bailouts are particularly useful for crisis resolution. When the implementation of a bailout improves the social welfare, the non-state-contingent tax rates $\tau_1 = \tau_2 = \frac{1}{2}\widehat{\tau}$ considered in the last section can become untrustworthy and the government is incited to modify them.

We consider hereafter that the government maintains the tax policy in the normal state but reduce the second-period tax rate in the adverse state to attenuate the effect of negative shocks during crisis times and to improve the social welfare.[10] This bailout program is akin to the one through a direct liquidity injection into banks in the adverse state while maintaining a constant tax rate. We distinguish two fiscal policy regimes,

[10] We may consider an alternative crisis management whereby policy makers increase the tax rate over $\widehat{\tau}/2$ in the normal state and reduce it under $\widehat{\tau}/2$ in the adverse state to obtain an average overall tax rate $\widehat{\tau}$. However, this policy does not improve the expected social welfare and is therefore superfluous.

which are associated with pre-committed and discretionary fiscal bailout respectively.

4.1 Commitment

The government will not alter fiscal policy in normal times, whereas it is committed to carrying out a bailout by reducing τ_2 in the adverse state at t_1.

Let Δ_2 ($\equiv \frac{1}{2}\widehat{\tau} - \tau_2^c$) denote the deviation of the tax rate under commitment in the adverse state, τ_2^c with the superscript "c" standing for commitment, from its value in the normal state $\frac{1}{2}\widehat{\tau}$. The government will never allow the expected overall tax rate to drop below $\tau_{\min}$; therefore, the scope of expected tax rate reduction is given by $\Delta_2 \in [0, \frac{\Delta_1}{1-\alpha}]$.[11] Given condition (13) and the definition of Δ_2, we have $\tau_2^c \geq 0$ for $\Delta_2 \in [0, \frac{\Delta_1}{1-\alpha}]$, implying that the bailout package can be entirely funded and fulfilled through a reduction of the tax rate in the second period.[12]

The maximization problem of the government under commitment is

$$\max_{\Delta_2} W^c(\widehat{\tau}, \Delta_2) = C + \alpha[U_1(\zeta, \tau) + \phi I(\widehat{\tau}, \Delta_2)] + (1-\alpha)[U_2(\zeta, \tau) + \phi J(\widehat{\tau}, \Delta_2)] \tag{18}$$
$$\text{s.t.} \qquad \frac{1}{2}\widehat{\tau} + [\frac{1}{2}\widehat{\tau} - (1-\alpha)\Delta_2] \geq \tau_{\min} \ ,$$

where $U_1(\zeta, \tau) \equiv \theta\widehat{\tau} I(\widehat{\tau}, \Delta_2)$ and $U_2(\zeta, \tau) \equiv \theta(\widehat{\tau} - \Delta_2) I(\widehat{\tau}, \Delta_2) - \zeta$ represent the utility of consumers in the normal and adverse state, respectively. Given that consumers sign a state-contingent contract with banks at t_0, which ensures an expected return equal to 1, the fiscal policy influences their consumption of public services but not their consumption of private goods.

The liquidity position of banks will be improved if the government reduces the tax rate τ_2^c below the threshold level ($\frac{1}{2}\widehat{\tau}$) in the event of a crisis. Such a tax reduction induces a welfare transfer from consumers to banks. Banks benefits from an increase in the investment following the tax reduction, while such a decision directly results in a deadweight utility loss ζ for consumers in the adverse state.

[11] In fact, $\Delta_2 > \frac{\Delta_1}{1-\alpha}$ implies $\tau_1 + \tau_2 < \tau_{\min}$. This induces an excessive risk-taking in the banking system according to (10). Therefore, the government must limit Δ_2 within the interval $[0, \frac{\Delta_1}{1-\alpha}]$.

[12] In other words, the government has no need to liquidate any public services produced with the tax revenue collected in the initial stage to fund the bailout in the intermediate stage.

Despite the attractiveness of risky assets, banks will adopt a safe balance sheet such that $\eta = 1-\rho_0$ when condition (10) is verified. Therefore, when considering a potential tax reduction in the adverse state, a government, aiming at stabilizing the banking system, will ensure that the expected overall tax rate to be no smaller than $\tau_{\min}$, i.e., $\frac{1}{2}\widehat{\tau} + [\frac{1}{2}\widehat{\tau} - (1-\alpha)\Delta_2] \geq \tau_{\min}$ holds.

This implies that $J(\widehat{\tau}, \Delta_2) = I(\widehat{\tau}, \Delta_2)$ in the adverse state. Thereby, we can rewrite the social welfare function under commitment as

$$W^c(\widehat{\tau}, \Delta_2) = C + \alpha U_1(\zeta, \tau) + (1-\alpha)U_2(\zeta, \tau) + \phi I(\widehat{\tau}, \Delta_2).$$

The government will not alter the tax rate in the event of a crisis if doing so fails to enhance the social welfare, i.e., $W^c(\widehat{\tau}, \Delta_2) < W \mid_{\tau=\widehat{\tau}}$. Using the definitions of $I(\tau)$, we can easily obtain that this condition is equivalent to

$$\phi < \theta\beta + \frac{\zeta(\beta + \widehat{\tau})[\beta + \widehat{\tau} - (1-\alpha)\Delta_2]}{\Delta_2 K} \equiv \Phi_2. \tag{19}$$

As Φ_2 decreases with Δ_2, if (19) holds for $\Delta_2 = \frac{\Delta_1}{1-\alpha}$, it will hold for all $\Delta_2 \in [0, \frac{\Delta_1}{1-\alpha}]$. The government's choice of tax rates depends on structural parameters (i.e., ζ, K, θ, β and ϕ), in particular the weight of the banking sector ϕ. According to (15) and (19), the commitment to bailing out the banking sector in the event of a crisis will not be optimal if the banking sector is moderately important, i.e., $\phi \in [\beta\theta, \Phi_2]$.

Using the definition of β and Δ_1 and substituting Δ_2 by $\frac{\Delta_1}{1-\alpha}$ in (19) yield

$$\phi < \theta\beta + \frac{\zeta(1-\alpha)(\beta + \widehat{\tau})(1-\rho_0)}{\Delta_1 K} \equiv \Phi_2 \mid_{\Delta_2 = \frac{\Delta_1}{1-\alpha}}. \tag{20}$$

When (20) is verified, any tax rate reduction $\Delta_2 \in [0, \frac{\Delta_1}{1-\alpha}]$ could decrease the social welfare. Thus, the tax rate policy under commitment is given by $\tau_1 = \tau_2 = \frac{1}{2}\widehat{\tau}$, as in section 3 when the bailout policy is neglected.

In the contrary case, i.e., if condition (20) does not hold, the constant tax rate policy may be sub-optimal in terms of social welfare. Given that condition (20) is more

restrictive than (16), we might have a situation in which condition (20) breaks while (16) holds, i.e., $\phi \in [\Phi_2, \Phi_1]$. For ϕ lying within this interval, the banking sector is too big to fail, leading the government to announce at t_0 a predetermined bailout package for the adverse state at t_1. If the government insists on a constant tax rate policy corresponding to the one verifying (16), the moral hazard problem will arise and will trigger an *ex-post* bailout in the adverse state. In the presence of an important banking sector, the implementation of the bailout policy lowers the costs of a crisis and improves the social welfare. However, the non-state-contingent fiscal policy given by $\tau_1 = \tau_2 = \frac{1}{2}\widehat{\tau}$ could be suboptimal in such circumstances. In a nutshell, the government will insist on a fiscal policy without bailout characterized by $\tau_1 = \tau_2 = \frac{1}{2}\widehat{\tau}$ when condition (20) holds. Otherwise, a social-welfare-improving fiscal policy with a bailout should be implemented.

Proposition 3 *The optimal fiscal policy under commitment*

- *(3a) is consistent with the no-bailout clause (i.e., $\tau_2 = \tau_1 = \frac{1}{2}\widehat{\tau}$, even in the adverse state) if the banking sector is modestly influential, i.e., $\phi \in [\beta\theta, \Phi_2]$.*
- *(3b) contains a pre-committed bailout plan (i.e., the expected second-period tax rate is $\tau_2 = \frac{1}{2}\widehat{\tau} - (1-\alpha)\Delta_2$) if the banking sector is relatively influential, i.e., $\phi \in [\Phi_2, \Phi_1]$.*

A bailout can be welfare-improving for an economy with a relatively big banking sector, as shown by the case (3b) of proposition 3. Thus, the 'optimal' fiscal policy ignoring the need for bailout, described by the case (2c) in proposition 2, can be socially sub-optimal. As a result, a pre-committed non-accommodative fiscal policy becomes clearly dubious and time-inconsistent if $\phi \in [\Phi_2, \Phi_1]$, implying that, to design a credible and time-consistent fiscal policy at t_0 under commitment, the government should consider the potential bailout.

4.2 Discretion

Under discretion, the government sets the second-period tax rate at t_1, which is set at $\frac{1}{2}\widehat{\tau}$ if no crisis occurs and could be reduced in the event of a crisis. At t_0, banking

entrepreneurs form expectations about the tax rate, i.e., $\tau_2^e \leq \frac{1}{2}\widehat{\tau}$ with the superscript "e" standing for expectations, that the policy maker would set at t_1 in the adverse state. Based on these expectations, they invest at scale $I(\tau_2^e)$ and hold just enough liquidity reserves $\eta^e I(\tau_2^e)$, with $\eta^e = \gamma - \tau_2^e - \delta$, to achieve the full-scale continuation investment in the event of a crisis. All agents know that the government will never accept an overall tax rate lower than $\tau_{\min}$ according to condition (10). Consequently, the expected tax rate reduction will not exceed $\frac{\Delta_1}{1-\alpha}$.

At t_1, the policy maker is not bound by any previous commitment and is free to set the tax rate to maximize the welfare. The tax rate set at t_1 is $\frac{1}{2}\widehat{\tau}$ in the normal state and may be altered during a crisis. The second-period tax rate set by the government in the case of crisis is denoted by τ_2^{nc} with superscript "nc" standing for non-commitment. The policy maker will never set the rate below τ_2^e.[13] For $\tau_2^{nc} > \tau_2^e$, banks cannot continue with full-scale refunding in crisis times. Thereby, τ_2^{nc} takes its value within the interval $[\tau_2^e, \frac{1}{2}\widehat{\tau}]$ and Δ_3, i.e., the gap between τ_2^{nc} and τ_2^e, takes its value within the interval $[0, \frac{\Delta_1}{1-\alpha}]$.

Using condition (7), $\tau_2 = \tau_2^{nc}$ and $1 - \rho_0 = \gamma - \tau_2^e - \delta$, we can define the reinvestment scale under the discretionary fiscal policy as follows:

$$J(\tau_2^e) = \frac{\gamma - \tau_2^{nc} - \delta}{\gamma - \tau_2^e - \delta} I(\tau_2^e). \tag{21}$$

Equation (21) is based on the fact that given the expected tax rate τ_2^e, the banking entrepreneur sets the payment to investors in the adverse state equal to $\delta = \gamma - \tau_2^e - \eta$ with $\eta = 1 - \rho_0$ to realize the full-scale continuation investment. The latter will be achieved if the government sets $\tau_2^{nc} = \tau_2^e$ in crisis times. For any $\tau_2^{nc} > \tau_2^e$, the liquidity reserves for the crisis times will not be adequate since $\gamma - \tau_2^{nc} - \delta = \eta < 1 - \rho_0$, meaning that the full-scale continuation investment cannot be implemented. In fact, equation (21) shows that without a credible pre-committed fiscal policy, the regulatory rules regarding the liquidity reserves and the capital requirement, if they are imposed, could be ineffective in dealing with the excessive risk-taking of banking entrepreneurs.

[13] The policy maker has no incentive to set a tax rate below τ_2^e, as that will not have any other effect than inducing the utility loss of consumers.

The government's optimization problem under discretion is

$$\max_{\tau_2^{nc}} W^{nc}(\tau_2^e, \tau_2^{nc}) = U(\zeta, \tau) + \phi J(\tau_2^e). \tag{22}$$
$$\text{s.t.} \quad \frac{1}{2}\widehat{\tau} + \alpha\frac{1}{2}\widehat{\tau} + (1-\alpha)\tau_2^{nc} \geq \tau_{\min}.$$

Observing the optimization program (22), the banking entrepreneur expect at t_0 the tax rate at t_1 to be τ_2^e in the adverse state, while the government sets τ_2^{nc} in line with this expectation only when the adverse state is realized at date t_1.

In the event of a crisis occurring at t_1, the policy maker sets $\tau_2^{nc} \in [\tau_2^e, \frac{1}{2}\widehat{\tau}]$ to maximize $W^{nc}(\tau_2^e, \tau_2^{nc})$. The policy maker will reduce the tax rate if a tax reduction realizing the expectations of banking entrepreneurs enhances the social welfare, i.e. $W^{nc} \mid_{\tau_2^{nc}=\tau_2^e} > W^{nc} \mid_{\tau_2^{nc}=\frac{1}{2}\widehat{\tau}}$. We can easily show that $W^{nc} \mid_{\tau_2^{nc}=\tau_2^e} > W^{nc} \mid_{\tau_2^{nc}=\frac{1}{2}\widehat{\tau}}$ is equivalent to

$$\phi > \theta\beta + \theta\tau_{\min} + \frac{\zeta[\beta + \widehat{\tau} - (1-\alpha)\Delta_3](1-\rho_0)}{\Delta_3 K} \tag{23}$$

where $\Delta_3 \equiv \frac{1}{2}\widehat{\tau} - \tau_2^e$ denotes the expected scale of tax rate reduction under discretion. All agents know that the government, with the objective of stabilizing the banking sector, will never accept an overall tax rate lower than $\tau_{\min}$ according to condition (10). Consequently, Δ_3 should remain within the interval $\left[0, \frac{\Delta_1}{1-\alpha}\right]$. When condition (23) is satisfied, a set of non-commitment equilibria exists, parameterized by the reduction of the tax rate expected by banking entrepreneurs in the event of a crisis. Consequently, the moral hazard problem is triggered at these equilibria.

The right-hand side (RHS) of (23) decreases with Δ_3, implying that the government is more tempted to bail out banks if the liquidity crisis is more severe.[14] Provided that banks' profits increase with the investment scale and the latter decreases with the expected overall tax rate, the verification of (23) implies that banks will expect a tax rate reduction up to its maximum possible value, i.e., $\Delta_3 = \frac{\Delta_1}{1-\alpha}$ and the government under discretion will set the second-period tax rate equal to $\tau_2^{nc} = \frac{1}{2}\widehat{\tau} - \frac{\Delta_1}{1-\alpha}$ at t_1 in the adverse

[14] Provided that the scale of continuation investment is determined by (21), the severity of the liquidity shortfall under discretion could be indirectly measured by $\tau^{nc} - \tau^e \equiv \Delta_3$.

state.

Substituting Δ_3 by $\frac{\Delta_1}{1-\alpha}$ and using the definition of β and Δ_1, we rewrite (23) as

$$\phi > \theta\beta + \theta\tau_{\min} + \frac{\zeta(1-\alpha)[\beta + \widehat{\tau} - \Delta_1](1-\rho_0)}{\Delta_1 K} \equiv \Phi_3. \tag{24}$$

The composite parameter Φ_3 defined in (24) is the threshold for the relative weight of the banking sector ϕ, above which an accommodative fiscal policy is expected and the government realizes banks' expectation by setting $\tau_2 = \tau_2^e = \frac{1}{2}\widehat{\tau} - (1-\alpha)\Delta_3 = \frac{1}{2}\widehat{\tau} - \Delta_1 = \tau_{\min} - \frac{1}{2}\widehat{\tau}$ in the adverse state.

Proposition 4 *The discretionary fiscal policy is consistent with the no-bailout clause (i.e., $\tau_2 = \tau_1 = \frac{1}{2}\widehat{\tau}$ even in the adverse state) if $\phi \in [\theta\beta, \Phi_3]$, and is consistent with a pre-committed fiscal bailout (i.e., a tax rate equal to the expected second-period tax rate $\tau_2^e = \tau_{\min} - \frac{1}{2}\widehat{\tau}$) if $\phi \in [\Phi_3, \Phi_1]$.*

Under commitment, a pre-committed bailout is justified if (20) is not verified, i.e., $\phi > \Phi_2$. This and condition (24) imply that under both fiscal policy regimes, the government has more incentive to bail out banks when the banking sector is quite influential (large ϕ).

4.3 The impact of policy regime

It is to notice that the expectation of banking entrepreneurs has much more influence over the fiscal policy under discretion than under commitment. Comparing condition (20) with (24) shows that the threshold of implementing accommodative fiscal policy under different regimes depends on bank capital relative to economic fundamentals such that there exists a cut-off point of bank capital:[15]

$$\widehat{K} \equiv \frac{(1-\alpha)[\beta + \widehat{\tau} - \Delta_1]}{\theta}\zeta. \tag{25}$$

[15] When the level of bank capital is $K = \widehat{K}$, we are well in the situation where $\Phi_2 = \Phi_3$.

From condition (25), $\widehat{K}$, is determined by economic fundamentals, such that it decreases with the productivity of public sector θ, but increases with the deadweight utility loss of consumers due to insufficient supply of public services and the riskiness of banks' project $(1-\alpha)[\beta+\widehat{\tau}-\Delta_1]$. Nevertheless, the investment scale is not a factor impacting the value of the switching point of bank capital. As a result, the regulation on leverage ratio l defined by condition (5) cannot affect the capital position of banks with respect to $\widehat{K}$.

It is to notice that the value of $\widehat{K}$ can be extremely high for countries with an inefficient public sector, i.e., productivity θ is limited, and/or with an utmost dependence on the offer of public goods, i.e., the deadweight utility loss ζ is very important, and *vice versa*. Consequently, $\widehat{K}$ is a country specific index of capital abundance, which directly impacts the sustainability of fiscal policy regarding banks' risky investment plans.

From now on, we refer the case of $K > \widehat{K}$ as a banking system being well-capitalized with respect to economic fundamentals, and *vice versa*. In the case where banks' capital is $K > \widehat{K}$, the threshold for fiscal intervention is higher under discretion than under commitment, i.e., $\Phi_3 > \Phi_2$, and *vice versa*.

The choice of policy regime will not have substantial influence on the economy, when the influence of banking sector in the government's objective function is such that $\phi < \Phi_3 < \Phi_2$ or $\phi < \Phi_2 < \Phi_3$.[16]

We are interested in the case of $\phi \in [\Phi_2, \Phi_3]$ and $\phi \in [\Phi_3, \Phi_2]$ in which the policy regimes plays an important role in determining the government's bailout incentive according to the capital position of the banking sector relative to economic fundamentals.

The situation $\phi \in [\Phi_2, \Phi_3]$ is realized when $K > \widehat{K}$. Banking entrepreneurs of a well-capitalized banking sector are more prudent about risky activity so that the investment scale under discretionary policy goes below the optimal level attainable under commitment policy, i.e., $I\mid_{\Phi_3} < I\mid_{\Phi_2}$. Therefore, the implementation of discretionary policy here implies an under-investment in long-term projects. It induces a contraction in output but not inefficient *ex post* bailout.

The situation $\phi \in [\Phi_3, \Phi_2]$ corresponds to $K < \widehat{K}$. It implies that an under-capitalized

[16] When $\phi < \Phi_3 < \Phi_2$ and $\phi < \Phi_2 < \Phi_3$, banks' investment plan is not impacted by the regime of fiscal policy, we have $I\mid_{\Phi_3} = I\mid_{\Phi_2}$

banking sector will over-invest in risky projects under discretion in expecting the *ex post* fiscal bailout, i.e., $I\mid_{\Phi_3} > I\mid_{\Phi_2}$. As a result, the government has more incentive to carry out *ex post* bailout, thus creating conditions favoring the appearance of moral hazard among banking entrepreneurs.

As a consequence, the discretionary regime, which intensifies the interplay between the bailout expectation of banking entrepreneurs and the fiscal decision of the government, can be suboptimal for a country either with a well-capitalized or with an under-capitalized banking system, if the latter has a large influence on the economy, i.e., $\phi > \Phi_2$ or $\phi > \Phi_3$.

By keeping a scale of long-term investment either under or over the optimal level, the discretionary regime cannot lead to the first-best allocation in an economy with an influential banking sector. As a result, discretionary fiscal policy, subject to banks' irreversible investments, cannot maximize the expected social welfare when the banking sector is largely influential relative to the rest of economy.

Proposition 5 *The impact on the economy of the choice of policy regimes is*

- *(5a) not substantial, when the banking sector is of little importance regarding economic fundamentals of a country, i.e.,* $\phi < \Phi_3 < \Phi_2$ *or* $\phi < \Phi_2 < \Phi_3$*;*
- *(5b) significant if the banking sector is enough influential relative to the rest of economy, i.e.,* $\phi > \Phi_2$ *or* $\phi > \Phi_3$*, and it depends on the level of bank capital:*
  - *(5b-1) If banks are relatively well-capitalized, i.e.,* $K > \widehat{K}$*, they will be overly prudent and under-invest in long-term projects under discretion compared to commitment. This results in a low output but not inefficient ex post bailouts.*
  - *(5b-2) If banks are relatively under-capitalized, i.e.,* $K < \widehat{K}$*, they will invest excessively in long-term projects given their expectation of ex post bailout under discretion. This leads to accruing incentive for the government to implement inefficient ex post bailouts.*

Proposition 5 indicates that when the banking sector is relatively influential, the commitment is preferred to discretion in terms of social welfare, disregarding the capital position of banking system with respect to economic fundamentals.

However, the issue of moral hazard arises if the government adopts a pre-committed no-bailout clause when $\Phi_3 < \Phi_2$. More precisely, for an under-capitalized banking system with a weight of $\phi \in [\Phi_3, \Phi_2]$, the no-bailout clause can become incredible in crisis times, if banking entrepreneurs expect the intervention to be implemented. In fact, as long as $\phi > \Phi_3$, the fiscal policy will succumb to moral hazard, whatever its initial design. Thus the time-inconsistency problem arises.

While most attention has been paid to the 'too big/influential to fail' phenomenon as the origin of the problem, we argue that such a phenomenon can only explain the bailout incentive of the government. According to our model, it is the under-capitalization of the banking system that accounts for the presence of moral hazard and the resulting bailout. The critical level of bank capital $\widehat{K}$ defined in (25) is largely influenced by the productivity of public sector (θ) and the deadweight utility loss of consumer (ζ) due to fiscal intervention. This implies that reinforcing incremental regulations by increasing capital/leverage ratios, as prescribed by the Basel Accords, may not eliminate the moral hazard incentive of banking entrepreneurs. Apparently, the capital/leverage ratios, while reinforcing banks' financial position, do not alter the relative weight of the banking sector in the government's objective function. Therefore, as long as the government has incentive to *ex post* bail out the influential banking system, the moral hazard of banking entrepreneurs subsists.

Proposition 6 *For an economy with an influential while relatively under-capitalized banking sector, i.e., $\phi > \Phi_3$ and $K < \widehat{K}$, a pre-committed no-bailout clause cannot avoid the time-inconsistency problem: an influential banking system can ignore the government's announcement and adopt a risky balance sheet in expecting ex post bailout; while the government, facing a costly failure of the weighty banking sector, will have incentive to implement inefficient ex post bailout.*

Since incremental regulation is not an appropriate instrument for either rectifying the moral hazard of banks or remedying the bailout incentive of the government, other policy responses are needed to shield the economy from inefficient bailout.

5 Crisis resolution through public lending

In this section, we show that in order to fight against the moral hazard of an influential while under-capitalized banking sector, the interactions between the government and banking entrepreneurs should be taken into account in the design of fiscal policy. More precisely, rather than implementing a regulatory leverage ratio, the authority need to rule out the moral hazard problem, which lies at the root of inefficiency.

The moral hazard appears because banks do not behave as followers in the strategic game between them and the government, and expect that a leeway exists for the alteration of the announced policy. In certain cases, the moral hazard could improve social welfare and its occurrence could be a rational response to an inadequate fiscal policy. In a situation in which the structural parameters of the economy verify condition (15) but not condition (19), a fiscal bailout in the adverse state is preferred in terms of social welfare. Considering that condition (16) is verified while ignoring the moral hazard problems, the government sets, under commitment, constant tax rates, i.e., $\tau_1 = \tau_2 = \frac{1}{2}\widehat{\tau}$ (see section 3). Nevertheless, as indicated by proposition 6, the problem of moral hazard becomes acute and pernicious when the banking sector is influential but under-capitalized.

To rule out the moral hazard incentive and its negative impact, the government can announce at t_0 that if banks do not set their investment plan conforming to the commitment to no tax reduction in the adverse state, the government will bail them out at t_1 through public lending rather than tax reduction.

Given condition (6), the liquidity needs for full-scale refinancing in the adverse state is $(1-\rho_0)I(\tau_2^e)$, while the liquidity reserves under the moral hazard is $\eta I(\tau_2^e) = (\gamma - \tau_2^{nc} - \delta)I(\tau_2^e)$. The equality between them requires an accommodative fiscal policy characterized by $\tau_2^{nc} = \tau_2^e$ at t_1. However, when the tax reduction is not implemented, i.e., $\tau_2^{nc} = \frac{1}{2}\widehat{\tau}$, the unfilled liquidity gap of the banking system is $[(1-\rho_0)-(\gamma-\frac{1}{2}\widehat{\tau}-\delta)]I(\tau_2^e) = (\frac{1}{2}\widehat{\tau}-\tau_2^e)I(\tau_2^e)$. Therefore, the amount of public lending Υ needed at least to cover the liquidity gap in the adverse state is

$$\Upsilon = (\frac{1}{2}\widehat{\tau} - \tau_2^e)I(\tau_2^e).$$

Since the government has no other income than the tax revenue, the loan Υ at t_1 implies a decline in the supply of public services, which results in a utility loss equal to $\theta\Upsilon$ for consumers at t_1. Denote by $R^p(>1)$ the gross interest rate on this loan. The bank should repay $R^p\Upsilon$ to the government at t_2 when the investment is mature. The government can transfer the pay-off $R^p\Upsilon$ resulting from the public lending to consumers with a unitary gain of utility equal to $\lambda > 0$.[17] Therefore, consumers' utility increases by $\lambda R^p\Upsilon$ at t_2.

The public lending will not induce an expected utility loss if $\theta\widehat{\tau}I(\tau_2^e) - \theta\Upsilon + R^p\lambda\Upsilon \geq \theta\widehat{\tau}I(\tau_2^e)$. The left-hand side (LHS) of the latter condition indicates the total utility resulted from public services and transfers received by consumers when banks repay the loan and its RHS represents the threshold level of public services. Using definitions of $I(\tau)$ and Υ, the previous condition is equivalent to

$$R^p \geq \frac{\theta}{\lambda}\frac{\beta + \alpha\widehat{\tau}}{\beta + \widehat{\tau}}. \tag{26}$$

Consequently, when the interest rate on public lending satisfies condition (26), consumers do not bear the cost of bailout. On the contrary, if the interest on lending is lower than R^p, consumers will suffer a utility loss of $(\theta - \lambda R^p)\Upsilon + \zeta$ caused by the banking bailout.

In general, we consider the policy efficient if it can effectively induce changes in the belief of banking entrepreneurs about the future profit from risky activity, and thus eliminate the moral hazard incentive of banks. Clearly, banking entrepreneurs will avoid public lending in the adverse state, if the reduction of expected profit due to the lending is large enough, such that

$$(\rho_1 - \rho_0)I(\tau_2^e) - (1-\alpha)R^p\Upsilon < (\rho_1 - \rho_0)I(\widehat{\tau}). \tag{27}$$

When condition (27) holds, the profit from a risky balance sheet, i.e., the LHS of (27) becomes lower than that from a safe one, i.e., the RHS of (27). Using $\gamma - \tau_2^e - \delta = 1 - \rho_0$

[17] The utility of consumers from liquidity transfer at t_2 is a linear function of their cost, which is captured by $\lambda > 0$. Besides, we can alternatively interpret λ as the capacity/efficiency of the government to transfer its revenue at t_2 to consumers at the same date.

implied by (21) and the definition of $I(\widehat{\tau})$, we rewrite (27) as

$$R^p > \frac{\rho_1 - \rho_0}{\beta + \widehat{\tau}}. \tag{28}$$

Given that $\frac{1}{\beta+\widehat{\tau}}$ $(\equiv l)$ represents the leverage ratio, the RHS of (28) corresponds to the expected rate of profit that banking entrepreneurs could realize by adopting a safe balance sheet. In fact, setting an interest rate R^p higher than $\frac{\rho_1-\rho_0}{\beta+\widehat{\tau}}$ is equivalent to imposing a penalty on banks. Such a penalty, if practicable, can incite banking entrepreneurs to adopt a safe balance sheet to avoid costly borrowing in crisis times. Consequently, the time-inconsistency problem of fiscal policy is resolved thanks to the disappearance of moral hazard incentive.

However, to ensure the feasibility of such a bailout program, R^p must not exceed a ceiling over which banks will not borrow in the event of a crisis. It is straightforward to see that banking entrepreneurs will take into account the costs of public lending in the design of their investment plan at t_0 if the following condition is satisfied:

$$(\rho_1 - \rho_0)I(\tau_2^e) - R^p\Upsilon > (\rho_1 - \rho_0)J(\tau_2^e). \tag{29}$$

The LHS of (29) represents banks' profits in the adverse state when they receive the public loans to realize the full-scale refinancing $(I(\tau_2^e))$. The RHS of (29) stands for banks' profits in the adverse state when public lending is refused, thus only a partial refinancing is realized $(J(\tau_2^e))$. It directly follows that when (29) dose not hold, the public lending policy becomes futile and thus infeasible.

For banks engaging in excessive risk-taking to accept public loans, (29) must be verified. Given the importance of the banking sector and the horrendous losses for the whole economy that a systemic banking crisis can induce, the government cannot just stand by idly in the case in which banks do not accept the public lending imposing a large penalty. To avoid massive premature liquidation, the government will thus be obliged to modify the bailout program at t_1 by decreasing either the second-period tax rate or the interest rate on public lending. Consequently, the time-inconsistency problem of the fiscal policy

remains unresolved and banks' excessive risk-taking is not prevented. The result that public lending with an exceedingly high interest rate will be ineffective in dealing with the banking crisis is consistent with empirical observations according to which extremely severe penalties are rarely implemented for morally hazardous banks.

Using (21), the definition of Υ, $\tau_2^{nc} - \tau_2^e = \frac{1}{2}\widehat{\tau} - \tau_2^e = \Delta_3$ and $\gamma - \tau_2^e - \delta = 1 - \rho_0$, condition (29) allows the determination of the above-mentioned interest ceiling such that:

$$R^p < \frac{\rho_1 - \rho_0}{1 - \rho_0}. \tag{30}$$

When (30) holds, banking entrepreneurs adopting a risky balance sheet will have an incentive to borrow from the government in the adverse state. Given the definition of β, we can easily verify that $1 - \rho_0 < \beta + \widehat{\tau}$, implying that $\frac{\rho_1 - \rho_0}{\beta + \widehat{\tau}} < \frac{\rho_1 - \rho_0}{1 - \rho_0}$, where the LHS is taken from (28) representing the minimum gross interest rate to be imposed to discourage the appearance of moral hazard in the banking sector. Therefore, the effective interest rate on public lending must be such that

$$R^p \in [\frac{\rho_1 - \rho_0}{\beta + \widehat{\tau}}, \frac{\rho_1 - \rho_0}{1 - \rho_0}]. \tag{31}$$

As long as (31) is verified, over-risky banking entrepreneurs will accept the public lending and bear a cost for the bailout since their profits will otherwise be lower. In fact, observing the gross interest rate verifying condition (31), banks will abandon the risky balance sheet in the first place and thereby no public lending will even be required. The mere announcement of such a policy permits to eliminate the moral hazard incentive, thus reinforce the credibility of the no-bailout policy and reduces the costs of crisis management. As a result, the public lending can be an efficient instrument to resolve both the moral hazard problem of banks and the time-inconsistency problem of the fiscal policy.

Two aspects of the implementation of public lending policy need to be emphasized: the timing and the social costs. First, the government should pre-commit to this bailout policy at t_0. Apparently, if the bailout policy is only announced at t_1 when the adverse state is realized, it cannot affect banks' irreversible investment decision in the planning

stage. Therefore, even banking entrepreneurs accept the policy characterized by (31), the over risk-taking is not avoided. Besides, when the interest rate conforming to (31) fails to verify condition (26), the cost of bailout through lending will lead to an inefficient utility loss of consumers and thus impairing the welfare. Only the announcement at t_0 can achieve the objective of eliminating the moral hazard of banking entrepreneurs and finally avoid the time-inconsistency problem of fiscal policy. In short, the pre-committed bailout package can avoid its implementation, whereas a discretionary one implies its actual execution that could be costly in terms of banks' profit and the social welfare.

Second, the implementation of the pre-committed bailout policy does not necessarily need to be costly for consumers. More precisely, if the condition

$$\theta < \frac{\rho_1 - \rho_0}{\beta + \alpha\widehat{\tau}}\lambda \tag{32}$$

holds,[18] consumers' utility loss due to the transfer implied by the bailout is relatively small comparing with the potential utility gain resulting from the success of public lending. Through setting an appropriate interest rate on public lending, the government could easily restrain the risk-taking of the banking sector. A government that maximizes social welfare could impose an gross interest rate at an intermediate level such that $R^p \in [\frac{\theta}{\lambda}\frac{\beta+\alpha\widehat{\tau}}{\beta+\widehat{\tau}}, \frac{\rho_1-\rho_0}{\beta+\widehat{\tau}}]$, and bail banks out through public lending in the adverse state. Unlike a bailout through the tax reduction forced by banks' irreversible risky investment due to the moral hazard, the public lending will be welfare-improving once carried out.[19] Furthermore, the decrease in the tax rate implies a pure welfare transfer from consumers to banks and thus a utility loss for consumers, while the cost of public lending can be borne by banks and will not necessarily induce a social loss if condition (32) is verified.

Proposition 7 *A well-defined and pre-announced bailout through public lending, with a gross interest rate such that* $\max\{\frac{\rho_1-\rho_0}{\beta+\widehat{\tau}}; \frac{\theta}{\lambda}\frac{\beta+\alpha\widehat{\tau}}{\beta+\widehat{\tau}}\} \leq R^p \leq \frac{\rho_1-\rho_0}{1-\rho_0}$, *can resolve the conflict between banks' profits and consumers' welfare due to the commitment to no tax reduction*

[18] We obtain (32) by imposing that the RHS of (26) is smaller than that of (28), i.e., $\frac{\theta}{\lambda}\frac{\beta+\alpha\widehat{\tau}}{\beta+\widehat{\tau}} < \frac{\rho_1-\rho_0}{\beta+\widehat{\tau}}$.

[19] This is the case in which both conditions (19) and (24) hold. The government sets a constant tax rate policy to maximize the social welfare as (19) is verified but has *ex post* incentive to bail out banks given the verification of (24).

in crisis times. Such a pre-committed bailout clause can not only guarantee the time consistency of the fiscal policy but also minimize the cost of banking bailout.

Given a well-defined bailout policy with commitment, whether banks adopt a risky balance sheet or not depends on the interest rate on public loans set by the policy maker at t_0. The credibility of the pre-committed fiscal policy is no longer subject to the investment plans of banks. To ensure the stabilization of the banking sector and to lower the cost of a banking crisis, this interest rate should be high enough to eliminate the moral hazard incentive but moderate enough to ensure the feasibility of the bailout program.

The bailout through public lending analyzed above can be considered as an efficient regulatory instrument complementary to the tax rate policy. Given the pre-committed constant tax rate policy, it can efficiently eliminate the moral hazard of under-capitalized banking system by encouraging banks to renounce the adoption of a risky balance sheet while ensuring that no bailout through a tax reduction is necessary.

In some circumstances, decreasing the tax rate is superior to public lending. Notably, when condition (19) is not verified, a pre-committed bailout through reducing the tax rate in the adverse state is welfare-improving, while the one through public lending with an interest rate in the interval $R^p \in [\frac{\rho_1-\rho_0}{\beta+\widehat{\tau}}, \frac{\rho_1-\rho_0}{1-\rho_0}]$ will depress the investment to an inefficient scale and hence the social welfare to a lower level.[20] As a result, a bailout through public lending cannot always replace a fiscal bailout through tax reduction. However, it remains an effective tool for fighting the banking crisis and can be used to avoid the time-inconsistency problem of the pre-committed tax rate policy caused by the moral hazard in the banking sector.

6 Conclusion

In this paper, we have studied several issues related to fiscal policy responses to banking crises in a country without monetary sovereignty, such as the member states of a monetary

[20] When (19) is not satisfied, we have $W^c(\widehat{\tau}, \Delta_2) > W \mid_{\tau=\widehat{\tau}}$. The public lending with $R^p \in [\frac{\rho_1-\rho_0}{\beta+\widehat{\tau}}, \frac{\rho_1-\rho_0}{1-\rho_0}]$ means that banks will set the leverage ratio corresponding to $\tau = \widehat{\tau}$. Consequently, the social welfare realized under the pre-committed tax rate reduction is $W^c(\widehat{\tau}, \Delta_2)$, which is higher than the welfare under the pre-committed public lending $W \mid_{\tau=\widehat{\tau}}$.

union. Such fiscal responses could be conceived as a strategic regulation, which might be more efficient in stabilizing the banking sector than incremental regulation rules (i.e., leverage and liquidity ratios). This is because the latter concentrate on reducing bank failures but fail to take account of their own impact on social welfare.

The credibility and efficiency of these rules depend largely on the expectations of banking entrepreneurs about the government's crisis resolution arrangements. When the fiscal (including bailout) policy is discretionary, incremental regulatory rules become problematic since they are reduced to 'soft' constraints on banks' balance sheet. A bank keeping a liquidity reserve ratio high enough for the normal state could suffer a large liquidity shortage in the adverse state if the government does not carry out the large fiscal bailout expected by banking entrepreneurs prone to moral hazard. Contrariwise, a pre-committed fiscal policy appropriately conceived as strategic regulation can restrain the riskiness of banks' balance sheet and minimize the social cost of a banking crisis given that the taxation can affect banks' choices of leverage and liquidity ratios simultaneously. It creates incentives for banking entrepreneurs to adopt a safe balance sheet to reduce the risk of insolvency, a goal that incremental rules also seek to achieve.

The optimal design of the fiscal policy depends on the structural parameters of the economy, in particular the weight and the level of capital of the banking sector. Our results show that the commitment regime excels the discretionary regime in terms of social welfare, because under discretion a well-capitalized banking system tends towards under-investment while a weakly-capitalized one inclines towards over-investment. For a country with a weakly-capitalized while relatively large banking sector, the social-welfare improving no-bailout clause can be unsustainable due to the moral hazard resulting from banking entrepreneurs' bailout expectations. Intensifying the incremental regulation, such as imposing a higher capital ratio, can be infeasible and/or inefficient to tackle the moral hazard problem, since it considers uniquely the financial position of the banking system while neglecting a country's specific economic fundamentals.

To deal with potential moral hazard problems linked with bailout expectations, we suggest that, to ensure its time consistency, a pre-committed tax rate policy should be

complemented by a pre-committed bailout through public lending to avoid the inefficient tax reduction caused by the moral hazard in the banking sector. For the interest rate set on public lending to improve the social welfare, it must be sufficiently but not exceedingly high. Otherwise, public lending will be ineffective in dealing with the banking crisis.

Using a credibly pre-committed fiscal policy embodying appropriately defined crisis resolution arrangements (including pre-committed fiscal bailouts and public lending) as a strategic regulation tool could remedy the lacunae of micro- and macro-prudential regulations introduced by Basle III and hence help avoid the repetition of the Eurozone crisis. We suggest that the Eurozone member states redesign their fiscal policies in a way to incite the banking sector, prone to moral hazard problems, to respect more strictly these regulations and to prevent it from taking excessive risk.

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A Technical Appendix

A.1 The determination of the investment scale I

The borrowing capacity of banks at t_0 is given by

$$(1+\tau_1)I - K = \alpha[\rho_0 + \gamma - \tau_2]I + (1-\alpha)\delta I \tag{A.1}$$

From the above condition, we obtain the investment scale I

$$[1 + \tau_1 - \alpha\rho_0 - \alpha\gamma + \alpha\tau_2 - (1-\alpha)\delta]I = K$$

Using $\eta \equiv \gamma - \tau_2 - \delta$, we replace δ by $\gamma - \tau_2 - \eta$ and have

$$\begin{aligned} [1 + \tau_1 - \alpha\rho_0 - \alpha\gamma + \alpha\tau_2 - (1-\alpha)(\gamma - \tau_2 - \eta)]I &= K \Longrightarrow \\ [1 + \tau_1 - \alpha\rho_0 - \gamma + \tau_2 + (1-\alpha)\eta]I &= K \end{aligned}$$

Arranging the terms in the last equation, we obtain the investment scale as follows:

$$I = \frac{K}{1 + \tau - \alpha\rho_0 - \gamma + (1-\alpha)\eta}, \tag{A.2}$$

where $\tau = \tau_1 + \tau_2$ is the overall tax rate for two periods. The above equation corresponds to the condition (4) in the main text.

A.2 The scale of continuation J

The condition $J \leq \eta I + \rho_0 J$, can be rewritten as :

$$J \leq \frac{\eta}{1-\rho_0} I$$

Replacing η by $\gamma - \tau_2 - \delta$ into the above condition and taking into account that no new investment will be initiated in the intermediate stage such that $J \leq I$, we can write the

condition for the scale of continuation investment J as

$$J = \min\{\frac{\gamma - \tau_2 - \delta}{1 - \rho_0}, 1\}I$$

The above equation is the condition (7) in the main text.

A.3 Tax rate policy as prudential instrument

A representative bank's profit is given by

$$\pi(\eta) = (\rho_1 - \rho_0)[\alpha I + (1-\alpha)J] = (\rho_1 - \rho_0)\frac{\alpha + (1-\alpha)\frac{\eta}{1-\rho_0}}{1 + \tau - \alpha\rho_0 - \gamma + (1-\alpha)\eta}K$$

To show the effect of liquidity reserves η on the bank's profit π, we derive π with respect to η as follows:

$$\begin{aligned}
\frac{\partial \pi}{\partial \eta} &= \frac{(\rho_1 - \rho_0)\partial\left[\frac{\alpha+(1-\alpha)\frac{\eta}{1-\rho_0}}{1+\tau-\alpha\rho_0-\gamma-(1-\alpha)\eta}K\right]}{\partial \eta} \Rightarrow \\
&= (\rho_1 - \rho_0)\frac{\frac{1-\alpha}{1-\rho_0}\left[1 + \tau - \alpha\rho_0 - \gamma + (1-\alpha)\eta\right] - (1-\alpha)[\alpha + (1-\alpha)\frac{\eta}{1-\rho_0}]}{\left[1 + \tau - \alpha\rho_0 - \gamma + (1-\alpha)\eta\right]^2} \Longrightarrow \\
&= \frac{(\rho_1 - \rho_0)\frac{1-\alpha}{1-\rho_0}(1 + \tau - \alpha - \gamma)}{\left[1 + \tau - \alpha\rho_0 - \gamma + (1-\alpha)\eta\right]^2}
\end{aligned}$$

It is straightforward to see that the bank's profit increases with the liquidity reserves: i.e., $\frac{\partial \pi}{\partial \eta}$ if

$$1 + \tau - \alpha - \gamma > 0 \tag{A.3}$$

Therefore, the profit increases with the liquidity reserves when $1 + \tau - \alpha - \gamma > 0$. The condition (A.3) is the condition (9) in the main text.

We can also verify if the gross return to capital is no smaller than shareholders' initial investment, i.e., $\pi|_{\eta=1-\rho_0} \geq K$, when the liquidity ratio is $\eta = 1 - \rho_0$, we have

$$\begin{aligned}
\pi|_{\eta=1-\rho_0} &= \frac{\rho_1 - \rho_0}{1 + \tau - \alpha\rho_0 - \gamma + (1-\alpha)(1-\rho_0)}K \Longrightarrow \\
&= \frac{\rho_1 - \rho_0}{1 + \tau - \gamma - \alpha + \eta}K
\end{aligned}$$

The maximum tax rate: For given structural parameters, the maximum tax rate that the government can set is determined by solving $\pi(\tau_{\max}) - K = 0$. For any $\tau > \tau_{\max}$, banks will not invest in any project, since the profit cannot even cover the costs K. The condition $\pi(\tau_{\max}) - K = 0$ is equivalent to

$$\begin{aligned}
\frac{\rho_1 - \rho_0}{1 + \tau_{\max} - \alpha\rho_0 - \gamma + (1-\alpha)(1-\rho_0)} &= 1 \Longrightarrow \\
1 + \tau_{\max} - \alpha\rho_0 - \gamma + (1-\alpha)(1-\rho_0) &= \rho_1 - \rho_0 \Longrightarrow
\end{aligned}$$

$$\tau_{\max} = \rho_1 - (1 - \gamma + 1 - \alpha) \tag{A.4}$$

A.4 The sensitivity of the tax revenue to the tax rate

From equation (A.2), we have directly that the investment decrease with the tax rate. To show the effect of adjusting tax rate on the tax revenue $\tau I(\tau)$, we calculate the elasticity as follows:

$$\begin{aligned}
I(\tau) + \tau\frac{\partial I}{\partial \tau} &> 0 \Longrightarrow \\
\frac{\tau}{I(\tau)}\frac{\partial I}{\partial \tau} &> -1 \Longrightarrow \\
\frac{\tau}{I(\tau)}\frac{\partial I}{\partial \tau} &= \frac{\tau}{\frac{K}{1+\tau-\alpha\rho_0-\gamma+(1-\alpha)\eta}} \times \frac{-K}{(1+\tau-\alpha\rho_0-\gamma+(1-\alpha)\eta)^2} > -1
\end{aligned}$$

Consequently, the tax revenue $\tau I(\tau)$ increases with the tax rate if

$$\begin{aligned}
\frac{\tau}{1+\tau-\alpha\rho_0-\gamma+(1-\alpha)\eta} &< 1 \Longrightarrow \\
1-\alpha\rho_0-\gamma+(1-\alpha)\eta &> 0
\end{aligned}$$

Let $\beta \equiv 1 - \alpha\rho_0 - \gamma + (1-\alpha)\eta$ measures the degree of illiquidity of the investment. Note that when $\eta = 1 - \rho_0$, we have $\beta|_{\eta=1-\rho_0} = 1 - \alpha - \gamma + 1 - \rho_0$.

The condition (3) in the main text ensures that $\beta > 0$ and hence $\frac{\tau}{I(\tau)}\frac{\partial I}{\partial \tau} > -1$, implying that the tax revenue $\tau I(\tau)$ decreases when the government reduces the tax rate τ.

A.5 The determination of the 'optimal' tax rate ignoring the fiscal bailout

The social welfare function for $\tau_{\min} \leq \tau < \widehat{\tau}$ is given by

$$W \mid_{\tau_{\min} \leq \tau < \widehat{\tau}} = C + \theta\tau I(\tau) - \zeta + \phi J(\tau).$$

Using (A.2) and the fact that $I = J$ at the optimum, the above function becomes

$$W \mid_{\tau_{\min} \leq \tau < \widehat{\tau}} = C + \frac{\theta\tau K}{1 + \tau - \alpha\rho_0 - \gamma + (1-\alpha)\eta} - \zeta + \frac{\phi K}{1 + \tau - \alpha\rho_0 - \gamma + (1-\alpha)\eta}$$

Substituting $1 - \alpha\rho_0 - \gamma + (1-\alpha)\eta$ by β, we obtain

$$W \mid_{\tau_{\min} \leq \tau < \widehat{\tau}} = C - \zeta + \frac{(\phi + \theta\tau)K}{\beta + \tau}.$$

To show the effect of the taxation on the social welfare, we derive the social welfare function with respect to τ:

$$\frac{\partial W \mid_{\tau_{\min} \leq \tau < \widehat{\tau}}}{\partial \tau} = \frac{\theta K(\beta + \tau) - (\phi + \theta\tau)K}{(\beta + \tau)^2} = \frac{K(\theta\beta - \phi)}{(\beta + \tau)^2}$$

We have that $\frac{\partial W|_{\tau_{\min} \leq \tau < \widehat{\tau}}}{\partial \tau} < 0$, if

$$\phi > \theta\beta.$$

The above inequality is the condition (15) in the main text. The same condition is true for ensuring that $\frac{\partial W|_{\tau \geq \widehat{\tau}}}{\partial \tau} < 0$ for $\tau \geq \widehat{\tau}$.

Since the welfare is strictly increasing within each of the two intervals of τ, the optimal tax rate is a corner solution.

For $\tau \geq \tau_{\min}$, the optimal tax rate is $\tau = \widehat{\tau}$. To obtain this result, we compare $W \mid_{\tau \geq \widehat{\tau}}$ and $W \mid_{\tau_{\min} \leq \tau < \widehat{\tau}}$, given that the welfare function jumps at the point $\widehat{\tau}$. We can show that

$$W \mid_{\tau = \tau_{\min}} < W \mid_{\tau = \widehat{\tau}} \Longrightarrow$$

$$
\begin{aligned}
& C-\zeta+\frac{\theta\tau_{\min}K}{1+\tau_{\min}-\alpha\rho_0-\gamma+(1-\alpha)\eta}+\frac{\phi K}{1+\tau_{\min}-\alpha\rho_0-\gamma+(1-\alpha)\eta} \\
< \; & C+\frac{\theta\widehat{\tau}K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta}+\frac{\phi K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta}
\end{aligned}
$$

Using $\beta|_{\eta=1-\rho_0}=1-\alpha-\gamma+1-\rho_0>0$ to simplify the above expression, we have

$$
\begin{aligned}
\zeta+\frac{\theta\tau_{\min}K}{\beta+\tau_{\min}}+\frac{\phi K}{\beta+\tau_{\min}} &< \frac{\theta\widehat{\tau}K}{\beta+\widehat{\tau}}+\frac{\phi K}{\beta+\widehat{\tau}} \Longrightarrow \\
\zeta &> K\frac{(\theta\tau_{\min}+\phi)(\beta+\widehat{\tau})-(\theta\widehat{\tau}+\phi)(\beta+\tau_{\min})}{(\beta+\tau_{\min})(\beta+\widehat{\tau})} \Longrightarrow \\
\zeta &> K\frac{\theta\beta(\tau_{\min}-\widehat{\tau})-\phi(\tau_{\min}-\widehat{\tau})}{(\beta+\tau_{\min})(\beta+\widehat{\tau})} \Longrightarrow \\
\zeta &> \frac{(\phi-\theta\beta)(\widehat{\tau}-\tau_{\min})K}{(\beta+\tau_{\min})(\beta+\widehat{\tau})} \qquad \text{(A.5)}
\end{aligned}
$$

Given the definition of β and $\tau_{\min}$, we obtain that $\beta+\tau_{\min}=1-\rho_0$. Replace $\beta+\tau_{\min}$ by $1-\rho_0$ and $\widehat{\tau}-\tau_{\min}$ by Δ_1, the condition (A.5) is equivalent to:

$$
\begin{aligned}
\phi &< \theta\beta+\frac{\zeta(\beta+\tau_{\min})(\beta+\widehat{\tau})}{(\widehat{\tau}-\tau_{\min})K} \Longrightarrow \\
\phi &< \theta\beta+\frac{\zeta(\beta+\widehat{\tau})(1-\rho_0)}{\Delta_1 K}
\end{aligned}
$$

The above condition is the condition (16) in the main text.

A.6 Fiscal policy under commitment taking account of the fiscal bailout

The welfare function taking account of the fiscal bailout is:

$$
\begin{aligned}
W^c(\widehat{\tau},\Delta_2) &= C+\alpha[U_1(\eta,\tau)+\phi I(\widehat{\tau},\Delta_2)] \\
& \quad +(1-\alpha)[U_2(\eta,\tau)+\phi J(\widehat{\tau},\Delta_2)]
\end{aligned}
$$

We have that $\eta = 1 - \rho_0$, when the constraint $\frac{1}{2}\widehat{\tau} + [\frac{1}{2}\widehat{\tau} - (1-\alpha)\Delta_2] \geq \tau_{\min}$ holds. This implies that $J(\widehat{\tau}, \Delta_2) = I(\widehat{\tau}, \Delta_2)$ in the adverse state. Thereby, using (A.2), we have

$$\begin{aligned} W^c(\widehat{\tau}, \Delta_2) = C + \alpha[\frac{\theta\widehat{\tau}K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_2}] \\ + (1-\alpha)[\frac{\theta(\widehat{\tau}-\Delta_2)K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_2} - \zeta] \\ + \frac{\phi K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_2} \end{aligned}$$

As the investment is relatively inelastic with respect to the tax rate, we have that $(\widehat{\tau} - \Delta_2)\theta I(\widehat{\tau}, \Delta_2) < \widehat{\tau}\theta I(\widehat{\tau})$. Consequently, consumers will suffer a utility loss ζ when the tax rate is reduced in the crisis times.

The government will promise to keep the tax rate unchanged in the event of a crisis if

$$W^c(\widehat{\tau}, \Delta_2) < W \mid_{\tau=\widehat{\tau}} .$$

We develop the above inequality as follows

$$\begin{aligned} \alpha[\frac{\theta\widehat{\tau}K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_2}] \\ + (1-\alpha)[\frac{\theta(\widehat{\tau}-\Delta_2)K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_2} - \zeta] \\ + \frac{\phi K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_2} < \frac{(\theta\widehat{\tau}+\phi)K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta} \end{aligned}$$

Using $\beta|_{\eta=1-\rho_0} = 1 - \alpha - \gamma + 1 - \rho_0 > 0$ to simplify the above expression, we have

$$\frac{\alpha\theta\widehat{\tau}K}{\beta+\widehat{\tau}-(1-\alpha)\Delta_2} + \frac{\alpha\theta(\widehat{\tau}-\Delta_2)K}{\beta+\widehat{\tau}-(1-\alpha)\Delta_2} - (1-\alpha)\zeta + \frac{\phi K}{\beta+\widehat{\tau}-(1-\alpha)\Delta_2} < \frac{(\theta\widehat{\tau}+\phi)K}{\beta+\widehat{\tau}} \Longrightarrow$$

$$\frac{K[\theta\widehat{\tau}+\phi-(1-\alpha)\theta\Delta_2](\beta+\widehat{\tau})}{(\beta+\widehat{\tau}-(1-\alpha)\Delta_2)(\beta+\widehat{\tau})} - \frac{(1-\alpha)\zeta(\beta+\widehat{\tau})[\beta+\widehat{\tau}-(1-\alpha)\Delta_2]}{(\beta+\widehat{\tau}-(1-\alpha)\Delta_2)(\beta+\widehat{\tau})} < \frac{K(\theta\widehat{\tau}+\phi)[\beta+\widehat{\tau}-(1-\alpha)\Delta_2]}{(\beta+\widehat{\tau}-(1-\alpha)\Delta_2)(\beta+\widehat{\tau})} \Longrightarrow$$

$$\frac{K[\theta\widehat{\tau}+\phi-(1-\alpha)\theta\Delta_2](\beta+\widehat{\tau}) - K(\theta\widehat{\tau}+\phi)[\beta+\widehat{\tau}-(1-\alpha)\Delta_2]}{(\beta+\widehat{\tau}-(1-\alpha)\Delta_2)(\beta+\widehat{\tau})} < \frac{(1-\alpha)\zeta(\beta+\widehat{\tau})[\beta+\widehat{\tau}-(1-\alpha)\Delta_2]}{(\beta+\widehat{\tau}-(1-\alpha)\Delta_2)(\beta+\widehat{\tau})} \Longrightarrow$$

$$\begin{aligned} K\left[\theta\widehat{\tau}+\phi-(1-\alpha)\theta\Delta_2\right](\beta+\widehat{\tau}) - K(\theta\widehat{\tau}+\phi)\left[\beta+\widehat{\tau}-(1-\alpha)\Delta_2\right] < \\ (1-\alpha)\zeta(\beta+\widehat{\tau})\left[\beta+\widehat{\tau}-(1-\alpha)\Delta_2\right] \Longrightarrow \end{aligned}$$

$$K\Delta_2(\phi - \theta\beta) < \zeta(\beta + \widehat{\tau})\left[\beta + \widehat{\tau} - (1-\alpha)\Delta_2\right] \Longrightarrow .$$

$$\phi < \theta\beta + \frac{\zeta(\beta + \widehat{\tau})\left[\beta + \widehat{\tau} - (1-\alpha)\Delta_2\right]}{\Delta_2 K}$$

The above inequality is the condition (19) in the main text.

When this condition is satisfied, we have $W^c(\widehat{\tau}, \Delta_2) < W \mid_{\tau=\widehat{\tau}}$ such that the fiscal bailout will induce a welfare loss and the government will insist on the constant tax rate policy at the optimum even in the adverse state.

As $\frac{\partial\left(\frac{\Delta_2(\phi-\theta\beta)}{(\beta+\widehat{\tau}-(1-\alpha)\Delta_2)(\beta+\widehat{\tau})}\right)}{\partial\Delta_2} > 0$, if condition (19) in the main text is satisfied for $\Delta_2 = \frac{\Delta_1}{1-\alpha}$, it will hold for all $\Delta_2 \in [0, \frac{\Delta_1}{1-\alpha}]$. We replace therefore Δ_2 by $\frac{\Delta_1}{1-\alpha}$ into the condition (19) and obtain

$$\phi < \theta\beta + \frac{\zeta(1-\alpha)(\beta + \widehat{\tau})\left(\beta + \widehat{\tau} - \Delta_1\right)}{\Delta_1 K}$$

Using the definitions of β and of Δ_1, the above condition is equivalent to

$$\phi < \theta\beta + \frac{\zeta(1-\alpha)(\beta + \widehat{\tau})\left(1 - \rho_0\right)}{\Delta_1 K}$$

The above inequality is the condition (20) in the main text.

A.7 Fiscal policy under discretion taking account of the fiscal bailout

We set $\Delta_3 = \frac{1}{2}\widehat{\tau} - \tau_2^e$. The policymakers will not reduce the tax rate in accordance with the expectations of banking entrepreneurs if

$$W^{nc}|_{\tau_2^{nc} > \tau_2^e} > W^{nc}|_{\tau_2^{nc} = \tau_2^e}.$$

Substituting $W^{nc}|_{\tau_2^{nc}>\tau_2^e}$ and $W^{nc}|_{\tau_2^{nc}=\tau_2^e}$ by their definitions yields:

$$\frac{\theta\widehat{\tau}K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_3}$$
$$+\frac{\gamma-\frac{1}{2}\widehat{\tau}-\delta}{\gamma-\frac{1}{2}\widehat{\tau}-\delta+\Delta_3}\frac{\phi K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_3}$$
$$>-\zeta+\frac{\theta(\widehat{\tau}-\Delta_3)K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_3}+\frac{\phi K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_3}\Longrightarrow$$

$$\zeta>\frac{1}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_3}\left[\frac{\Delta_3}{\gamma-\frac{1}{2}\widehat{\tau}-\delta+\Delta_3}\phi K-\theta\Delta_3 K\right]\Longrightarrow$$

$$\frac{\zeta}{K}>\frac{\Delta_3\left[\phi-\theta(\gamma-\frac{1}{2}\widehat{\tau}-\delta+\Delta_3)\right]}{(\gamma-\frac{1}{2}\widehat{\tau}-\delta+\Delta_3)\left[1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_3\right]}$$

$$\frac{\zeta}{K}>\frac{\Delta_3\left[\phi-\theta\left(\gamma-\frac{1}{2}\widehat{\tau}-\delta+\Delta_3\right)\right]}{\left[\beta+\widehat{\tau}-(1-\alpha)\Delta_3\right](\gamma-\frac{1}{2}\widehat{\tau}-\delta+\Delta_3)}\Longrightarrow$$

As shown in the main text, the banking entrepreneur sets the payment to investors in the adverse state equal to $\delta=\gamma-\tau_2^e-\eta$ with $\eta=1-\rho_0$. Using this result and $\Delta_3=\frac{1}{2}\widehat{\tau}-\tau_2^e$, we obtain $\gamma-\frac{1}{2}\widehat{\tau}-\delta+\Delta_3=1-\rho_0$. Substituting $\gamma-\frac{1}{2}\widehat{\tau}-\delta+\Delta_3$ by $1-\rho_0$ and using the property $\beta+\theta\tau_{\min}=1-\rho_0$ into the above inequality leads to

$$\phi<\theta(\gamma-\frac{1}{2}\widehat{\tau}-\delta+\Delta_3)+\frac{\zeta\left[\beta+\widehat{\tau}-(1-\alpha)\Delta_3\right](1-\rho_0)}{K\Delta_3}\Longrightarrow$$

$$\phi<\theta(1-\rho_0)+\frac{\zeta\left[\beta+\widehat{\tau}-(1-\alpha)\Delta_3\right](1-\rho_0)}{K\Delta_3}\Longrightarrow$$

$$\phi<\theta\beta+\theta\tau_{\min}+\frac{\zeta\left[\beta+\widehat{\tau}-(1-\alpha)\Delta_3\right](1-\rho_0)}{\Delta_3 K}.$$

The inverse of the above inequality gives condition (24) in the main text.

To obtain the condition (25), we compare the right-hand sides of conditions (19) and (23). We get:

$$\theta\beta+\frac{\zeta(\beta+\widehat{\tau})\left[\beta+\widehat{\tau}-(1-\alpha)\Delta_2\right]}{\Delta_2 K}=\theta\beta+\theta\tau_{\min}+\frac{\zeta\left[\beta+\widehat{\tau}-(1-\alpha)\Delta_3\right](1-\rho_0)}{\Delta_3 K}$$

Given that both Δ_2 and Δ_3 take their value within the interval $[0, \frac{\Delta_1}{1-\alpha}]$, we can simplify the above condition by replacing Δ_2 by Δ_3 so as to compare the effects of change of same scale in the tax rate under two policy regimes as follows

$$\zeta(\beta+\widehat{\tau})\left[\beta+\widehat{\tau}-(1-\alpha)\Delta_3\right]=\zeta\left[\beta+\widehat{\tau}-(1-\alpha)\Delta_3\right](1-\rho_0)+\theta\tau_{\min}\Delta_3 K$$

Replacing $1-\rho_0$ by $\beta+\widehat{\tau}-\Delta_1$ yields

$$\zeta[\beta+\widehat{\tau}-(1-\alpha)\Delta_3]\Delta_1=\Delta_3 K\theta\tau_{\min}$$

Substituting Δ_3 by $\frac{\Delta_1}{1-\alpha}$, the above equation becomes

$$\widehat{K}=\frac{(1-\alpha)\zeta\left[\beta+\widehat{\tau}-\Delta_1\right]}{\theta}$$

The above inequality is the condition (25) in the main text.

B The utility of consumers when the bailout is carried out through public lending

The consumer will not suffer a utility loss if the interest rate on public lending satisfies

$$\theta\widehat{\tau}I(\tau_2^e)-\theta\Upsilon+R^p\lambda\Upsilon-\theta\widehat{\tau}I(\widehat{\tau})>0.$$

Using the definition of I associated with corresponding tax rates, the above inequality becomes:

$$\theta\left[\frac{\widehat{\tau}K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_3}-\frac{(\frac{1}{2}\widehat{\tau}-\tau_2^e)K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_3}\right]$$
$$+\lambda R^p\frac{(\frac{1}{2}\widehat{\tau}-\tau_2^e)K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_3}-\frac{\theta\widehat{\tau}K}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta}>0\Longrightarrow$$

$$\frac{\theta\left[\widehat{\tau}-(\frac{1}{2}\widehat{\tau}-\tau_2^e)\right]+R^p\lambda(\frac{1}{2}\widehat{\tau}-\tau_2^e)}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_3}>\frac{\theta\widehat{\tau}}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta}.$$

Using $\Delta_3 \equiv \frac{1}{2}\widehat{\tau} - \tau_2^e = 1 - \rho_0$ and the fact $\gamma - \tau_2^e - \delta = 1 - \rho_0$, the above inequality could be rewritten as:

$$\begin{aligned}
\frac{\theta\widehat{\tau} - \theta(1-\rho_0) + \lambda R^p(1-\rho_0)}{1+\widehat{\tau}-\alpha\rho_0-\gamma} &> \frac{\theta\widehat{\tau}}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta} \Longrightarrow \\
\lambda R^p(\beta+\alpha\widehat{\tau}) &> \theta\left[(\beta+\alpha\widehat{\tau}) - \widehat{\tau}(1-\alpha)\right] \Longrightarrow \\
R^p &> \frac{\theta}{\lambda}\left(\frac{\beta+\alpha\widehat{\tau}}{\beta+\widehat{\tau}}\right).
\end{aligned}$$

The above condition is the condition (26) in the main text.

B.1 Interest rate on public lending

The bank will not over-load in short-term debt if the interest rate on public lending satisfies the condition:

$$(\rho_1 - \rho_0)I(\tau_2^e) - (1-\alpha)R^p\Upsilon < (\rho_1 - \rho_0)I(\widehat{\tau})$$

Substituting $I(\tau_2^e)$ and Υ by their definitions into the above condition yields

$$\frac{K\left[(\rho_1-\rho_0) - (1-\alpha)R^p\right]}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta-(1-\alpha)\Delta_3} < \frac{K(\rho_1-\rho_0)}{1+\widehat{\tau}-\alpha\rho_0-\gamma+(1-\alpha)\eta}$$

Using $\Delta_3 \equiv \frac{1}{2}\widehat{\tau} - \tau_2^e = 1 - \rho_0$ and $\gamma - \tau_2^e - \delta = 1 - \rho_0$, we obtain

$$\begin{aligned}
\frac{\rho_1-\rho_0-(1-\alpha)R^p\Delta_3}{1+\widehat{\tau}-\alpha\rho_0-\gamma-(1-\alpha)\Delta_3+1-\rho_0} &< \frac{\rho_1-\rho_0}{1+\widehat{\tau}-\alpha-\gamma+1-\rho_0} \Longrightarrow \\
(1-\alpha)R^p\Delta_3(1+\widehat{\tau}-\alpha-\gamma+1-\rho_0) &> (1-\alpha)\Delta_3(\rho_1-\rho_0 \Longrightarrow \\
R^p &> \frac{\rho_1-\rho_0}{1+\widehat{\tau}-\alpha-\gamma+1-\rho_0} \Longrightarrow \\
R^p &> \frac{\rho_1-\rho_0}{\beta+\widehat{\tau}}.
\end{aligned}$$

The above inequality is the condition (28) in the main text.

The bailout policy satisfying $R^p > \frac{\rho_1-\rho_0}{\beta+\widehat{\tau}}$ is viable if over risk-taking banks have incentive to borrow in the adverse state. We establish then the following condition, when it is verified banks will accept the public lending proposed by the government and thus

bear some costs due to the bailout:

$$(\rho_1 - \rho_0)I(\tau_2^e) - R^p\Upsilon > (\rho_1 - \rho_0)J(\tau_2^e)$$

Using condition (21) in the main text for $\tau_2^{nc} = \frac{1}{2}\widehat{\tau}$ (given that the government will not bail out through the tax rate reduction) and the definition of Υ, the above condition is equivalent to

$$\left[(\rho_1 - \rho_0) - R^p(\frac{1}{2}\widehat{\tau} - \tau_2^e)\right] I(\tau_2^e) > (\rho_1 - \rho_0)\frac{\gamma - \tau_2^{nc} - \delta}{\gamma - \tau_2^e - \delta + \Delta_3} I(\tau_2^e),$$

Using $\gamma - \tau_2^e - \delta = 1 - \rho_0$, and $\tau_2^{nc} - \tau_2^e = \frac{1}{2}\widehat{\tau} - \tau_2^e = \Delta_3$, the above inequality can be rewritten as follows

$$\begin{aligned} \rho_1 - \rho_0 - R^p\Delta_3 &> (\rho_1 - \rho_0)\frac{1 - \rho_0 - \Delta_3}{1 - \rho_0} \Longrightarrow \\ (\rho_1 - \rho_0)\left[1 - \frac{1 - \rho_0 - \Delta_3}{1 - \rho_0}\right] &> R^p\Delta_3 \Longrightarrow \\ R^p &< \frac{\rho_1 - \rho_0}{1 - \rho_0}. \end{aligned}$$

The above inequality corresponds to the condition (30) in the main text.