Taxation of banks: A theoretical framework

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Abstract

The goal of this paper is to develop a model of financial intermediation to analyze the impact of various forms of taxation. The model considers in a unified framework various functions of banks: monitoring, transaction services and asset transformation. Particular attention is devoted to conditions for separability between deposits and loans. The analysis focuses on: (i) competition between banks and alternative financial arrangements (investment funds and organized security markets), (ii) regulation, and (iii) banks' monopoly power and risk taking behavior.

1 Introduction

In most countries banking activity is subject to general taxation (personal and corporate income taxes), but often banking services are differently treated by tax authorities. In some cases, they enjoy a favorable treatment. For instance, in the European Union most financial services are exempt from

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value-added tax (VAT). In other cases, they are subject to special taxes, like in the case of unremunerated reserve requirements. Exemption to VAT is usually justified for technical reasons, although the issue is currently under consideration. Unremunerated reserve requirements are an implicit form of bank-specific taxation which work in combination with inflation.

Taxation of banks is of particular interest for various reasons. First, banks are financial intermediaries that perform unique and crucial functions, although in many countries they are currently subject to increasing competition from investment funds and security markets. Second, banks are heavily regulated and monitored, which reduces the administrative costs of some forms of taxation, and at the same time they are subsidized through under-priced deposit insurance and bailouts of insolvent banks. Third, banks often enjoy some monopoly power, especially in the household and small business sectors.

The goal of this paper is to develop a theoretical framework to analyze the impact of various forms of taxation. The model is based on the modern theory of the banking firm and integrates in a unified framework the most important aspects of banking activity; in particular, monitoring, transaction services, and asset transformation. It is important to understand how each of these functions is affected by taxation. Banks reduce informational asymmetries with their loan applicants by ex-ante screening, interim monitoring, and ex-post verifying financial returns. Moreover, banks develop long-run customer-specific relationships which allow them to reuse the information acquired in previous transactions. Bank deposits play an important role in the payment system. They can easily be converted into cash or directly used in transactions through checks, credit and debit cards. Depositors can also set up automatic payments. Some of these transaction services may be separately priced, but to a large extent they are implicitly paid by accepting a rate of return on bank accounts below those of alternative assets. Finally, banks and other financial intermediaries perform an important asset transformation function. In particular, bank assets are riskier and less liquid than their liabilities. In the current model I abstract from risk diversification and exclusively focus on liquidity insurance (Diamond and Dybvig, 1983).

The model developed in this paper focuses on how efficiently savings are channeled into various investment opportunities. Thus, it takes as given the amount of funds. In this sense it is a partial equilibrium model. The simplest version of the model is presented in Section 2 and analyzed in Sections

3 and 4, and assumes perfect competition in both the deposit and the loan market. A crucial determinant of the incidence of bank taxation is whether the deposit and loan segments are separable, that is whether deposit and loan interest rates are independently determined. Under separability a tax on deposits does not affect lending, and viceversa a tax on bank loans leaves the level of deposits unchanged. The framework developed in this paper makes a heavy use of the separability hypothesis. In particular, it is assumed that banks can invest in a safe asset with an exogenous rate of return. Section 8 revisits the separability hypothesis and argues that in the real world the necessary conditions to obtain separability may be violated quite often. However, simultaneous deviations may partially compensate each other, and as a result a model assuming separability may still be a useful benchmark.

Recent improvements in information technology and innovations in financial contracting have increasingly challenged traditional banking activities.[1] Section 5 considers explicitly the effects of increasing competition from investment funds and more efficient security markets. Investment funds are characterized as perfect substitutes of banks in the asset transformation function. This is extreme, but it captures the idea that the implications of asset pooling by any large financial intermediary are similar. Another caveat is that some investment funds are already providing in some countries a limited amount of transaction services. If investment funds manage to develop such services then bank deposits and investment fund holdings will become almost perfect substitutes. In some less developed countries the main source of competition for banks comes from the informal credit sector. Some of the effects may be analogous to those discussed in the paper, although the normative implications are likely to be very different.

Section 6 deals with imperfect competition. Banks' market power introduces two new effects. First, the distortionary effects of taxes and market power are compounded, and as a result even a small tax rate is likely to have a negative first order effect on welfare. However, the distortions associated to market power decrease with the ability of banks to price discriminate, which is likely to be significant in the loan market. Second, taxes may at least partially fall on banks' economic profits, and hence reduce the tax

[1] Recent changes in the size and composition of bank activities are discussed, for instance, in Mishkin (1996) and Allen and Santomero (2001).

burden of investors (which, in a more general model, would reduce the distortion on savings decisions). However, economic profits may prevent banks from taking excessive portfolio risk. Section 7 discusses whether taxes may induce higher risk taking by altering the rewards to prudent behavior.

Taxation and regulation are shown to interact in various ways. On the one hand, corporate income taxation can not be exclusively a tax on pure economic profits if capital requirements are binding. On the other hand, if new taxes induce excessive risk taking behavior then existing solvency regulation must be strengthen in order to preserve the stability of the banking system. Some of these issues are analyzed throughout the paper and also discussed in Section 8.

The last section summarizes the main results of the paper.

2 The benchmark model

The economy is populated by four types of agents: investors, entrepreneurs, banks and non-bank financial intermediaries (investment funds)[2], and transactions take place at three consecutive periods, indexed by t, $t = 0, 1, 2$. There is a continuum of ex-ante identical investors with mass equal to N, which is assumed to be sufficiently large. Each investor has an endowment of one unit at time $t = 0$. Next, at time $t = 1$ she finds out whether she is impatient, i.e., she must consume then and obtain a utility of $u(c_1)$, or she is patient, i.e., she must consume at $t = 2$, and obtain utility $u(c_2)$. Investors' type (whether she is patient or impatient) is assumed to be the agent's private information. The probability of the two events is, for simplicity, one half.[3] Ex-ante preferences on consumption of real goods are given by expected utility:

$$U = u(c_1) + \rho u(c_2)$$

where ρ is a positive discount factor and u is a concave (and twice differentiable) function.

Investors have access to the following safe investment technologies:

[2] The role of investment funds is presented in Section 5.

[3] Thus, as in Diamond and Dybvig (1983), investors' preferences are extreme: the utility of consumption is positive either at $t = 1$ or at $t = 2$.

a) Short-term investment: each unit of investment at $t = 0$ yields one unit at $t = 1$. The same technology can be operated between periods 1 and 2.

b) Long-term investment: each unit of investment at $t = 0$ yields $R > 1$ at $t = 2$. The investment project can be liquidated at $t = 1$ in which case the unit return is Z.

Assumption 1:

$$R^{-1} < Z < 1$$

In order to simplify the presentation I fix the time discount factor:

Assumption 2:

$$\rho = R^{-1}$$

There is a continuum of heterogeneous entrepreneurs, with mass equal to 1, who have no funds but have access to two types of projects (safe and risky). They can invest one unit in the safe project at $t = 0$ and obtain X at $t = 2$. Alternatively, they can invest one unit at $t = 0$ in the risky project and obtain at $t = 2$ a random financial return:

$$\begin{cases} X \text{ with probability } p \\ 0 \text{ with probability } 1 - p \end{cases}$$

plus a non-financial return (private benefit) of $\phi\,(1 - p)$.

Entrepreneurs differ only in their probability of success of the risky project, p, which is common knowledge. Entrepreneurs are distributed over the interval $[0, 1]$ according to the probability density function $h\,(p)$. Let us $H\,(p)$ denote the cumulative distribution. Finally, entrepreneurs are assumed to be risk neutral and wish to consume only at time $t = 2$. In other words, their objective function is the expected net return at time $t = 2$.

Assumption 3:

$$R + \phi > X > R > \phi$$

As shown below, the first inequality implies that in the absence of monitoring entrepreneurs prefer the inefficient (risky) project. From the second inequality it follows that the safe project has a positive net present value

(NPV), which is always higher than the NPV of the risky project (third inequality). However, if p is sufficiently close to one then the risky project also has a positive NPV.

Banks are assumed to perform three functions: monitoring, transaction services and liquidity transformation. That is, first, they can monitor entrepreneurs, which reduces agency costs in the credit market; second, they provide transactions services to investors (routine payments, check writing, etc.), and third, they offer investors liquidity insurance.

More precisely, banks can monitor an entrepreneur, which involves a cost $m > 0$ (measured in time $t = 2$ units) independently of p, and induce the entrepreneur to choose the efficient project (the safe project). Thus, bank monitoring sets an upper bound on the size of the agency cost of all entrepreneurs. This a bit drastic, since in equilibrium all entrepreneurs get credit independently of market conditions. The purpose here is to focus on the choice between bank and non-bank financing rather than on entrepreneurs' credit availability.

Banks' liabilities are also special. As we will see below they can provide a better time structure of returns than direct investment, and moreover by incurring a cost μ per unit of deposit they provide transaction services, which are valued by investors according to the function $v(D)$ where D is the level of bank deposits and v is a concave (and twice differentiable) function, with $v(0) = 0$, $v'(0) = \infty$, and $v'(D) > 0$ if and only if $D < 1$. The utility derived from transaction services enters additively in investors' utility function. Thus, investors' ex-ante preferences can be written as:[4]

$$U = u(c_1) + \rho u(c_2) + v(D) \tag{1}$$

Notice that under such a formulation the supply of deposits will depend not only on the relative return of deposits with respect to alternative assets, but also on investors's income. This is analogous to the interest rate and income effects in the money demand function, which has a very broad empirical support.

[4]It makes sense to assume that transaction services are enjoyed the same period that consumption takes place (impatient consumers at time $t = 1$, and patient consumers at time $t = 2$). Banks pay the costs of providing those services accordingly. Finally, the function v represents the expected value of deposits.

3 The walrasian outcome in the absence of taxes and investment funds

3.1 Direct investment

Let us first look at the walrasian equilibrium under direct investment. That is, suppose that there exist perfectly competitive markets to trade, both at $t = 0$ and at $t = 1$, the claims on various investment projects. For simplicity, we assume that investors do not incur in any transaction cost when purchasing assets at time $t = 0$, but they pay a cost d at time $t = 1$ (measured in current units) if they sell a claim on one unit delivered at time $t = 2$. This is meant to capture the idea that the cost of acquiring an asset is relatively small but frequent transactions in the secondary market is relatively more costly. One important implication of the above assumption is that at time $t = 0$ investors can perfectly diversify their portfolios and hence act as risk neutral agents when lending to a particular entrepreneur. Of course, this is very extreme. The goal here is to concentrate on the term structure of assets (liquidity insurance) and completely abstract from asset risk. On the other hand, the entrepreneur incurs a non-pecuniary cost of f,(measured in time $t = 2$ units) $f < m$, when collecting one unit of funds in the market for securities.

Given the structure of returns and because of limited liability, security design is not an issue in this model. Thus, without loss of generality let us assume that entrepreneurs can issue a bond that promises to repay r^b in case of success. If they invest in the risky asset they obtain $p\left(X - r^b\right) + (1-p)\,\phi$, and if they do it in the safe asset they get $X - r^b$. Given Assumption 3 and since investors require $r^b \geq R$ then entrepreneurs of all types prefer to invest in the risky project.

Competition among investors implies that the net benefit from lending to entrepreneurs instead of investing in the long-term technology is zero, i.e.

$$r^b = \frac{R}{p}$$

Because of limited liability $r^b \leq X$. As a result, only those entrepreneurs with $p \geq p_0$ can obtain financing in the securities market, where p_0 is given by:[5]

[5]It is easy to check that, provided f is not too large, entrepreneurs' participation

$$\frac{R}{p_0} = X$$

Given that entrepreneurs' projects have a two-period maturity, those with $p \leq p_0$ will obtain financing provided investors wish to invest a sufficient amount in assets with such maturity. In other words, we need to worry about market clearing. Similarly, since the liquidation value of entrepreneurs' projects at time $t = 1$ is zero, we need to check that the secondary market works properly. These issues are discussed in the Appendix.

Let us now turn to investors' decisions. At time $t = 0$ investors must decide how to distribute their unit endowment between short-term assets, $1 - I$, and long-term assets, I. At time $t = 1$ there are potential gains from trade. Patient consumers would like to use the proceeds from short-term assets to buy assets that mature at time $t = 2$, and impatient consumers may be willing to sell their long-term assets. Let q be the price paid by patient consumers at time $t = 1$ for a claim on one unit at time $t = 2$. Hence, sellers obtain $q\,(1 - d)$ per unit. At time $t = 1$ patient consumers are willing to participate in the secondary market provided the implicit return on those assets is not below their alternative investment opportunity (the short-term investment technology). Thus, patient consumers are willing to buy the claims sold by impatient consumers provided $q \leq 1$. Similarly, impatient consumers are willing to sell their claims on second period returns only if they find it profitable, i.e., if $q\,(1 - d)\,R \geq Z$. The following assumption simplifies the analysis considerably.

Assumption 4

$$(1 - d)R = Z$$

Under Assumption 4 impatient consumers trade if and only if $q \geq 1$. As a result, the equilibrium price is $q = 1$. At time $t = 0$ investors are able to anticipate the equilibrium price of the secondary market. Hence, their consumption profile as a function of their portfolio is given by:

$$\begin{aligned} c_1 &= 1 - I + q\,(1 - d)\,RI = 1 - (1 - Z)\,I \\ c_2 &= \frac{1 - I}{q} + RI = 1 + (R - 1)\,I \end{aligned} \qquad (2)$$

constraint is not binding. In other words, all entrepreneurs that can get financing are willing to accept it.

Investors choose I in order to maximize 1 subject to 2. The solution is fully characterized by the first order condition:

$$\frac{u'(c_1)}{u'(c_2)} = \frac{1 - R^{-1}}{1 - Z}$$

Given Assumption 1, $c_1 < c_2$, which implies that $I > 0$.

The assumption about positive transaction costs in the secondary market is not innocuous. In case $d = 0$, then the equilibrium in the secondary market is $q = R^{-1}$ and as a result $c_1 = 1$ and $c_2 = R$. It turns out, as pointed out by Jacklin (1987), that in this case banks can not improve the market allocation (can not provide liquidity insurance). Diamond (1997) and Homstrom and Tirole (1998) present more sophisticated models of liquidity with implications analogous to our formulation.

3.2 The role of banks

Let us now introduce banks into the picture. They intermediate between investors, on the one hand, and the safe investment technologies and entrepreneurs, on the other. Thus, when considering lending to entrepreneurs their opportunity cost of funds is R. The distinctive feature of banks in the asset side is that they can monitor entrepreneurs (at a cost) and induce the efficient project selection. In other words, bank monitoring eliminates any potential inefficiencies originated by entrepreneurs' moral hazard problem. Alternatively, a large literature has focused on a different type of informational failure in the credit market: adverse selection (hidden types), instead of moral hazard (hidden actions). In particular, Boadway and Keen (this volume) analyze the effect of adverse selection in the credit market and the potential role of corrective taxes.[6] Thus, our characterization of the role of banks in reducing informational asymmetries is clearly limited, although it suffices to illustrate how various forms of taxation may reduce banks' contribution to economic efficiency in the credit market (through the desintermediation effect).

Competition among banks implies that a loan contract will require the entrepreneur to choose the safe project and pay back at time $t = 2$ an interest rate:

[6]In Section V, Boadway and Keen study various adverse selection models and conclude that the type of public intervention in the credit market that enhances efficiency is model dependent, which suggests that in practice it may be best not to intervene at all.

$$r^l = R + m \tag{3}$$

Clearly, we need to assume that monitoring is economically feasible:
Assumption 5:

$$X > R + m$$

As a result, an entrepreneur with a probability of success on the risky project p, will apply to a bank loan instead of issuing bonds provided the following condition holds:

$$X - r^l \geq p\left(X - r^b\right) + \phi\left(1 - p\right) - f$$

The left hand side is the expected return of borrowing from a bank. In such a case the entrepreneur expects to be forced to choose the safe project. The right hand side is the expected return of borrowing on the securities market (which is feasible if and only if $p \geq p_0$). Given the equilibrium values of r^l and r^b such a condition can be written as $p \geq p^*$, where p^* is given by:

$$p^* = 1 - \frac{m - f}{X - \phi}$$

For simplicity, let us assume that the entrepreneur who is indifferent between the two sources of credit is not constrained in the securities market, i.e.:

Assumption 6

$$p^* > p_0$$

Thus, entrepreneurs with a low value of p (high agency cost in the securities market) choose to borrow from banks, while entrepreneurs with a value of p close to one (low agency cost) prefer to borrow on the securities market. Notice that banks make credit feasible for entrepreneurs with $p < p_0$ (those who are excluded from the bond market).

Let us now turn to the liability side of banks' balance sheet. Bank deposits provide transaction services and on top of this they are able to offer a better time profile of financial returns than direct investment. In particular, a bank deposit could offer investors a return r_1^d if funds are withdrawn at time $t = 1$, and a return r_2^d if they are withdrawn at time

$t = 2$. Thus a patient consumer withdrawing at time $t = 1$ can invest the funds withdrawn in the short-term investment technology (or buy claims in the secondary market). Hence, banks must take into account investors' incentive compatibility constraint:

$$r_1^d \leq r_2^d \tag{4}$$

Banks do not need to transact in the secondary market because there is no aggregate uncertainty and they can exploit the law of large numbers. Since banks anticipate that one half of their depositors will withdraw their funds at time $t = 1$, they need to invest a proportion β of their deposits in long-term assets, and a proportion $1 - \beta$ in short-term assets, in such a way that:

$$\begin{aligned} \frac{1}{2}(r_1^d + \mu) &= 1 - \beta \\ \frac{1}{2}\left(r_2^d + \mu\right) &= \beta R \end{aligned} \tag{5}$$

Eliminating β in the above equations we obtain the set of all possible combinations of r_1^d and r_2^d that can be offered to investors:

$$r_1^d + \frac{r_2^d}{R} = 2 - \mu\frac{1+R}{R} \tag{6}$$

If investors decide to deposit in a bank a fraction D of their endowment and to invest directly a fraction $1 - D$, then they can enjoy the following consumption profile:

$$\begin{aligned} c_1 &= r_1^d D + (1-D)\left[1 - (1-Z)\, I\right] \\ c_2 &= r_2^d D + (1-D)\left[1 + (R-1)\, I\right] \end{aligned} \tag{7}$$

Thus, in equilibrium bank deposit contracts will be part of the solution to the following optimization problem: choose $(r_1^d,\ r_2^d, D, I)$ in order to maximize 1 subject to 4, 6 and 7 and the feasibility constraint $D \leq 1$.

Notice that the market allocation implies a higher return in the second period than in the first. However, in the absence of the incentive compatibility constraint, banks would offer a structure of returns such that consumption in both periods is the same, which implies that the deposit rate in the first period is higher than in the second. Clearly, this violates the incentive compatibility constraint 4. Hence, in equilibrium:

$$r_1^d = r_2^d \equiv r^M - \mu \equiv \frac{2R}{1+R} - \mu \tag{8}$$

The first order condition that characterizes the optimal amount of deposits can be written as:

$$u'(c_1)\frac{R-Z}{R-1}\left(r^M - \mu - 1\right) + v'(D) = 0 \tag{9}$$

By pooling assets banks can in principle offer investors a time profile of financial returns that dominates that of direct investment, since banks do not need to trade in the secondary market or liquidate projects too early. Moreover, deposits provide transaction services. On the negative side those services are costly, which implies that the overall return on deposits must be lower. Thus, we must distinguish two cases depending on the costs of providing transaction services:

a) If $r^M - \mu - 1 > 0$ then the optimal amount of deposits is $D = 1$. In this case, deposits dominate direct investment.

b) If $r^M - \mu - 1 < 0$ then $D < 1$. In this case deposits do not dominate direct investment. The cost of providing transaction services is sufficiently large to reduce the level of financial returns, which leaves room to a positive amount of direct investment.

4 Bank taxation in the absence of investment funds

In this section we study the effects of taxation under perfect competition among banks but in the absence of non-bank financial intermediaries. We look at five types of taxation: on deposits, loans, value-added, investors' capital income and banks' corporate income. By focusing on one type of taxes at a time, we study the effects of 'differential' taxation. Since in this paper we pay little attention to normative issues, we do not discuss in detail how to achieve tax neutrality with respect to portfolio allocation.

4.1 A tax on deposits

The structure of the model involves separability between loans and deposits. In particular, loan interest rates or credit availability are not affected by changes in the deposit market. The reason is that banks' opportunity cost of funds in the loan market is the (exogenous) return on the long-term investment technology, and not the deposit rate. Suppose that the government sets a proportional tax on the gross interest rate on deposits, τ^d.[7] Clearly, such a tax will not change the structure of pre-tax deposit rates: $r_1^d = r_2^d = r^M - \mu$. However, investors will take into account such a tax when deciding the amount of deposits, since the after-tax return is now $\left(1 - \tau^d\right) r_t^d$, $t = 1, 2$. We must distinguish between two cases:

a) If $r^M - \mu - 1 > 0$ then deposits dominate direct investment, and as a result a small τ^d is non-distortionary. If the tax rate is sufficiently large then the effects are analogous to those of the second case.

b) If $r^M - \mu - 1 < 0$ then investors face a trade-off between a higher (composite) return of direct investment and the transaction services provided by bank deposits. In this case, the optimal level of deposits is given by the first order condition of the representative investor's optimization problem (adaptation of equation 9):

$$u'\left(c_1\right) \frac{R - Z}{R - 1} \left[\left(1 - \tau^d\right)\left(r^M - \mu\right) - 1\right] + v'\left(D\right) = 0$$

Clearly,

$$\frac{dD}{d\tau^d} < 0$$

Taxes affect the supply of deposits through two different channels. A higher tax rate: (i) increases the opportunity cost of deposits (the difference between the rates of return of deposits and direct investment), and (ii) reduces investors' disposable income. Both effects reduce the supply of deposits. Notice that the effect of τ^d on deposits depends on the second

[7] A reserve requirement is equivalent to a proportional tax on deposits, except for the timing of revenues. See Section 8. If banks can price transaction services separately, then it is easy to show that a proportional tax on deposits is equivalent to a proportional tax on transaction services. That is, if both taxes are required to raise the same amount of revenue then they must cause the same distortion on the level of deposits.

derivative of functions $u(.)$ and $v(.)$. This allows us to sign such a derivative, but also suggests that it is very difficult a priori to determine how changes in various parameters influence the distortionary effect of taxes. The next proposition summarizes these results.

Proposition 1 *Under perfect competition in banking and in the absence of investment funds: (i) A tax on deposits has no effect on the loan market. (ii) If the costs of providing transaction services are sufficiently small, so that bank deposits dominate direct investment, then a small tax on deposits does not affect the amount of deposits.(iii) If the costs of providing transaction services are sufficiently large so that bank deposits do not dominate direct investment, then a tax on deposits reduces the amount of deposits and increases direct investment. Thus, two functions of banks are jeopardized: provision of transaction services, and liquidity insurance.*

It is immediate to check that even in the second case (deposits do not dominate direct investment) a small tax rate on deposits has only a second order effect on total welfare, since the market allocation is efficient.

4.2 A tax on bank loans

Suppose that the government sets a proportional tax on the gross return on bank loans, τ^l. Let r^l denote the after tax loan rate. The competitive rate is independent of taxation and hence entrepreneurs must pay $\frac{r^l}{1-\tau^l}$. Therefore, the threshold value of p, p^*, is now given by:

$$p^*(\tau) = 1 - \frac{m + \tau^l R - f\left(1-\tau^l\right)}{(1-\tau^l)(X-\phi)} \tag{10}$$

Thus,

$$\frac{dp^*\left(\tau^l\right)}{d\tau^l} < 0$$

Under separability a tax on bank loans does not have any effect on the deposit rate, or the provision of transaction services and liquidity insurance. However, it raises the cost of loans which discourages entrepreneurs away from information-intensive financing and into unmonitored financing.

Proposition 2 *Under a perfectly competitive banking system and in the absence of investment funds a proportional tax on bank loans: (i) raises loan rates and induces some entrepreneurs to switch from bank to non-bank financing (the level of bank monitoring decreases), and (ii) does not have any effect on the deposit interest rate or the level of deposits.*

It has been argued that bank monitoring creates a positive informational externality on the securities market (Besanko and Kanatas, 1993).[8] This would not alter the qualitative results, but it would amplify the distortionary effects of taxation.[9]

4.3 A tax on banks' value-added

Consider a tax on banks' value-added under the cash-flow approach..[10] Suppose that entrepreneurs are VAT-registered businesses, but depositors are not engaged in commercial activities. At times $t = 0$ and $t = 1$ banks have zero net cash flow and hence they pay no tax. At time $t = 2$ their net cash flow is:

$$CF = r^l L + RB - \frac{1}{2}\left(r^d + \mu\right) D \tag{11}$$

where L is the amount of loans and B is the amount of investment in the long-run technology (or bonds). Banks' feasibility constraint can be written as:

$$L + B = \left[1 - \frac{1}{2}\left(r^d + \mu\right)\right] D \tag{12}$$

Using 12 we can rewrite 11:

$$CF = \left(r^l - R\right) L + \left[\frac{R+1}{2}\left(r^M - \mu - r^d\right) + \mu\right] D \tag{13}$$

In the absence of taxes, r^l and r^d are given by equations 3 and 8. Plugging these equations into 13, it is immediate to verify that

[8] Empirical support is provided by James (1987).

[9] In the absence of the externality a small τ^l has only a second order effect on welfare. However, if banks create a positive externality to the securities market even a small tax would have a first order effect on welfare.

[10] See Poddar and English (1997).

$$CF = mL + \mu D$$

Notice that such a measure of banks' value-added only captures monitoring and transaction services, but disregards liquidity provision. The reason is that we have assumed that asset transformation is costless.

Suppose that the government sets up a tax τ^v on banks' value-added. More specifically, value added throughout the economy is already taxed at the rate τ^v, and the government lifts the exemption of banking services from general VAT. Under perfect competition after-tax profits in both loans and deposits must be zero. This implies that the equilibrium loan rate is given by:

$$r^l = R + \frac{m}{1 - \tau^v} \tag{14}$$

Similarly, the deposit rate in equilibrium can be written as:

$$r^d = r^M - \mu - \frac{2\tau^v \mu}{(R+1)(1-\tau^v)}$$

Since we have assumed that depositors are outside the VAT system, this implies that lifting the exemption on banking services is equivalent to a tax on deposits. However, since the tax paid on loans reduces the borrowers' tax bill, the effect on the loan market is null. In order to check this last statement, simply notice that under the exemption, those entrepreneurs financed by loans obtain:

$$\pi^E = \left(X - r^l\right) - \tau^v X = (1 - \tau^v) X - R - m$$

If the exemption is lifted, then entrepreneurs get:

$$\pi^E = X - r^l - \tau^v \left(X - r^l + R\right)$$

The reason is that now entrepreneurs can reduce their tax bill by the amount $\tau \left(r^l - R\right)$.[11] Using 14 in the last equation, we can check that entrepreneurs' profits are identical in both regimes.

[11] Under the cash-flow method borrowers should pay τ^v on their capital inflow at time $t = 0$, and then get a credit of $\tau^v r^l$ on their capital outflow at time $t = 2$. We assume that the tax payment associated with a cash inflow of a capital nature can be carried forward to the period during which the capital transaction is reversed, although the deferral is subjet to interest charges at the market rate, R. This is the Cash-Flow Method with Tax Calculation Account (Poddar and English, 1997).

Proposition 3 *If borrowers are VAT-registered firms and depositors are not engaged in commercial activities, then lifting the exemption of banking services in the base of the general VAT is equivalent to setting a tax on deposits, with no impact on the loan market.*

4.4 A tax on gross interest income

Let us consider a proportional tax on investors' gross interest income, τ^Y. The tax base of such a tax includes gross interest from deposits as well as the gross return of direct investment. Clearly, the relative return of deposits and direct investment remains unaffected. However, such a tax reduces the supply of deposits through the income effect. More specifically, if $\left(r^M - \mu\right) - 1 < 0$, then the supply of deposits is given by equation 9:

$$u'(c_1)\frac{R-L}{R-1}\left(r^M - \mu - 1\right) + v'(D) = 0$$

The effect of such a tax comes through c_1. In particular, a higher tax rate reduces disposable income, which implies a reduction in both consumption of real goods and the demand for banks' transaction services (reduces the supply of deposits). Thus, we have the following result:

Proposition 4 *Provided that deposits do not dominate direct investment, a tax on interest income reduces the amount of deposits.*

Thus, as long as the income effect in the supply of deposits is significant, general taxes like the personal income tax may also have an effect on financial intermediaries.[12]

4.5 Banks' corporate income taxes

A complete analysis of the impact of corporate taxation on banking activity requires a satisfactory theory of banks' capital structure. Unfortunately, such a theory is not available yet. The role of banks as intermediaries implies that the bank will tend to have little inside capital. However, if bankers

[12] We may wonder about the effect of a general tax on firms' profits. In our model, the demand for credit is inelastic and hence such a tax would create no distortion. However, in a richer model the amount of entrepreneurial projects may also depend on their net return. In that case, profit taxes are likely to reduce bank loans.

are subject to moral hazard and perfect diversification is not feasible, then inside capital provides incentives to monitor (Holmstrom and Tirole, 1997). In any case, in the real world banks tend to hold relatively low levels of capital[13] and as a result capital requirements are frequently binding.

Our model is not able to deal with security design issues, and hence debt and equity are indistinguishable. Nevertheless, it can still provide a preliminary analysis of the effects of corporate income taxation whenever capital requirements are binding. Suppose that banks hold a ratio of capital to loans equal to η, $K = \eta L$.[14] Since aggregate risk or corporate control is not an issue in our framework, and equity must have the same maturity as loans, potential shareholders will require a rate of return at time $t = 2$ equal to R.[15] Finally, let banks' corporate tax rate be τ^c. Since banks offer depositors a constant interest rate and invest in the short-run technology the exact amount in order to pay impatient depositors, then banks' economic profits can be written as:

$$\pi^B = \left(r^l - m\right) L + RB - \frac{r^d + \mu}{2} D - \frac{R}{1 - \tau^c} \eta L \tag{15}$$

Notice that the cost of equity for the bank is $\frac{R}{1-\tau^c}$. Banks' feasibility constraint is:

$$D = \frac{r^d + \mu}{2} D + B + (1 - \eta) L \tag{16}$$

The first term of the right hand side is the amount invested in the short-run technology. The rest is invested in the long run technology, B, or in loans, $(1 - \eta) L$ (an amount ηL of loans are financed by equity). Plugging equation 16 into 15 and rearranging:

$$\pi^B = L \left[r^l - m - R \left(1 - \eta + \frac{\eta}{1 - \tau^c} \right) \right] + D \frac{R + 1}{2} \left(r^M - r^d - \mu \right)$$

[13] One reason why banks find equity financing expensive (sometimes prohibitively expensive) is adverse selection (Stein, 1998). Boyd and Gertler (1993) observe that for the US banking industry the equity to assets ratio has been steadily declining since 1980.

[14] Solvency ratios usually take the form of a minimum ratio of capital to a risk-weighted measure of assets. In our formulation we give a positive weight only to loans to entrepreneurs.

[15] Investors will be willing to buy banks' equity at an implicit rate of return R only if deposits do not dominate direct investment, i.e., $r^M - \mu - 1 < 0$. In this subsection we deal only with this case.

Under perfect competition (and because of separability) banks make zero profits in both deposits and loans. As a result, deposit rates are unaffected by corporate income taxes, $r^d = r^M - \mu$, but loan rates are not:

$$r^l = \left[(1-\eta) + \frac{\eta}{1-\tau^c}\right] R + m$$

Thus, we have that:

Proposition 5 *If capital requirements are binding, and under perfect competition, a tax on banks' corporate income is equivalent to a tax on bank loans. Hence, it raises the loan interest rate (and reduces the amount of loans) but does not affect the deposit rate.*[16]

The result that a corporate income tax is a tax on loans may be more general than it appears. Suppose that capital requirements are not binding but banks' inside capital provides positive incentives to monitor borrowers (like in Holmstrom and Tirole, 1997). Then loans and capital are also complementary and similarly a tax on corporate income would also fall over loans.

5 Competition from alternative financial arrangements

In this section we ask to what extent the presence of alternative financial arrangements affects the previous analysis. In particular we focus on the one hand, on the appearance of other financial intermediaries (mutual and pension funds) that offer investors imperfect substitutes of bank deposits; and, on the other hand, on the impact of more efficient markets for securities, that allow an increasing number of firms to consider issuing bonds as an alternative to bank loans.

[16]In case capital requirements are computed in such a way that all bank assets get a positive weight, and provided deposits and equity are the only source of funds for banks, then is it immediate to show that separability breaks down and corporate taxes also affect deposit rates.

5.1 Investment funds

In principle, any large intermediary can supply investors the same asset transformation function offered by banks. Asset pooling allow intermediaries to issue financial contracts with lower risk and higher liquidity. Actually, this is the main role of mutual and pensions funds. In this dimension, banks are no longer special. This motivates in the context of the current model the following characterization of investment funds: they can supply the same liquidity services than banks (in particular, they can offer a constant return) but they can not monitor entrepreneurs or offer investors transaction services. Such a characterization overlooks various observations. First, Money Market Funds in the US have started providing some transaction services.[17] Second, investment funds have been reported in some instances to monitor the management of corporations where they hold stock. Third, various intermediaries seem to specialize in issuing different varieties of financial contracts. Therefore, the proposed characterization must be considered only as a first approximation.

In particular, we assume that perfectly competitive investment funds can hold the same portfolio in terms of maturity structure than banks and thus offer investors liquidity insurance. In principle, investment funds (under perfect competition) should offer contracts which allow investors a unit return of r_1^M if they withdraw their funds at time $t = 1$, and r_2^M if they wait until time $t = 2$. Drawing from the previous analysis of equilibrium deposits we can conclude that perfectly competitive investment funds will offer:

$$r_1^M = r_2^M = r^M \equiv \frac{2R}{1+R}$$

As discussed above such a structure of returns dominates direct investment. As a result, banks face tighter competition. In the absence of taxes investors can achieve the following consumption structure as a function of their portfolio:

$$\begin{aligned} c_1 &= r_1^d D + r^M (1 - D) \\ c_2 &= r_2^d D + r^M (1 - D) \end{aligned} \tag{17}$$

[17]However, Whitesell (1992) argues that money market funds may provide efficient services for very large transactions, but that cash and checks are more efficient for small and medium size transactions, respectively.

Thus, the equilibrium deposit contract will be part of the solution to the following optimization problem: choose (r_1^d, r_2^d, D) in order to maximize 1 subject to 17. As expected, deposit interest rates are also constant over time:

$$r_1^d = r_2^d = r^M - \mu = \frac{2R}{1+R} - \mu$$

Thus, consumption is the same in both periods, $c_1 = c_2 = c$, and the optimal supply of deposits is given by:

$$-u'(c)\frac{1+R}{R}\mu + v'(D) = 0 \tag{18}$$

where

$$c = r^M - \mu D$$

Now we can compare the level of deposits in the absence and in the presence of investment funds (equations 9 and 18). If $\mu < \frac{R-1}{R+1}$ then bank deposits dominate direct investment, but do not dominate investment fund holdings. Hence, competition from investment funds unambiguously reduces the level of deposits. The reason is that without direct investments investors are at a corner solution ($D = 1$), but competition from investment funds place investors in an interior solution ($D < 1$). However, if $\mu > \frac{R-1}{R+1}$, then the effect of investment funds on bank deposits is ambiguous. If we evaluate the first order condition 18 at the level of deposits without investment funds, then c_1 is larger, which implies that $u'(c_1)$ is lower. However, the relative price of deposits in terms of consumption is higher. That is,

$$\frac{1+R}{R}\mu > \frac{R-Z}{R-1}\left(1 - r^M + \mu\right)$$

Hence, in this case the effect of investment funds on deposits is ambiguous. The intuition is straight forward. On the one hand, the presence of investment funds raises the opportunity cost of holding deposits (the price effect). On the other hand, investment funds expands the set of feasible financial returns (income effect). The price effect works against deposits but the income effect works in the opposite direction.[18]. The effect of investment funds on bank deposits is summarized in the following proposition:

[18]The empirical evidence seems to indicate that the emergence of pension and mutual funds have mostly affected directly held assets, but not so much bank assets. See the discussion in Allen and Santomero (2001).

Proposition 6 *The presence of investment funds: (i) unambiguously reduces the level of bank deposits, if the latter dominate direct investment, (ii) the effect on bank deposits is ambiguous, if the latter does not dominate direct investment.*

After analyzing the effect on the tax base, let us now turn to the impact of investment funds on the distortionary effects of taxation. Let us consider again the effect of a tax on deposits. Under competition from investment funds, the amount of deposits will be given by:

$$u'(c_1)\frac{1+R}{R}\left[\tau^d\frac{2R}{1+R}+\left(1-\tau^d\right)\mu\right]=v'(D)$$

where

$$c_1=\frac{2R}{1+R}-D\left[\tau^d\frac{2R}{1+R}+\left(1-\tau^d\right)\mu\right]$$

Clearly,

$$\frac{dD}{d\tau^d}<0$$

Notice that the size of the distortionary effect depend among other things on the degree of convexity of the utility functions (on the sign of $u'''(.)$ and $v'''(.)$. Hence, it is rather difficult to make statements based on theoretical arguments about how competition from investment funds influence the effect of taxes.

Because of separability, competition from investment funds does not affect the impact of a tax on loans.

Proposition 7 *In the presence of investment funds: (i) A tax on deposits unambiguously reduces the level of deposits. (ii) Provided bank deposits do not dominate direct investment, the effect of a deposit tax may be higher or lower than in the case where bank deposits only compete with direct investment. (iii) Bank-specific taxes can only reduce monitoring and provision of transaction services, since liquidity insurance is also provided by banks' competitors.*

5.2 More efficient security markets

On the asset side banks are increasingly facing in some industrial countries tighter competition from security markets (development of commercial paper market). This could be captured by a decrease in the transaction costs incurred by entrepreneurs when they borrow on security markets (a reduction in f).

In order to study the effect of a change in f on the credit market equilibrium we need to refer again to equation 10:

$$p^*\left(\tau^l\right) = 1 - \frac{m + \tau^l R - f\left(1 - \tau^l\right)}{\left(1 - \tau^l\right)(X - \phi)}$$

Thus, the effect of a reduction in transaction costs on the entrepreneurs' choice of the source of funds is simply:

$$\frac{dp^*\left(\tau^l\right)}{df} = \frac{1}{X - \phi} > 0$$

Unsurprisingly, a reduction in transaction costs will reduce the number of entrepreneurs who choose to apply for a bank loan instead of issuing securities. What is less obvious is the effect of f on the impact of taxes. Notice that:

$$\frac{d^2 p^*}{d\tau^l df} = 0$$

That is, the level of f does not affect the impact of taxes on the threshold level p^*. Hence, the impact of f on the size of the distortion caused by taxes depends exclusively on the distribution of entrepreneurs, i.e., on the shape of $h(p)$.

It could be reasonable to expect that, in the relevant range, $h'(p^*) < 0$. That is, if the securities market is very inefficient (f large), then p^* is close to 1, and hence the number of firms borrowing on the securities market is small. Moreover, a small tax would reduce the threshold but would induce only a few additional entrepreneurs to switch from bank lending to unmonitored lending. However, if transaction costs are very low then the threshold level p^* could fall in a region where the density of entrepreneurs is substantially higher, and as a result a tax would have a larger impact on bank lending. Although reasonable, this was only a conjecture on the shape of the distribution of entrepreneurs on the relevant dimension. Summarizing:

Proposition 8 *As security markets become more efficient: (i) The level of bank loans falls as more firms choose to obtain their funds in the security markets. (ii) The distortionary effect of taxes may increase or decrease, although the former appears more likely.*

6 Taxing imperfectly competitive banks

Banks seem to enjoy some degree of market power, at least in the household and small business sectors.[19] Monopoly power creates distortions in the allocation of resources, provided banks can neither perfectly price discriminate across customers nor offer non-linear prices. Price discrimination seems particularly likely in the loan market, since rates are individually tailored. In this section we study how market power and taxes interact. We consider two polar cases. First, we assume that banks enjoy market power in the deposit market but can not offer non-linear prices (depositors are identical). Second, we assume that banks enjoy market power in the loan market and can perfectly price discriminate (the loan size is exogenous).

6.1 Monopoly power in the deposit market

In this subsection we extend the model of Section 5 to allow for monopoly power in the deposit market. Thus, banks not only compete with each other but with a perfectly competitive investment fund industry. Suppose there are 2 banks, A and B, (given the static nature of the game it can easily be generalized to n banks). Preferences of the representative investor are given by:

$$U = u(c_1) + \rho u(c_2) + v(D_A, D_B)$$

where D_i is the amount of deposits in bank $i, i = A, B$. For simplicity, we follow Matutes and Vives (2000) and restrict ourselves to a quadratic function:

[19] Market power may be partly created by regulation (entry and branching restrictions, interest rate ceilings, etc.). It has been shown that deregulation and liberalization have increased competition and reduced bank profits. See Keely (1990) and Demirgüç-Kunt and Detragiache (1998). Other traditional factors may be crucial to explain banks' market power in the household and small business sector: geographic differentiation, specialization, customer-specific investments, etc.

$$v(D_A, D_B) = \alpha(D_A + D_B) - \frac{1}{2}\left(D_A^2 + 2\lambda D_A D_B + D_B^2\right)$$

where λ represents the degree of substitutability between deposits at the two banks, $0 < \lambda < 1$. As $\lambda \to 0$ then the two goods become independent and banks become monopolists. In the opposite extreme, as $\lambda \to 1$ then the two goods become perfect substitutes and (under interest rate competition) the market for deposits become perfectly competitive.

The timing of the game is the following. First, banks simultaneously set their deposit interest rates, and next investors choose how much to deposit into each bank and in investment funds. It is easy to show (see Appendix) that if bank owners face the same liquidity shocks as investors, then in equilibrium they offer deposit contracts with constant interest rates, $r_{i1}^d = r_{i2}^d = r_i^d$, and mutual funds also offer a constant interest rate: $r^M = \frac{2R}{1+R}$. As a result, investors' consumption profile is also constant over time: $c_1 = c_2 = c$. Thus, given (r_A^d, r_B^d), then investors choose (D_A, D_B) in order to maximize:

$$U = \frac{1+R}{R} u(c) + v(D_A, D_B)$$

subject to

$$c = r^M - \left(r^M - i_A^d\right) D_A - \left(r^M - i_B^d\right) D_B \tag{19}$$

where i^d denotes the after-tax deposit rate, i.e., $i_i^d = \left(1 - \tau^d\right) r_i^d$. The supply of deposits is obtained by inverting the first order conditions. For $i, j = A, B$, i$\neq j$:

$$D_i = a - b\Omega\left(r^M - i_i^d\right) + k\Omega\left(r^M - i_j^d\right) \tag{20}$$

where

$$\begin{aligned} a &\equiv \frac{\alpha}{1+\lambda} \\ b &\equiv \frac{1}{1-\lambda^2} \\ k &\equiv \frac{\lambda}{1-\lambda^2} \\ \Omega &\equiv \frac{1+R}{R} u'(c) \end{aligned}$$

For convenience we assume, that banks are relatively large to be able to affect interest rates, but sufficiently small not to affect investors' consumption.[20] Thus, the supply of deposits to bank i increases with the deposit rate set by bank i and decreases with the deposit rate set by the rival bank. In case of identical deposit rates, the aggregate supply of deposits decreases with the difference between the return on investment funds, r^M, and the return on deposits, i^d. Such a margin depends on three factors: intermediation costs, μ, taxes, and monopoly power. If the margin is zero then investors put all their funds in bank deposits. As the margin increases, the aggregate supply of deposits decreases. I assume that banks need to set a positive deposit rate in order to attract a positive amount of deposits, i.e.,[21]

Assumption 7

$$a - (b - k)\, r^M \Omega < 0$$

If we plug equation 20 into 19 then we get consumption as a function of the deposit rates. In case of equal deposit rates, $i_A^d = i_B^d \equiv i^d$, we have that:

$$c = r^M - 2\left(r^M - i^d\right)\left[a - (b - k)\,\Omega\left(r^M - i^d\right)\right]$$

Notice that a higher deposit rate may increase or decrease consumption. The reason is that a higher deposit rate, on the one hand, reduces the opportunity cost of deposits and induces investors to demand more transaction services at the cost of lower consumption (substitution effect), on the other hand, it expands the feasible set which tends to increase both, the demand for transaction services and the demand for real consumption (income effect).

It is also shown in the Appendix that if bank owners are subject to the same liquidity shocks that investors (have the same preferences on financial returns) then the banks' expected return out of deposits is equal to $r^M =$

[20] We can think of the representative investor as a coalition of multiple agents, each one in charge of a small fraction of total savings and instructed to maximize the coalition's objective function, anticipating that all returns are pooled before consumption takes place. This is somewhat analogous to the celebrated assumption in Lucas (1990).

[21] This is actually an assumption on the marginal utility of consumption, since this is equivalent to $4u'(c) > 1 + \lambda$.

$\frac{2R}{1+R}$. Thus, given the interest rate set by other banks, r_j^d, and the tax rate on deposits, τ^d, bank i chooses r_i^d in order to maximize:

$$\pi_i = \left[r^M - \mu - r_i^d\right] D_i\left(r_i^d, r_j^d\right)$$

where $D_i\left(r_i^d, r_j^d\right)$ is given by equation 20 .

Evaluating the first order condition at the symmetric equilibrium:

$$r^d = \frac{b\left(r^M - \mu\right)\left(1 - \tau^d\right) + (b-k)\, r^M - \frac{a}{\Omega}}{(2b-k)\left(1-\tau^d\right)} \tag{21}$$

Notice that Ω depends on c, and hence on r^d. Therefore, the effect of τ^d on r^d and i^d is complex. The direct effect of τ^d on i^d is clearly negative. However, if a higher tax implies lower consumption, and hence higher Ω, the indirect effect has a positive sign. Nevertheless, in the Appendix it is shown that the direct effect always dominates the indirect effect and hence:

$$\frac{di^d}{d\tau^d} < 0$$

A direct implication of this result is that a tax on deposits reduces the level of deposits:

$$\frac{dD}{d\tau^d} < 0$$

Similarly, because of Assumption 7, the direct effect of τ on r^d is positive, but if a higher tax implies higher consumption the indirect effect is negative. In this case, in the Appendix it is shown that for some parameter values the indirect effect dominates. In general, the direct effect dominates provided the difference between the return on investment funds, r^M,and the return on deposits, i^d, is not too large. In other words, it is more likely that $\frac{dr^d}{d\tau^d} > 0$ if intermediation costs and the tax rate are not too large, and banks do not have too much monopoly power.[22]

Deposit taxes unambiguously reduce investors' utility, since they reduce the after-tax deposit rate and hence investors' feasible set shrinks. The

[22] In the limit as λ goes to one (Bertrand competition) the deposit rate converges to $r^M - \mu$ (the perfectly competitive deposit rate), and hence $\frac{dr^d}{d\tau^d} = 0$, and taxes fall entirely on investors.

effect of taxes on banks' profits is less straightforward. In the case that $\frac{dr^d}{d\tau^d} > 0$, clearly taxes reduce bank profits since the supply of deposits faced by each bank shifts downwards. In the case $\frac{dr^d}{d\tau^d} < 0$, there is the possibility that softer rate competition more than compensates the decrease in the aggregate supply of deposits, and as a result bank profits increase rather than decrease with taxes. However, this is highly unlikely, since taxes reduce deposit rates only if banks have sufficient monopoly power, so that the strategic complementarity effect (the reduction in rate competition) is not an important determinant of bank profits. In other words, for most parameter values a tax on deposits falls on both investors and banks.

Proposition 9 *A tax on deposits unambiguously decreases the net interest rate received by investors and hence it reduces the amount of deposits. If the interest margin is not too large (which occurs as a combination of low intermediation cost, low tax rate and low monopoly power) then it increases the deposit rate paid by banks. As a result, the burden of the tax is shared by investors and bank owners.*

Notice that in this case a small tax has a first-order effect on welfare since in the absence of taxation the level of deposits is too low because of banks' monopoly power. However, the model may be abstracting from other important distortions. For instance, Whitesell (1992) argues that since one of the alternatives to bank deposits, cash, is typically taxed by inflation, in the absence of bank specific taxes the level of deposits may actually be too high.

Let us now turn to corporate income taxation. The analysis is similar than in the case of perfect competition. In particular, monopoly rents after taxes are given by:

$$\pi^B = (1-\tau^c)\,L\left[r^l - m - R\left(1-\eta+\frac{\eta}{1-\tau^c}\right)\right] + D\frac{R+1}{2}\left(r^M - r^d - \mu\right)$$

Therefore, the incentives to set deposit rates are unchanged. Hence, the corporate income tax is a tax on pure economic profits. At the same, as discussed in Section 4, corporate income taxation distorts loan rates. In other words:

Proposition 10 *If capital requirements are binding, a tax on banks' corporate income is equivalent to a tax on both economic profits and loans. Thus, it raises the loan rate and reduces bank profits.*

Similarly, a value-added tax under the same conditions of Section 4 is a tax on deposits and hence it distorts the deposit rate. The burden of the tax tends to be shared by bank owners and investors.

6.2 Monopoly power in the loan market

Suppose that all entrepreneurs have access to the securities market but the loan market is segmented in such a way that each entrepreneur can only borrow from a particular bank.[23] Thus, banks do not interact with each other and the only limit to their market power comes from the securities market. As discussed in Section 3, provided $p \geq p_0$ entrepreneurs can get credit in the securities market at the rate $\frac{R}{p}$ and will select the risky project. Hence, monopolistic banks will find it optimal to set an interest rate r^l that leaves the entrepreneur (with $p \geq p_0$) indifferent between borrowing from the bank or from the securities market:

$$X - \frac{r^l}{1-\tau} = p\left(X - \frac{R}{p}\right) + \phi\,(1-p) - f \tag{22}$$

that is

$$\frac{r^l}{1-\tau} = (1-p)\,(X-\phi) + R + f$$

provided such loan rate is above the average cost, i.e., $r^l \geq R + m$.[24] In other words, a bank lends to entrepreneurs at the rate given by equation 22, if and only if $p_0 \leq p \leq p^*$, where p^* is given by:

$$p^* = 1 - \frac{\tau R + m - (1-\tau)\,f}{(1-\tau)\,(X-\phi)} \tag{23}$$

Notice that equations 10 and 23 are identical. Since banks can price discriminate (to the same extent that markets do) then monopoly power does not involve any additional distortion and only affects the distribution of surplus between banks and entrepreneurs. Taxes have the same distortionary effects analyzed in Section 4. Also, notice from equation 22 that

[23] One possible justification could be that banks and entrepreneurs have been engaged in a long-run relationship and at a point in time the incumbent bank has an advantage in monitoring previous customers, which is sufficiently large to imply complete segmentation of the loan market.

[24] For those borrowers with $p < p_0$ the monopolist will set a loan rate $r^l = (1-\tau)\,X$.

the loan rate paid by entrepreneurs, $\frac{r^l}{1-\tau}$, is independent of the tax rate. Hence, only the marginal entrepreneurs are affected by taxation (they are induced to switch to market financing) but the bulk of the tax falls on bank owners. Consequently, we obtain the following result:

Proposition 11 *The effect of loan taxation on entrepreneurs' choice of credit is the same under perfect competition and monopoly. Thus, a small tax rate has a second order effect on welfare and, moreover, the burden of the tax falls exclusively on bank owners.*

The above proposition may have important implications for the design of optimal taxes.[25] Under perfect competition and constant returns to scale taxing intermediaries is dominated by other forms of taxation (Diamond and Mirreless, 1971). However, if banks are local monopolists and able to price discriminate, then a tax on bank loans may be part of the optimal tax system, since it is a tax on pure economic profits and a small rate has only second order effects on welfare (Caminal, 1997).

The relationship between monopoly power and the allocation of monitoring effort could be affected by a double moral hazard problem (Holmstrom and Tirole, 1997; Besanko and Kanatas, 1993). If banks can not commit ex-ante to monitor borrowers then they need to be given incentives to exert efficient levels of monitoring effort. Inside capital is one possible source of incentives. Monopoly power is another one (Caminal and Matutes, 1997). In the latter case if taxation falls on bank owners then incentives to monitor may be jeopardized.

7 Bank solvency

It is commonly agreed that banks' moral hazard is one of the relevant factors behind banking failures. Because of limited liability, and amplified by risk-insensitive deposit insurance, bank owners wish to take excessive risk. Direct supervision is not sufficient, and solvency requirements force banks to take on more capital, which involves a higher cost. It has been

[25] As in the case of perfect competition, in this context a tax on banks' corporate income provided capital requirements are binding is equivalent to a tax on bank loans. Also, a tax on banks' value-added, under the same conditions of Section 4, is exclusively a tax on deposits.

suggested that an efficient complementary measure is to protect banks' profits either by relaxing competition policy in banking (Perotti and Suarez, 2001) or by setting deposit interest rate ceilings (Hellmann et al, 2000). The relationship between market structure and risk taking has been well documented empirically.[26] When banks' moral hazard problem is binding, then taxation is likely to affect incentives to prudent behavior. However, different types of taxes may have different effects on risk taking attitudes. Let us illustrate this point.

Let us introduce the following changes in the version of the model analyzed in Section 6.1. First, deposit interest rates are set by the authorities. Second, banks can invest in two types of long-run assets. A safe asset yields at time $t = 2$ a rate of return equal to R with probability one. Instead, a risky asset yields at time $t = 2$ a rate of return equal to γ with probability θ, and 0 with probability $1 - \theta$.

Assumption 8:

$$\gamma > R > \theta\gamma$$

Thus, the risky asset yields a higher return in case of success although from an ex-ante point of view it is dominated by the safe asset (lower expected return and higher risk).

Investors are not concerned about banks' investment policies because we assume that deposits are protected by a flat-fee deposit insurance system. For simplicity (and this is the third departure from the model of Section 6), bank owners are risk neutral and only care about consumption at $t = 2$.

Suppose that the government sets a binding deposit rate ceiling, which is constant overtime, $\overline{r^d} < r^M - \mu$. If at time $t = 1$ banks do not pay back $\overline{r^d}$ to impatient consumers then the bank is intervened and owners obtain zero. Hence, it is a dominant strategy for banks to invest in short-term assets such that they can meet their payment obligations at time $t = 1:$

$$1 - \beta = \frac{1}{2}\left(\overline{r^d} + \mu\right)$$

[26] Keely (1990) blames the decline of charter values due to liberalization and deregulation for the increase in failures in the US banking industry since the 1980's. Demirgüç-Kunt and Detrigiache (1998) also points at liberalization as one of the factors that explain banking crises in a large set of countries. Inappropriate regulation accompanying liberalization seems to aggravate crises.

Banks can still choose whether to allocate the rest of the funds to the safe or to the risky asset. In case of prudent behavior the amount of profits per unit of deposits is given by:

$$\pi^P = R\beta - \frac{\overline{r^d} + \mu}{2} = R - \frac{R+1}{2}\left(\overline{r^d} + \mu\right)$$

If a bank chooses to invest in the risky asset, then expected profits per unit of deposits is:

$$\pi^R = \theta\left[\gamma\beta - \frac{\overline{r^d} + \mu}{2}\right] = \theta\left[\gamma - \frac{\gamma+1}{2}\left(\overline{r^d} + \mu\right)\right]$$

Hence, banks choose prudent behavior if and only if $\pi^P \geq \pi^R$, i.e.,:

$$\overline{r^d} \leq \frac{2\left(R - \theta\gamma\right)}{R - \theta\gamma + 1 - \theta} - \mu \equiv \overline{r} - \mu < r^M - \mu$$

Thus, if the interest rate ceiling is below the threshold level, $\overline{r} - \mu$, then the bank chooses to invest in the safe asset, otherwise they take excessive risk. Since the threshold level is strictly below the competitive return on deposits, this implies that the regulator faces a trade-off: either to grant banks a certain level of profits at the cost of lowering deposit rates and transaction services, or to induce banks to take excessive risk.

Let us now consider the effect of a tax on deposits. Taxes and rate ceilings can be combined in two different ways. First, the ceiling can be set on the rate that banks pay, $\overline{r^d}$ in our notation. In this case, clearly a tax falls entirely on investors and it does not affect banks' risk taking incentives. Second, the ceiling can be set on the rate that investors receive, $\overline{i^d} = \left(1 - \tau^d\right) r^d$. In this case, the tax falls entirely on banks and if the following condition holds:

$$\frac{\overline{i^d}}{1 - \tau^d} > \overline{r} - \mu \geq \overline{i^d}$$

then taxes induce risk taking.

In the case that deposit rates are freely determined, a tax on deposits would tend to fall on both investors and bank owners. As in Hellman et al. (2000) the reduction in profits induce banks to take excessive risk,[27]

[27] However, there is a countervailing effect. Lower bank rents may discourage bank monitoring and increase credit rationing. As a result, banks' portfolios may be less exposed to aggregate risk. See Caminal and Matutes (2002). The relation between market structure, regulation and financial fragility is also studied in Matutes and Vives (1996 and 2000).

although the analysis becomes more tedious because of the income effect in the supply of deposits.

Let us now consider a tax on banks' corporate income. In the absence of capital requirements banks will choose to hold zero capital[28] and the returns from prudent and risky behavior will be respectively:

$$\pi^P = (1-\tau^c)\left[R - \frac{R+1}{2}\left(\overline{r^d}+\mu\right)\right]$$

$$\pi^R = (1-\tau^c)\,\theta\left[\gamma - \frac{\gamma+1}{2}\left(\overline{r^d}+\mu\right)\right]$$

Clearly, risk behavior is unaffected by taxation of banks' corporate income.[29] The next proposition summarizes the main message of this section.

Proposition 12 *Whenever bank solvency requires positive economic profits, taxation may induce excessive risk taking. For instance, a tax on deposits that increases banks' costs of funds will make riskier portfolios relatively more attractive. However, a proportional tax on pure economic profits is neutral with respect to risk.*

Thus, if the main priority of the government is to preserve bank solvency, a tax on deposits must be accompanied by a change in regulation. There are two main options (a) higher capital requirements and (b) additional market power. Capital requirements may not be efficient and sometimes it may even induce higher risk-taking.[30] Alternatively, the government can grant banks more monopoly power (through additional entry and branching restrictions, softer competition policy, rate regulation, and so on). In other words, if the social costs of banking failures are sufficiently large, then it may be optimal to allow banks to make a certain amount of profits, which implies that a tax on deposits must go along additional regulatory changes. As a result, the burden of taxation falls exclusively on banks' customers.

[28]The argument below is robust to the introduction of capital requirements. More specifically, capital requirements are likely to reduce risk taking, but their presence do not alter the neutrality of a tax on profits.

[29]In general the treatment of loss offsets may affect banks' risk taking behavior. However, in this particular model, if the tax law allows a rebate in case of default, nothing changes since bank owners can not appropriate the rebate.

[30]See Hellmann et al. (2000) and references quoted there.

8 Discussion

8.1 Separability between loans and deposits revisited

8.1.1 How realistic is separability?

The incidence of bank taxation depends on whether there is separability between loans and deposits, i.e., whether conditions in one of the markets affect equilibrium prices in the other. The model developed in this paper makes a heavy use of the separability hypothesis. In particular, in the model banks have access to a safe investment technology, which represented simultaneously the expected return of the funds collected through deposit contracts, and the opportunity cost of the loans to entrepreneurs. This was a convenient artifact that requires further discussion.

The literature tends to identify separability with the following set of conditions:[31]

(a) banks are able to borrow and lend in a perfect bond market at an exogenous interest rate. This is the case, for instance, if there is an organized interbank lending market, whose interest rate is fixed either by monetary authorities or by arbitrage with international capital markets.

(b) the costs of granting loans and capturing deposits are additively separable. In other words, the marginal cost of loans are independent of the level of deposits, and viceversa.

(c) the supply of deposits and the demand for loans are independent.

(d) banks' probability of failure is zero.

Clearly, these conditions are quite restrictive. If the banking industry is an oligopoly and the economy is closed (or capital mobility is imperfect) then (a) may not hold. Also, there may be economies of scope and (b) may fail. Finally, Dermine (1986) shows that if the bank's probability of failure is positive, there is deposit insurance and banks enjoy limited liability then the (monopolistic) bank's optimization problem ceases to be separable. The reason is that a higher deposit rate increases the probability of default, which reduces the cost of lending one additional unit.[32]

[31] See Freixas and Rochet (1997) for a more detailed discussion.

[32] If banks offer 'tied-up contracts' (consumers can obtain credit from a bank only if they deposit their cash in the same bank, or if they get a lower loan rate if they do so) then (c) fails. Chiappori et al. (1995) show in the context of Salop model that in an unregulated banking sector this type of contract would never emerge, but it does if deposits are subject to interest rate ceilings (in this case banks are willing to subsidize credit).

8.1.2 Tax analysis in the absence of separability

The above discussion suggests that many real world situations are likely to deviate in various dimensions from separability. Nevertheless, I will argue that a model assuming separability may be more useful than it might appear at first sight. The reason is that simultaneous deviations may compensate each other to some extent.

Let us first consider the interaction between loans and deposits through costs. In particular, let us assume that monitoring costs are reduced with the level of deposits, i.e., m is a function of D, with $m'(D) < 0$. This may be explained by the fact that banks use information from deposits in their loan granting decisions (Fama, 1985).[33] In this case, the effects of a tax on deposits would clearly spillover into the loan market. In particular, an increase in the deposit tax rate would depress deposits (unless investment funds are absent and bank deposits dominate direct investment), which would increase monitoring costs. As a result, loan rates would increase and some entrepreneurs would turn to the securities market to get their funding.

Let us now consider the case of bankruptcy risk. Because of limited liability banks perceive a lower cost of funds as the probability of bankruptcy increases. As a result, banks become more aggressive in the credit market, pricing their loans at lower rates. In this context a tax on deposits falls partially on bank profits (the ex-ante deposit rate increases) and hence the probability of bankruptcy increases, which pushes loan rates downwards.

Thus, if both channels operate at the same time, it is unlikely that a tax on deposits leaves loan rates unaffected, but the size of the effect may be small and, more importantly, of ambiguous sign.[34]

8.2 Empirical evidence on the effect of taxation

The empirical evidence on the effects of bank taxation is rather fragmented. The most important cross-country study we are aware of is Demirgüç-Kunt and Huizinga (1999). Unfortunately, their information on the shape of the

[33] See also Mester et al. (1998) for empirical evidence.

[34] If the interest rate on the safe asset is determined by domestic supply and demand conditions, and in the absence of government intervention, then a tax on deposits will tend to increase the loan rate. The size of this effect depends on the elasticity of savings with respect to their average return and on the weight of deposits in total savings.

implicit and explicit tax schedules is rather imprecise; particularly, in the former case. They find that reserves reduce interest margins and profits, especially in less developed countries, which may reflect the fact that the opportunity cost of reserves (the implicit tax) is higher in less developed countries. They also present evidence favorable to a complete pass-through of corporate income tax to bank customers. In fact, their regression analysis shows that both interest margin and profitability increase with the tax on corporate income.

There exist previous empirical studies on the incidence of reserve requirements. Bartuneck and Madura (1996) study the effects of two unique reserve requirement adjustment in the early 1990's. The results indicate that not all of the benefit from the reduction in the implicit tax resulting from the lowering of reserve requirements was passed on to depositors and borrowers. The larger banks tended to experience strong favorable valuation effects.[35]

The existing evidence on the incidence of reserve requirements (Bartuneck and Madura, 1996) seems compatible with the results of Section 6.1. Provided size is positively related to market power, shareholders of large banks are expected to capture a larger share of the benefits from the reduction in reserve requirements. Depositors are also expected to benefit from such a reduction.

However, the evidence on banks' corporate income taxes (Demirgüç-Kunt and Huizinga, 1999) does not fit well into the picture. First, the positive effect of taxation on profitability is difficult to reconcile with any sensible economic model. Second, the complete pass-through result suggests that banking is a perfectly competitive industry (otherwise such a tax would fall on economic profits), which is at odds with most of the evidence.

8.3 Macroeconomic implications

The fact that reserve requirements are an implicit form of taxation has long been recognized.[36] Such a requirement induces banks to hold a higher fraction of their deposits in the form of non-interest-bearing reserves, which reduces the average return of banks' portfolios and increases their demand for

[35] See also Osborne and Zaher (1992) for similar evidence. The earlier studies on the incidence of reserve requirement are discussed in Dermigüç -Kunt and Huizinga (1999).

[36] See, for instance, Fama (1980).

monetary base. Thus, the reserve requirement operates as a tax by increasing seigniorage revenue (by expanding the base of the inflation tax). More specifically, under certain assumptions a reserve requirement is equivalent to a proportional tax on deposits plus an open market sale of government bonds of an amount equivalent to the volume of resources kept captive by the requirement (Romer, 1985; and Bacchetta and Caminal, 1994).

Thus, our non-monetary model was unable to accommodate a precise description of reserve requirements and hence the interaction between banking activity, inflation and the government budget constraint was missing. This is an important limitation at least for two reasons. First, in practice inflation is only imperfectly controlled by monetary authorities. As a result, the implicit tax is likely to have an arbitrary (random) component. Second, the inflation tax affects not only bank deposits but also one of their imperfect substitutes: cash. Thus, a complete analysis of the effect of reserve requirements on the level of deposits should consider how inflation and reserve ratios affect the choice between cash and deposits, otherwise the welfare implications may be misleading (Whitesell, 1992). In particular, if we interpret reserve requirements as a tax on deposits then our model is likely to overstate their distortionary effects.

A related issue is the modelling of transaction services. This is bound to be important for a normative analysis but not so much for the positive analysis we conduct in this paper. We have modelled transaction services provided by banks as an argument of investors' utility function: as an additional consumption good. Alternatively, we could have assumed that deposits reduce transaction costs. Results on optimal taxation may strongly depend on such a choice.[37]

The model analyzed in this paper has focused on the role of banks in the allocation of savings and abstracted from the substitutability between capital and labor and from the determination of the level of savings. In dynamic general equilibrium models capital taxation creates a gap between the rate of return on savings and the marginal product of capital. The optimality of capital income taxation depends on various circumstances. In infinitely-lived representative consumer models it is well known that capital income taxes can not be part of the optimal tax system in steady state (Chamley, 1986).[38] Bank taxes are also capital income taxes and on

[37]See, Kimbrough (1989) and Chia and Whalley (1999).

[38]Results are different if agents have finite horizons (Erosa and Gervais, 2001).

top of that they affect the efficiency of the allocation of funds to various investment opportunities. Thus, if we incorporate our model in a standard general equilibrium framework then we expect to obtain the same results than under standard capital income taxes augmented by the additional distortionary effects that we have identified.[39]

There is another literature, both empirical and theoretical, that relates financial intermediation and long-run growth. Some of these models characterize banks as institutions that either provide liquidity services or alleviate informational asymmetries.[40]. In some cases, the engine of growth is a capital externality à la Romer, and in others is innovation effort. Once again, we can describe the role of banks as reducing the gap between the return on savings and the marginal return on investment. Externalities in R+D or in capital accumulation transform level effects into growth effects. The empirical evidence is compatible with a positive relationship between financial development and economic growth, although it is more difficult to establish the direction of causality.[41] Overall, this literature suggests that bank taxation could have negative implications for long-run growth.[42]

9 Concluding remarks

In this paper we have developed a theoretical framework to analyze the impact of various forms of taxation. Banks have been characterize as intermediaries able to perform three main functions: asset transformation, provision of transaction services and monitoring. Investors can directly access security markets, but the resulting portfolios are relatively illiquid. Also, they may or may not have access to investment funds, which also perform an asset transformation function. On the other side of market, some entrepreneurs may have access to security markets (unmonitored credit),

[39] Some of the literature on banking in general equilibrium has focused on the role of banks on the propagation of shocks and on the transmission of monetary policy. See, for instance, Smith (1998) and Fuerst (1994). From an international perspective, the ability to tax the banking industry may be drastically reduced after the liberalization of the domestic financial system. See Bacchetta and Caminal (1992).

[40] An example of the first type is Bencivenga and Smith (1991). Greenwod and Jovanovic (1990) and De la fuente and Marín (1996) belong to the second group.

[41] Levine (1997) provides an excellent survey of the main theoretical arguments as well as of the empirical evidence.

[42] See Roubini and Sala-i-Martín (1995) for a model with this type of result.

but those entrepreneurs with high risk projects prefer information-intensive credit (bank loans) over uninformed credit (commercial paper). The total amount of funds is exogenous, and hence the model focuses on the allocation of those funds among alternative financial arrangements. The main results can be stated as follows:

a) Under certain conditions, the loan and deposit markets are separable, and hence a tax on deposits does not affect neither loan rates nor monitoring activity. Similarly, a tax on loans does not affect neither deposit rates nor the provision of transaction services and liquidity insurance. The benchmark case where all these conditions are met may be more useful than it appears at first sight since multiple deviations from the benchmark may partially compensate each other. Some of the results listed below presume that separability holds.

b) If borrowers are VAT-registered firms and investors are not then a value-added tax is equivalent to a tax on deposits. If loans and bank capital are complementary (which occurs, for instance, when capital requirements are binding) then a tax on banks' corporate income is equivalent to a tax on both economic profits and loans.

c) A tax on deposits tends to reduce the level of deposits and increase direct investment and/or investment fund holdings. As a result the level of transaction services is reduced and, if investment funds do not exist, investors enjoy a lower level of liquidity insurance. In the absence of investment funds, it may be the case that deposits dominate direct investment and a small tax rate does not create any distortion. Imperfect competition in the deposit market has two effects. First, it distorts the laissez-faire equilibrium and hence even a small tax rate has a first order effect on total welfare. Second, taxes fall partially on economic profits which alleviates the tax burden of investors (and potentially it reduces the distortion on savings decisions).

d) A tax on bank loans reduces the amount of lending and monitoring effort and induces more firms to borrow on the securities market. The size of the distortion is likely to increase with the efficiency of the securities market. The effect of banks' market power in the loan market are similar to those in the deposit market, except that banks' ability to price discriminate is higher in this market. In the extreme case that individual banks compete exclusively with capital markets then a tax on bank loans may fall exclusively on bank owners.

e) A general tax on capital income reduces the level of deposits, since investors' willingness to pay for banks' transaction services increase with their disposable income.

f) A tax on deposits may induce banks to invest in riskier portfolios. If bank solvency is the top priority then such a tax must be introduced only if at the same time banks are given more monopoly power. In this case the tax would fall entirely on banks' customers.

Summarizing, bank taxation increases the gap between the marginal return on investment and the marginal return on savings (like general capital income taxation), and on top of that it tends to reduce the efficiency of the transformation of savings into investment by reducing banks' contribution. However, in case banks' market power is excessive (i.e., beyond the level required by the goal of preserving the stability of the banking system) then the overall distortion associated to bank taxation may substantially shrink.

One important limitation of the current discussion is that we have overlooked tax enforcement problems. In particular, if foreign financial intermediaries are available then evasion could be relatively easy and the impact of taxing domestic financial intermediaries may be substantially altered.[43] On the other hand, taxes on financial intermediaries may induce more cash transactions, reduce financial records within intermediaries, and make more costly for tax authorities monitoring firm income. This may undermine the collectibility of other taxes. These issues are beyond the scope of this paper.

Other extensions of the current framework appear to be fruitful. First, a complete welfare analysis of the desintermediation effects of taxation requires an explicit consideration of alternative means of payment (cash) and potential informational spillovers from bank monitoring to security markets. Second, it would be nice to transform the current model into a building block of a standard dynamic general equilibrium model in order to develop a more complete picture of the aggregate effects of taxation.

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[43]See also footnote 39.

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11 Appendix

11.1 Market clearing under direct investment

At time $t = 0$ an amount of funds IN are invested in long-term assets. All entrepreneurs with $p \leq p_0$ obtain financing if the following condition holds:

$$1 - H(p_0) = L < IN$$

We do not need to worry about market clearing in the secondary market since both buyers and sellers are indifferent between trading in the secondary market and in alternative assets. However, it is important that claims on entrepreneurs' projects are not liquidated. In particular, we require that:

$$\frac{1}{2} R\left[1 - H(p_0)\right] < \frac{1}{2} N(1 - I)$$

The left hand side is the amount of claims on entrepreneurs' projects that must be sold in the secondary market and the right hand side is the total demand for claims. In the text it has been shown that $I > 0$. Also, if consumers' degree of risk aversion is not too small then $I < 1$. In other words, investors always have a diversified portfolio (they hold both short term and long term assets). Therefore, provided N is large enough the above two conditions will be satisfied.

11.2 The objective function of oligopolistic banks

Suppose that bank shareholders are subject to the same liquidity shocks than investors, i.e., half of shareholders will turn out to be impatient and the other half will turn out to be patient. In order to accomodate such liquidity shocks it can be arranged that patient shareholders buy the shares of those who claim to be impatient at time $t = 1$ at a prespecified price. Let π_1 denote the payment received by impatient shareholders per unit of deposits. Thus, each impatient shareholder of bank i receives $2\pi_1 D_i$. Similarly, let π_2 denote the payment received by patient shareholders per unit of deposits at time $t = 2$, i.e., each patient shareholder receives $2\pi_2 D_i$. If bank i committs to pay depositors $\left(r_{i1}^d, r_{i2}^d\right)$ then must invest a fraction $1 - \beta$ on short-term assets:

$$1-\beta=\frac{1}{2}\left(r_{i1}^{d}+\mu\right)+\pi_1 \tag{24}$$

Also, the budget constraint at time $t=2$ determines residual profits:

$$\pi_2=\beta R-\frac{1}{2}\left(r_{i2}^{d}+\mu\right) \tag{25}$$

Solving equation 24 for β and plugging it into equation 25 , we obtain the shareholders' intertemporal budget constraint:

$$\pi_2=R\left(1-\frac{r_{i1}^{d}}{2}-\frac{r_{i2}^{d}}{2R}-\pi_1\right)-\frac{R+1}{2}\mu \tag{26}$$

Under the assumption that banks can not affect investors' consumption (see footnote 18) and if other banks and investment funds sets constant interest rates, then the supply of funds to bank i is given by:

$$D_i=a-bu'\left(c^{d}\right)\left(\Delta_{i1}+\frac{1}{R}\Delta_{i2}\right)+k\frac{R+1}{R}u'\left(c^{d}\right)\Delta_j \tag{27}$$

where c^d is the constant level of consumption by investors, $i\neq j$, and

$$\Delta_{it}=r^{M}-(1-\tau)\,r_{it}^{d}$$

Finally, if $\Delta_{i1}=\Delta_{i2}$ then such a constant level is denoted by Δ_i.

Thus, given the constant interest rate set by the rival bank, r_j^d, bank i's shareholders choose $r_{i1}^d, r_{i2}^d, \pi_1$ and π_2 in order to maximize:

$$U=u\left(c_1^s\right)+\frac{1}{R}u\left(c_2^s\right)$$

where

$$\begin{aligned} c_1^s &= 2\pi_1 D_i \\ c_2^s &= 2\pi_2 D_i \end{aligned}$$

and subject to budget constraint 26 and D_i given by equation 27. From the first order conditions it follows that:

$$r_{i1}^{d}=r_{i2}^{d}=r_i^{d}$$

$$\pi_1 = \pi_2$$

As a result, bank i's shareholders also enjoy a constant level of consumption, given by:

$$c^s = \left(r^M - \mu - r_i^d\right) D_i$$

This expression is the starting point of the analysis in the text. Notice that the above time structure of shareholder returns makes the plan incentive compatible, since patient shareholders have no incentive to pretend to be impatient.

11.3 Taxation and the oligopolistic deposit rate

It has been assumed that individual banks can not affect aggregate consumption, but clearly taxes do affect consumption. Thus, the effect of taxes on the deposit rate can not be computed by simply taking the partial derivative in equation 27.

Let $v_i\left(D_A, D_B\right)$ denote the partial derivative with respect to D_i, then:

$$v_i\left(D_A, D_B\right) = \alpha - D_i - \lambda D_j$$

where $i \neq j$. We can adapt our previous assumption on the saturation point, by assuming that in a symmetric allocation the marginal utility of investing all the funds in deposits is zero:

$$v_i\left(\frac{1}{2}, \frac{1}{2}\right) = \alpha - (1+\lambda)\frac{1}{2} = 0$$

Hence, $a = \frac{1}{2}$.

The equilibrium level of consumption in a symmetric equilibrium can be written as:

$$c = r^M - 2\left(r^M - i^d\right) D \tag{28}$$

where D is the level of deposits at each bank, i.e.:

$$D = a - (b-k)\frac{1+R}{R}u'(c)\left(r^M - i^d\right) \tag{29}$$

Totally differentiating equations 28 and 29 and solving, we get:

$$\frac{dc}{di^d} = \frac{2\left[a - 2\left(b-k\right)\frac{1+R}{R}u'\left(c\right)\left(r^M - i^d\right)\right]}{1 - 2\left(b-k\right)\frac{1+R}{R}u''\left(c\right)\left(r^M - i^d\right)^2} \tag{30}$$

The denominator is positive but the sign of the numerator is ambiguous. A change in the after-tax interest rate makes the relative price of deposits cheaper (substitution effect) which induces less consumption, but also expands the feasible set (income effect) which induces higher consumption.

From equation 21 in the text, we have that

$$i^d = \frac{b\left(r^M - \mu\right)\left(1 - \tau^d\right) + \left(b-k\right)r^M - \frac{a}{\Omega}}{\left(2b-k\right)} \tag{31}$$

Applying the implicit function theorem to this equation we can compute the effect of taxation on the after tax interest rate:

$$\frac{di^d}{d\tau^d} = \frac{-b\left(r^M - \mu\right)}{\left(2b-k\right) - \frac{au''(c)}{\Omega}\frac{dc}{di^d}}$$

Using equation 30, we can show that the denominator has a positive sign:

$$\left(2b-k\right)\left[1 - 2\left(b-k\right)\frac{1+R}{R}u''\left(c\right)\left(r^M - i^d\right)^2\right] -$$

$$-\frac{2au''\left(c\right)}{\Omega}\left[a - 2\left(b-k\right)\Omega\left(r^M - i^d\right)\right] > 0$$

The first three terms are positive and the fourth is negative. However, the sign of the last three terms is equal to the sign of:

$$\Gamma \equiv \frac{a^2}{\Omega} + \left(b-k\right)\left(2b-k\right)\frac{1+R}{R}\left(r^M - i^d\right)^2 - 2a\left(b-k\right)\left(r^M - i^d\right)$$

Since

$$u'\left(c\right) < 1 + \lambda < \frac{2-\lambda}{1-\lambda} \equiv \frac{2b-k}{b-k}$$

we have that:

$$\Gamma > \left(a\sqrt{\frac{R}{1+R}} - \left(r^M - i^d\right)\sqrt{(b-k)(2b-k)\frac{1+R}{R}u'(c)}\right)^2 > 0$$

Therefore, it has been shown than a higher tax rate implies a lower after-tax deposit rate.

Let us turn now to the effect of taxation on the pre-tax deposit rate, r^d. Totally differentiating equation 21 with respect to r^d, c and τ we get:

$$dr^d = \frac{(b-k)\, r^M - \frac{a}{\Omega}}{(2b-k)\,(1-\tau^d)^2} d\tau + \frac{\frac{a}{\Omega}\frac{u''(c)}{u'(c)}}{(2b-k)\,(1-\tau^d)} dc$$

From the definition of i^d we have that:

$$dc = \frac{dc}{di^d}\left[\left(1-\tau^d\right) dr^d - r^d d\tau^d\right]$$

where $\frac{dc}{di^d}$ is given by equation 30. Hence:

$$\frac{dr^d}{d\tau^d} = \frac{M_0}{M_1}$$

where:

$$\begin{aligned} M_0 &\equiv \frac{(b-k)\, r^M - \frac{a}{\Omega}}{1-\tau^d} - \frac{a}{\Omega}\frac{u''(c)}{u'(c)} r^d \frac{dc}{di^d} \\ M_1 &\equiv (2b-k)\left(1-\tau^d\right) - \frac{a}{\Omega}\frac{u''(c)}{u'(c)}\left(1-\tau^d\right)\frac{dc}{di^d} \end{aligned}$$

Notice that if $\frac{dc}{di^d} > 0$, then $\frac{dr^d}{d\tau^d} > 0$. However, in principle the sign of $\frac{dc}{di^d}$ is ambiguous. In fact, such ambiguity is easily translated into the sign of $\frac{dr^d}{d\tau}$. In general, from equation 31 we have that:

$$r^M - i^d = \frac{b\left[\tau r^M + (1-\tau)\,\mu\right] + \frac{a}{\Omega}}{2b-k} \tag{32}$$

Let us look at two extreme cases. First, suppose $\mu = \tau = 0$. If we plug equation 32 into equation 30, evaluated at $\mu = \tau = 0$, it can be checked that $\frac{dc}{di^d} > 0$, and hence $\frac{dr^d}{d\tau^d} > 0$. By continuity, provided μ and τ are not too large then a proportional tax on deposits raises the before-tax deposit rate.

Second, suppose that banks are monopolists, i.e., $\lambda = 0$, and consider the case $\tau^d = 0$. This implies that $b = 1$ and $k = 0$. As a result,

$$\frac{dc}{di^d} = \frac{-2\Omega\mu}{1 - \frac{1+R}{2R}u''(c)\left(\mu + \frac{1}{2\Omega}\right)^2} < 0$$

The numerator of $\frac{dr^d}{d\tau}$ can be written as follows:

$$M_0 = r^M\left[1 - \frac{1}{4u'(c)}\right] + \frac{u''(c)}{u'(c)}\frac{\mu r^d}{1 - \frac{1+R}{2R}u''(c)\left(\mu + \frac{1}{2\Omega}\right)^2}$$

For any value of $\mu > 0$, there exists a utility function such that $4u'(c)$ is higher but arbitrarily close to 1. As a result, the first term is positive but arbitrarily small, while the second term is negative. In fact, as $4u'(c)$ goes to one, the first term goes to zero, while the second goes to strictly negative number.

Finally, the denominator of $\frac{dr^d}{d\tau}$ can be written as follows:

$$M_1 = 2 - \frac{u''(c)}{u'(c)}\frac{\mu}{1 - \frac{1+R}{2R}u''(c)\left(\mu + \frac{1}{2\Omega}\right)^2}$$

Therefore, provided $4u'(c)$ is close enough to one and μ is positive but not too large, then M_1 is positive and M_0 is negative. In this case, a higher tax rate induces a lower pre-tax deposit rate.