Document de travail de l'OFCE

GOVERNMENT, TAXES AND FINANCIAL CRISES

N° 2010-01

JANUARY 2010

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30 March 2009

Abstract.

This paper analyzes the effectiveness of different governmental policies to prevent the emergence of financial crises. In particular, we study the impact on welfare of using public resources to recapitalize banks, government injection of money into the banking system through credit lines, the creation of a buffer and taxes on financial transactions (the Tobin tax). We illustrate the trade-off between these policies and derive policy implications.

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Acknowledgements: *The authors would like to thank Sandro Brusco and seminar participants at the MFA 2008, Universidad Carlos III , XVI Foro de Finanzas - ESADE, 25th Symposium on Money, Banking and Finance – Luxembourg, University of Chile, IE, UAB, University of Bern, VU Amsterdam, University of Zurich, Utrecht School of Economics and CERAM – OFCE for their helpful comments in an earlier version of this paper. This research is partially funded by the Spanish Ministry of Education and Culture, project SEJ2007-67448/ECON. Ángel López also acknowledges support from the Juan de la Cierva Program.*

1 Introduction

The recent financial turmoil has restored the debate concerning the government's responsibility on crises management. It also shows that investors, governments and depositors share their ignorance about the real quality of banks' investments; this ignorance has been deepened and worsened by actions taken by the main risk rating agencies like Moody's, Standard and Poor's and Fitch Ratings. As the crises of the 30's, Black Fridays, LTCM and the subprime crisis have shown, governments can not predict the proximity of a crisis and consequently have to work once it has already appeared.

Whenever there is a systemic banking crisis there is a need to inject liquidity into the banking system in order to avoid an excessive credit contraction. Different mechanisms might be used but all of them are costly. A recent study of the IMF [1] analyses forty two systemic banking crises and shows that in thirty two of them, there was some kind of government intervention to recapitalize banks. From those, in seven, the government bought bad assets/loans, in twelve of them, the government injected cash to banks; whereas in two, governments provided credit lines to banks.

Particularly, in the crises of Mexico and Japan the government purchased toxic assets, but the fiscal cost of such policy was very high. In contrast, in the banking crises of Sweden, Norway and Finland, the recapitalization was done mainly by injections of public capital into the banking system. The US government, however, has hesitated on the possibility of buying toxic mortgage assets.

Evidently, during crises governments have taken an active role in most countries. However, this role has been ignored in the banking literature, which is mostly concerned with the role of the Central Bank. The aim of this paper is to theoretically analyze the role of the government in crises management. In particular, recent examples in Argentina and Uruguay $(2001-2002)$ have shown that government policies might in some cases intensify while in others ameliorate the effect of financial crises.[2] This paper is a first attempt to give some insights in such direction.

We model an economy where agents can deposit their money in banks or privately invest

[1] Systemic Banking Crises: A New Database, Laeven and Valencia (2008).

[2] While Uruguay kept property rights, the currency denomination of bank deposits and public debt, and promoted a mutual agreement with international debt holders, Argentina did exactly the opposite; more specifically, it "pesified" deposits (changed the denomination of deposits from American dollars to Argentinean pesos), unilaterally declared default and devaluated the currency.

it in a long-term technology. In addition, agents may face a liquidity shock and become impatient depositors. Impatient depositors face a utility loss of not having enough liquid assets, and therefore the possibility of risk sharing provided by banks is generally welfare improving. In our model, the government may raise taxes so as to provide public services, as for instance education, health, social security, national security, recreation activities, etc. Taxing has an implicit cost because at the same time it lowers the availability of funds for private investments. Actually, we show that this may exacerbate a financial crisis. Although funds might be reoriented once a financial crisis is expected to occur, this practice normally has an additional cost that decreases its effectiveness. In the absence of taxes, agents may not face the risk of a bank run but they do not consume public services either. We analyze the accuracy of different policies in the hand of governments to prevent systemic banking crises, such as using public resources to recapitalize banks or government injection of money into the banking system through credit lines. We will show that public lending might in some cases be preferred to recapitalization, even if the former is more costly and promotes investments with negative net present value. In other cases, the government should create a buffer, in particular, when it cannot obtain funds easily.

We also study taxes on financial transactions that exist in some developing countries like Argentina, Brazil, Colombia and Serbia. These taxes have been extensively used in emerging markets as a way to obtain government funding but no so much as a way to prevent bank runs, as we analyze in this paper. Actually, taxes on financial transactions represent an important source of funding for those governments (22,471.9 millions of dollars for Brazil and around 2,700 millions of dollars for Argentina in 2007). In particular, we consider the Tobin tax, which is a sort of tax on financial transactions. Usually those taxes are implemented for a certain period (for example, for a year in Venezuela). The existence of a tax on short term transactions generates incentives to use the assets that are not taxed, and as a result might decrease the incentives to run on banks. Nevertheless, banking crises might sometimes be efficient, this is the case when using taxpayers money is too costly or too risky and/or the government is not able to find resources efficiently.

This article is related to several papers in the banking literature. In the seminal model by Diamond and Dybvig (1983), banks are considered to be liquidity providers, but are subject to bank runs in the form of sunspots. In our setting, agents also face liquidity shocks but bank runs are the result of a bad signal about the success of the long-term project. Our paper is close in spirit to Goldstein and Pauzner (2005), that present bank runs as a phenomenon closely related to the state of the business cycle.[3] Relatedly, Gorton (1988) suggests that bank runs are not due to sunspots but to the existence of rational agents that modify their expectations due to a change in economic conditions (for example a change in the business cycle).

In the present paper, a smaller banking activity is compensated by a greater government size. Governments and banks improve welfare but they have to compete for private funds. Besides the fact that a government can provide more public services, it makes banking crises more likely to occur. Also, crises occur with positive probability as in Cooper and Ross (1998) and Chang and Velasco (2000a,b).

We build on the model of Chen and Hasan (2006), although we modify their framework by introducing a government that may raise taxes so as to provide public services. Additionally, in our model, depositors receive a clearer signal about the evolution of the investments. Moreover, we investigate how governments can affect the occurrence as well as the resolution of banking crises instead of focusing only on the bank side as it is the case in most of the previous academic literature on banking.[4] For open economies, Chang (2007) presents a very good approach for the coexistence of financial and political crises but without focusing neither on the financial activity of banks nor on the role of the government as a provider of public services, which are our main concerns.

The rest of the paper is organized as follows. Section 2 presents the basic features of the model. Section 3 studies bank runs and the optimal deposit contract. Section 4 and 5 analyze different government policies to handle banking crises. Section 6 concludes.

2 The Model

We consider a three-date (0, 1, and 2) and one-good economy. There is a continuum of agents, of measure one, in the economy. Each agent receives an endowment of one unit of the good at date 0 and can deposit it at a bank or alternatively invest it in a long-term project. At date 2 the long-term project transforms each unit of the good into R units with

[3] Recent studies, see e.g., Hasman and Samartín (2008) and Hasman, Samartín and Van Bommel (2008), have shown that information concerning the evolution of bank loans plays an important role not only in generating a banking crisis but also in its propagation.

[4] For an excellent review of the academic literature on banking see Gorton and Winton (2002).

probability p and 0 with probability $(1-p)$. Let $p = p_0$ be the prior probability of success of this project. We assume that $p_0 R > 1$ and that the long-term technology can be liquidated at no cost. At date 1, depositors receive a public signal $s \epsilon \{H, L\}$ on the true return of the long-term project, where H reveals that the probability of success is higher than 1/2 and L reveals the contrary. Depositors update their beliefs in accord with Bayes' rule. Let p^H and p^L be the posterior probabilities of success when $s = H$ and $s = L$.[5] We assume that $p^H > p_0 > p^L$ and that $p^L R > 1$. Finally, there exists a short-term technology that is not profitable at any date. In particular, this technology transforms each unit of the good at date t into R' units with probability p' and 0 with probability $(1 - p')$ at date $t + 1$, with $p'R' < 1$. Therefore, at date 0 neither banks nor agents will find it optimal to invest in such technology. However, as will be shown in Section 4, a government policy may induce banks to do so.

At date 0, the government may raise T taxes, with $0 < T < 1$, so as to invest in a public asset.[6] The taxpayers are both depositors and agents who invest in the long-term project. The public asset transforms the T units of the good into public services that are consumed by everybody at date 1. We assume that the utility of consuming public services is a linear function of its cost: θT, where $\theta > 0$. The government's objective is to maximize the agents' expected utility.

At date 1 agents may face a liquidity shock: a proportion γ of them becomes impatient and must consume by date 1. Agents do not know at date 0 whether they will be impatient (type-1) or patient (type-2) at date 1 but they know the value of γ. We assume that if impatient agents consume less than $r > 1$ of the private good at date 1, then they will suffer a utility loss $X > 0$. Agents normally face fixed payments but sometimes they need extra funds to deal with special contingencies, in such a case they need liquid assets in order to afford the payments plus the contingencies (so as to cover r). If they do not have enough cash, then they will have to deal with the bureaucracy and moreover face different costs as for example bankruptcy, lawyers or *search* costs so as to get cash. Let X denote this utility

[5] Therefore, $p^H \equiv \Pr[R|H] = \Pr[H|R] * p_0/(\Pr[H|R] * p_0 + \Pr[H|0] * (1 - p_0))$ and $p^L \equiv \Pr[R|L] = \Pr[L|R] * p_0/(\Pr[L|R] * p_0 + \Pr[L|0] * (1 - p_0))$.

[6] We assume that the size of the public expenditure, T, is exogenous. For instance, T could be the result of a political program or the rate of taxation at which maximal revenue is generated (the point at which the Laffer curve achieves its maximum).

loss and c_t the agent's consumption at date t. The utility function of a type-1 agent, U_1, is

$$U_1(c_1, X) = \begin{cases} c_1 - X + \theta T & if \quad c_1 < r \\ c_1 + \theta T & if \quad c_1 \geq r \end{cases}, \tag{1}$$

whereas the utility function of a type-2 agent is $U_2(c_1, c_2) = c_1 + c_2 + \theta T$.

We assume a perfectly competitive banking industry and so the banks' expected profit is zero. At the beginning of date 0 each bank offers a deposit contract $d = (d_1, d_2)$ to agents, where d_t $(t = 1, 2)$ denotes the maximum amount of money that can be withdrawn at date t. Depositors are sequentially served, so if all of them run to withdraw their money at date 1, only a fraction of them will receive the promised amount. The depositor's type is private information.

Any impatient agent who has not invested her money in a bank succeeds to obtain one unit of the good from liquidation, as a result she will always suffer the utility loss X. The existence of a banking industry that promises $d_1 \geq r$ should then improve her welfare.

The sequence of events is as follows: at $t = 0$, agents pay taxes and invest the rest of their resources in banks or in the long-term investment project; at $t = 1$, agents suffer the liquidity shock, receive the public signal s, decide wether to withdraw their money from banks and consume public services. At $t = 2$, the long-term project matures and patient depositors are paid.

3 Bank runs and the optimal deposit contract

In this section we study the role of taxes on bank runs and derive the optimal deposit contract $d = \{d_1, d_2\}$.

Bank runs

The return of the total amount of money left in banks at date 2 is $(1-T-\gamma d_1)R$, provided that the long-term project succeeds.[7] Due to perfect competition, this amount of money is totally transferred to type-2 depositors,[8] therefore it must hold that $(1-\gamma)d_2 = (1-T-\gamma d_1)R$.

[7] After paying taxes, $(1-T)$ is invested in banks and γ impatient depositors withdraw d_1 at date 1.

[8] This is the standard debt contract whereby banks offer the total return of the long-term project when it succeeds at maturity and the return from liquidating the bank's assets when it does not succeed (the latter

Then, for a given d_1 the optimal deposit contract must satisfy

$$d_2 = \max\left\{0, \left(\frac{1 - T - \gamma d_1}{1 - \gamma}\right) R\right\} \tag{2}$$

At date 1 depositors update their beliefs according to Bayes' Rule, so the expected return of a patient depositor is pd_2, where $p = \{p^L, p^H\}$. For a given d_1, a type-2 depositor will not withdraw if $pd_2(T) \geq d_1$, or equivalently, if

$$p \geq \widehat{p}(T) = \frac{(1 - \gamma)d_1}{(1 - T - \gamma d_1)R}. \tag{3}$$

We focus on the case $\widehat{p}(T) < p^H$ for a given d_1. This means that if the realization of s is H, then patient consumers will not withdraw at date 1 for any $T \geq 0$. Consequently, the observation of H rules out the possibility of bank runs; the economy faces three possible states of nature when $s = L$: i) if $p^L < \widehat{p}(0) < \widehat{p}(T)$, a bank run will occur in the presence and absence of taxes; ii) if $\widehat{p}(0) < p^L < \widehat{p}(T)$, a bank run will only occur in the presence of taxes; iii) if $\widehat{p}(0) < \widehat{p}(T) < p^L$, a bank run will never occur. We are primarily interested in the second case, which reflects a situation in which the economy is more sensitive to the observation of a low profitability signal due to taxes. The reason is that in the presence of taxes there is less money invested in the long-term project, and this in turn lowers its expected return $pd_2(T)$. From now on, we assume that this case holds.[9]

Notice that when agents do not invest their endowment in the banking industry and observe $s = L$, they will not find it optimal to liquidate the technology when they are patient since $p^L R > 1$. Conversely, if they invest their endowment in the banking industry and observe $s = L$, they will find it optimal to run on banks. Moreover, the banks will have to liquidate assets even if by doing so they lose resources (investments with positive net present value are liquidated).

Optimal deposit contract

As agents can privately invest their endowment in the long-term project, banks can only obtain deposits by offering a sufficiently attractive contract. By investing on their own,

return is zero in our model).

[9] For any given $d_1 > 0$ and $d_2 > 0$, there exists a low enough p^L so that $p^L d_2 < d_1$.

agents suffer the utility loss X with probability γ: liquidating the technology yields 1 but $r > 1$. Therefore, banks should at least offer $d_1 \geq r$, in order to attract deposits. In order to ensure participation, the agent's expected utility of depositing their endowment in banks, $W^B(d_1, T)$, must be equal or higher than the agent's expected utility of privately investing it in the long-term project, $W^{NB}(T)$. The higher the taxes, the less capital the banks have to invest in the long-term project and hence the lower d_2 will be. Agents face a clear trade-off. On the one hand, higher taxes lower the depositors' expected utility because of its negative impact on the banks' expected return, but on the other hand they raise the agents' expected utility through the consumption of public services. We have that the agent's expected utility of privately investing in the long term project is:

$$W^{NB}(T) = \gamma(1 - T - X) + (1 - \gamma)p_0(1 - T)R + \theta T, \tag{4}$$

i.e., impatient agents suffer the utility loss X, patient agents have the expected return of the long-term project and both patient and impatient agents pay taxes and obtain surplus from consumption of public services. The expected utility of depositing the endowment at banks, $W^B(d_1, T)$, is however a step function: if $d_1 \geq r$ and $s = H$, then patient and impatient depositors will not suffer the utility loss X, whereas if $d_1 < r$ and $s = H$, only impatient depositors will suffer this utility loss. Also, in the presence of a bank run the expected return of a (patient or impatient) depositor, $V_{BR}(T)$, depends on d_1: if $d_1 \geq r$, only a fraction of impatient depositors who are not served by banks suffer the utility loss X, whereas if $d_1 < r$, any impatient depositor gets $-X$. More formally, we have

$$\begin{aligned} W^B(d_1, T)\big|_{d_1 \geq r} &= (1 - \pi)\, V_{BR}|_{d_1 \geq r} + \pi[\gamma d_1 \\ &\quad + (1 - \gamma)p^H \frac{(1 - T - \gamma d_1)}{(1 - \gamma)} R] + \theta T, \end{aligned} \tag{5}$$

where π is the prior probability of the event H[10] and

$$\begin{aligned} V_{BR}\big|_{d_1 \geq r} &= \gamma \left[\frac{(1-T)}{d_1}(d_1) - \left(1 - \frac{(1-T)}{d_1}\right) X \right] + (1-\gamma) \left[\frac{1-T}{d_1}(d_1) \right] \\ &\quad + \theta T \\ &= (1-T) \left(1 + \frac{\gamma X}{d_1}\right) - \gamma X + \theta T. \end{aligned} \tag{6}$$

Here, $(1-T)/d_1$ is the probability of being paid d_1 when a bank run occurs. Notice that T has a threefold impact on the depositors' expected utility. An increase in T i) lowers the probability of being paid: $\partial[(1-T)/d_1]/\partial T = -1/d_1$, ii)lowers the expected utility of type-1 depositors through the utility loss of not having liquidity: γX, and iii) raises the depositors' expected utility through a higher consumption of public services. Similarly,

$$\begin{aligned} W^B(d_1, T)\big|_{d_1 < r} &= (1-\pi)\, V_{BR}^K\big|_{d_1 < r} + \pi[\gamma(d_1 - X) \\ &\quad + p^H(1 - T - \gamma d_1)R] + \theta T, \end{aligned} \tag{7}$$

where

$$V_{BR}\big|_{d_1 < r} = 1 - T - \gamma X + \theta T. \tag{8}$$

We have the following,

Proposition 1 *In equilibrium, banks offer the deposit contract*

$$d(T) = \left(r, \left(\frac{1 - T - \gamma r)}{1 - \gamma} \right) R \right)$$

and agents deposit their endowment at banks as long as X *is large enough and moreover the inequality* $\gamma < ((1-T)R - r)/(rR - r)$ *holds.*

Proof: See the Appendix

This inequality ensures that $d_1 < d_2$, otherwise a bank run would always occur because patient and impatient depositors would find it optimal to withdraw at date 1. Note that the above condition also implies that $d_2 > 0$. A large enough X ensures full participation. Intuitively, if agents deposit their endowment at banks, then they will suffer the utility loss

[10] Therefore, $\pi = \Pr[H|R] * p_0 + \Pr[H|0] * (1 - p_0)$.

X with probability $\gamma(1-\pi)$ (i.e., agents must be impatient and also receive the bad signal), whereas if they invest their endowment in the long-term project, then they will suffer this loss with a higher probability: γ.

4 Analysis of government policies

Collecting T taxes, raises the expected utility of agents as long as $\Delta = W^B(r,T) - W^B(r,0) > 0$. In particular, $\partial\Delta/\partial\theta = T > 0$ and

$$\frac{\partial \Delta}{\partial X} = \gamma(1-\pi)\left[\frac{1-T}{r} - 1\right] < 0. \tag{9}$$

Therefore, for a given X there exists a high enough θ so that raising taxes is socially optimal. Instead, for a given θ there exists a large enough X so that raising taxes is not socially optimal. The probability of being an impatient depositor and receiving the bad signal has a clear impact on $\partial\Delta/\partial X$: decreasing γ or increasing π, lowers the impact of X on Δ.

In our economy there is a bank run when the signal is bad, $s = L$, and the government raises taxes. However, the government may resolve a banking crisis by means of different policies. Next, we analyze some of them.

4.1 Spending taxpayers money

In this section we study a bailout plan that is paid by taxpayers, i.e., the government spends taxpayers money in order to improve the liquidity of the banking sector (as in recent events). We assume that using taxpayers money to rescue banks has a direct negative impact on the utility of taxpayers. In this paper, the taxpayers money comes from liquidation of the public asset, i.e., the government may liquidate part of the public asset for cash and inject it into the banking industry. By liquidating the public asset we mean modifying the direction of public funds before they are spent but once they have been accepted in the public budget.[11]

Liquidating the public asset means consuming less public services, but this policy has also an opportunity cost (e.g., this money could be passed directly to agents -by collecting less taxes), and moreover implies that taxpayers take the risk: if banks fail they will lose

[11] Alternatively, the government could borrow money and use it to bail out banks. However, we do not analyse this issue as we are considering a one shot game, and public debt should be repaid in the future.

their money. To keep the analysis simple, this cost is modeled by θ. A bailout plan, however, may generate some externalities in the economy that could lead to an increase in the return of the banks' assets. For example, this is the case when banks succeed to pay loans back and moreover encourage economy activity. As will be shown below, in this case, the government can transfer those returns to agents although probably at some cost (e.g. agents prefer to consume public services earlier). Let λ denote this additional cost for each unit of the good.

To rescue the financial system, the government should use the taxpayers money to cover up the losses on the balance sheet of banks. We consider two alternatives for the government to inject liquidity into the banking industry: recapitalization or lending money to banks.

Recapitalization

Let δ denote the amount of money that should be injected into the banking system so as to recapitalize banks and stop the bank run, then $r = p^L d_2(T) + \delta$ (patient depositors are thus indifferent between withdrawing or not).

The depositors' utility is given by $U_C = r + \theta(T - \delta)$. Therefore, it is welfare improving to stop the bank run only if $V_{BR}|_{d_1=r} < r + \theta(T - \delta)$, which holds if

$$\delta < \delta^C \equiv \frac{r + \gamma X - (1 - T)(1 + \gamma X/r)}{\theta} \tag{10}$$

The utility loss of using taxpayers money is offset by the depositors' utility gain of having liquidity only when δ is lower than δ^C. Notice that this policy is limited by the social cost of using taxpayers money: δ^C decreases with θ, i.e., the higher is θ, the higher will be the utility loss of agents from using the taxpayers money in a bailout plan, which in turn lowers δ^C. This is not to say that such a policy is never socially optimal. Indeed, from (10) we have that recapitalization may improve social welfare when δ and θ are low enough. The next section compares this policy with public lending based on taxpayers money.

Public Lending

In this case, the government lends money to the banks. At date 1, banks receive an amount of money $\tilde{\delta}$, which they must pay back at the end of date 2. Let the interest rate on this loan be i. To pay the loan back, banks will invest in the short-term project that yields R' at date 2, with probability p'. The expected return of this technology is: $p'R' < 1$, however in the presence of limited liability, banks have incentives to invest in it as they will only pay the debt back when they can do so. This is true whenever $p'[R' - (1+i)] > 0$, which is satisfied for a small enough i. Therefore, to prevent a bank run the loan $\tilde{\delta}$ must satisfy the following condition:

$$\widetilde{d_2} = d_2 p^L + \frac{\tilde{\delta}[R' - (1+i)]}{(1-\gamma)} p' = r, \tag{11}$$

where $\widetilde{d_2}$ is the expected payoff of type-2 depositors. This condition imposes that patient depositors are indifferent between withdrawing and not. The value of $\tilde{\delta}$ is then

$$\tilde{\delta} = \frac{\delta(1-\gamma)}{p'[R' - (1+i)]}, \tag{12}$$

where we have used the fact that $\delta = r - d_2 p^L$.

As mentioned above, when banks succeed to pay loans back, the government can transfer the returns $(p'\tilde{\delta}(1+i))$ to the economy at a cost λ. Therefore, the depositors' utility with public lending is given by $U_L = r + \theta[T - \tilde{\delta} + \lambda p'\tilde{\delta}(1+i)]$. In general, comparing the expected utility with lending, $U_L = r + \theta[T - \tilde{\delta} + \lambda p'\tilde{\delta}(1+i)]$, versus the utility with recapitalization, $U_C = r + \theta(T - \delta)$, we have that lending will be preferred to recapitalization whenever:

$$\tilde{\delta}[1 - \lambda p'(1+i)] < \delta. \tag{13}$$

So, even if lending is more expensive than recapitalization ($\tilde{\delta} > \delta$), the former will be preferred to the latter whenever equation (13) is satisfied. Additionally, from equation (12), we have that a sufficient condition for public lending to dominate recapitalization is $p'(R' - (1+i)) > (1-\gamma)$, which implies that $\tilde{\delta} < \delta$, so (13) is also satisfied.

Finally, it should be stressed that for some parameter values, even though the government knows that banks will invest in the negative NPV technology, it is welfare improving to extend credit to banks, instead of allowing bank runs.[12]

[12] A good example of this has been actually observed in the US, where the government injected money to bailout banks, even after knowing that part of this money would be used to pay primes of old directors.

5 Additional policies for small economies

In this section we analyze two additional policies that may be of special interest when recapitalization or lending money to banks is too expensive. This may be the case of small economies, where the public budget is so small so that there is not scope for liquidating public assets (the Iceland recent subprime mortgage crisis may be an example[13]) or when the country has great difficulty obtaining external funding, as for instance emerging economies during a crisis.

5.1 A preventive policy: creating a buffer

The government may frozen some funds to prevent the emergence of crises. Since the government can only anticipate the realization of the event after having raised taxes, it may prefer to invest only part of the funds in the public services and store the rest of them as a buffer for a potential financial crisis.[14]

Let B denote the necessary buffer size to stop the financial crisis, then $B = r - p^L d_2(T)$, as a result the government invests only $T' = T - B$ in the public service. We may also assume that when the government observes the realization of the event H, it may reinvest B in the public service but at expense of some cost λ. Here, the government faces the following trade-off: whether to spend money in public services but to make the system more prone to shocks or to spend less money in public services and to make the system more resilient to shocks. More specifically, it is socially optimal to create the buffer as long as the agents' expected utility of doing so is higher than the agents' expected utility of investing all the taxes in public services:

$$\begin{aligned}(1-\pi)r + \pi(\gamma r + (1-\gamma)p^H d_2(T)) + \theta(T' + \pi\lambda B) \quad \geq \quad & (1-\pi)V_{BR} \\ & +\pi(\gamma r + (1-\gamma)p^H d_2(T)) + \theta T.\end{aligned} \tag{14}$$

[13]Iceland could not afford itself the banking crisis. Also, it found difficulty obtaining external funding: Western countries refused to help Iceland, after which it asked Russia to extend 3bn credit.

[14]This is the case of Chile, which has a buffer that accounts for 11% of its GDP so as to deal with potential problems. This policy is also in the agenda of the Euro governments.

This last expression can be rewritten as follows:

$$(1-\pi)(r-V_{BR}) \geq \theta[T-(T'+\pi\lambda B)]. \tag{15}$$

This condition says that creating the buffer B is socially optimal when the expected gain of stopping the bank run is higher than the expected utility loss of using taxpayers money. Therefore, the size of θ and λ are key in determining whether the government will prefer to invest all the funds in the public services or not. In particular, for given π and λ there may exist a high enough θ so that the government may prefer that financial crises occur with positive probability.

5.2 Taxes on financial transactions (the Tobin tax)

This policy is also more prone to be used in emerging markets, where governments are more constrained on their funding capacity, i.e., when using taxpayers money is too costly.

The government can levy an additional tax on early withdrawals in order to decrease the incentives of patient depositors to withdraw at $t=1$ and thus stop the bank run. These taxes are too costly for impatient depositors: they will afford the whole cost of preventing the crisis and moreover suffer the utility loss of not having enough liquid assets.[15]. Let δ^{TT} denote the necessary amount of money to prevent the bank run, then $r-\delta^{TT}=p^L d_2$

The utility of impatient depositors is

$$U_1^{TT}=r-\delta^{TT}-X+\theta(T+\lambda\gamma\delta^{TT}), \tag{16}$$

whereas the utility of patient depositors is

$$U_2^{TT}=p^L d_2+\theta(T+\lambda\gamma\delta^{TT}). \tag{17}$$

Thus, the total expected utility of this policy is

$$W=\gamma(r-\delta^{TT}-X)+(1-\gamma)p^L d_2+\theta(T+\lambda\gamma\delta^{TT}), \tag{18}$$

[15]In practice, this type of taxes might be levied by charging taxes on short term withdrawals and on every use of debit and credit cards for a certain period of time.

making use of the fact that $\delta^{TT} = r - p^L d_2$ we have

$$W = \gamma(-X) + p^L d_2 + \theta(T + \lambda\gamma(r - p^L d_2)). \tag{19}$$

This policy must be compared to the expected utility with bank runs (V_{BR}), in particular $W > V_{BR}$, given by (6), as long as

$$p^L d_2 + \theta\lambda(r - p^L d_2) > (1 - T)(1 + \gamma X/r). \tag{20}$$

The left-hand side of the above expression is the expected return of the patient depositors (since the bank run is avoided) plus the discounted social benefit derived from investing the collected taxes on the public asset, that is, $\theta\lambda\delta^{TT}$. The right hand side of the expression captures the utility gain of those impatient depositors that are not affected by the bank run, i.e., $[(1 - T)/r]\gamma X$, where $(1 - T)/r$ is the probability of being paid r under a bank run. Finally, when a bank run occurs the available rent $(1 - T)$ is shared among all agents (of measure one), this rent must be included in the right-hand side of inequality (20). Therefore, the Tobin tax is welfare improving (with respect to the emergence of a bank run) when X is small enough. Intuitively, in the presence of the Tobin tax all impatient depositors suffer the utility loss X, whereas in the presence of a bank run only some of them obtain this utility loss: patient and impatient depositors withdrawing at date 1 can consume with some probability as they are sequentially served. Thus, the Tobin tax is optimal only if X or the proportion of impatient depositors (γ) are small enough.

6 Concluding Remarks

This paper analyzes the role that government policies on public expenditure play in the development as well as in the administration of banking crises.

We construct a model that incorporates a government into a banking economy. This government raises taxes so as to provide public services. In this way, we can investigate the resolution of banking crises from the government's point of view instead of focusing only on the bank side as it is the case of most of the previous academic banking literature.

In particular, we analyze the effect of using public resources either to recapitalize banks or to inject those funds into the banking system through credit lines. It is shown that public lending might in some cases dominate recapitalization, even if it is more costly. The reason is that through public lending, some of the funds are returned to the economy (positive externalities). Actually, public lending might be preferred to recapitalization even in the presence of negative NPV projects or toxic assets.

We also study other policies in the hands of governments like the Tobin tax or the creation of a buffer. These policies might be more appropriate for small or emerging economies, in which governments have more difficulties to obtain funding. Whilst the Tobin tax is an emergency policy (applied when a financial crisis is imminent), the creation of a buffer is a preventive one.

Future research might be devoted to extending the model to different governments and successive periods.

7 Appendix

Proof of Proposition 1. Notice that perfect competition implies that in equilibrium banks maximize the expected utility of agents. In the presence of taxes ($T > 0$) and using (5), we have

$$\frac{\partial}{\partial d_1}\left(W^B(d_1,T)\big|_{d_1\geq r}\right) = \pi\gamma(1-p^H R) - (1-\pi)(1-T)\frac{\gamma X}{(d_1)^2} < 0.$$

Thus, increasing d_1 above r, lowers the expected utility of agents. Additionally, $d_1 > pd_2$ with $p \in \{p^L, p^H\}$, triggers a bank run,[16] in which case the expected utility is lower than $W^B(r,T)$ as some depositors are not paid and/or suffer the disutility X. Thus, in equilibrium banks cannot offer $d_1 > r$.

When $d_1 < r$, agents get $-X$ with probability γ. Consider the contract d_1 with $r > d_1 > p^L d_2$. We have

$$\begin{aligned} W^B(d_1,T)\big|_{r>d_1>p^L d_2} &= (1-\pi)\ V_{BR}\big|_{d_1<r} + \pi[\gamma(d_1 - X) \\ &\quad + p^H(1-T-\gamma d_1)R + \theta T], \end{aligned}$$

where $V_{BR}|_{d_1<r}$ is given by (8). Thus, $\partial\left(W^B(d_1,T)\big|_{r>d_1>p^L d_2}\right)/\partial d_1 < 0$, i.e., $d_1 = p^L d_2$ maximizes W^B in the range $r > d_1 > p^L d_2$. Consider now the contract d_1 with $r > p^L d_2 > d_1$. In this case there is no bank run since $p^L d_2 > d_1$, the expected utility of depositors is then given by

$$\begin{aligned} W^B(d_1,T)\big|_{r>p^L d_2>d_1} &= (1-\pi)\left[\gamma\left(d_1 - X\right) + (1-\gamma)p^L d_2\right] \\ &\quad + \pi\left[\gamma(d_1 - X) + (1-\gamma)p^H d_2\right] + \theta T, \end{aligned}$$

where $d_2 = (1-T-\gamma d_1)R/(1-\gamma)$. Then,

$$\frac{\partial\left(W^B(d_1,T)\big|_{r>p^L d_2>d_1}\right)}{\partial d_1} = (1-\pi)\gamma\left[1-p^L R\right] + \pi\gamma\left[1-p^H R\right] < 0.$$

That is, $d_1 = 0$ maximizes W^B provided that $d_1 < r$. This means that in the presence of

[16] Notice that the upper bound of d_1 is given by $\gamma d_1 \leq 1 - T$.

perfect competition, the optimal deposit contract is $d_1 = r$ whenever $W^B(r,T) > W^B(0,T)$, where

$$W^B(r,T) = (1-\pi)[(1-T)\left(1+\frac{\gamma X}{r}\right) - \gamma X]. + \pi[\gamma r + p^H(1-T-\gamma r)R] + \theta T$$

and

$$W^B(0,T) = (1-\pi)[\gamma(-X) + p^L(1-T)R] + \pi[\gamma(-X) + p^H(1-T)R] + \theta T.$$

Therefore, $W^B(r,T) > W^B(0,T)$ holds for a large enough X so that

$$X > \frac{1}{\gamma\left[(1-\pi)(1-T)/r + \pi\right]}\left[(1-\pi)(1-T)(p^L R - 1) + \pi\gamma r(p^H R - 1)\right]$$

Now we study what conditions ensure full participation. In the presence of taxes, agents will deposit their endowment at banks whenever $W^B(r,T) > W^{NB}(T)$. Using (5) and (4), this inequality holds if X is large enough so that

$$\begin{aligned} X \;\; > \;\; & \frac{1}{\gamma\pi}\left[\gamma(1-T) + (1-\gamma)p_0(1-T)R - (1-\pi)(1-T)\left(1+\frac{\gamma X}{r}\right)\right. \\ & \left. -\pi(\gamma r + p^H(1-\gamma r - T))\right]. \end{aligned}$$

■

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