Costly State Monitoring and Reserve Requirements: A Quantitative Study in the Context of Southern European Countries

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Abstract
The paper explores one rationale behind the existence of financial repression, with the latter being represented through the obligatory reserve requirement of the banks, in the context of Southern European countries. Using an overlapping generation production-economy model, with asymmetric information between financial intermediaries and entrepreneurs, we try and answer whether at all these high reserve requirements are to discipline the banks besides being motivated to maintain a steady source of seigniorage revenue for the social planner. Seigniorage becomes relevant if tax evasion is prevalent. Results indicate that sizes of reserve requirements are contingent on the probability of banking crises and as to how the social planner weighs the welfare of the consumers relative to the entrepreneurs. Moreover, the results are qualitatively the same for alternative choices of parameters. Explicit taxation is found to be more relevant for countries with positive probability of crises, rather than seigniorage.

Journal of Economic Literature Classification: E44, E52, E58

Keywords: Reserve requirements; Tax evasion; Information Asymmetry in Financial Markets; Costly state verification.

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1 Introduction

The paper tries to explore one rationale behind the existence of financial repression. Note we follow Drazen (1989), Bacchetta and Caminal (1992), Haslag and Hein (1995), Espinosa and Yip (1996), Haslag (1998) and Haslag and Koo (1999), in representing financial repression through the “high” reserve deposit requirement. Motivation for modelling financial repression through “high” reserve requirements in these economies is purely data-driven and is vindicated by Tables 1, 2 and 3. The study attempts to assay whether there exists a plausible explanation as to why the reserve requirements in the economies of our concern, Greece, Italy, Portugal and Spain, are relatively higher compared to other developed European economies.¹

As can be seen from the first column of Table 1 shows that seigniorage, i.e., an implicit tax on monetary assets (mainly cash and bank deposits) yielding a return below market rates, has been traditionally an important source of public revenue in Italy, Spain, Greece, and Portugal, but is almost negligible for the other European Community (EC) countries. As pointed out by Bacchetta and Caminal (1992):

“The literature usually represents seigniorage as an inflation tax on cash holdings and neglects the role of financial intermediation.”² When banks are taken into account, however, another element of seigniorage is the ratio of required reserves on bank deposits held at the central bank. These reserves usually bear no interest or an interest well below the market rate. Thus an increase in reserve requirements broadens the tax base on

¹However, as will be realized since this is a general model, trying to analyze why reserve requirements vary across countries, our sample economies should be viewed more as examples. The analysis can be extended across any economy that is subjected to reserve requirements.

²See Spaventa (1989) for a survey of the literature. Fischer (1982) was among the first authors to revive the interest in seigniorage in the 1980s.
which the inflation tax is applied. Governments imposing seigniorage usually rely both on the level of inflation and on required reserves.”

Table 1: Seigniorage Revenue in some European Economies (1980-2002)

<table>
<thead>
<tr>
<th>Country</th>
<th>Seigniorage</th>
<th>Reserves/ Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(percentages of Deposits Inflation)</td>
<td>revenue) (percentage) rate</td>
</tr>
<tr>
<td>Spain</td>
<td>6.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>12.0</td>
</tr>
<tr>
<td>Greece</td>
<td>19.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>22.9</td>
</tr>
<tr>
<td>Italy</td>
<td>1.8</td>
<td>11.7</td>
</tr>
<tr>
<td>Portugal</td>
<td>6.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>17.5</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.0</td>
</tr>
<tr>
<td>France</td>
<td>0.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.0</td>
</tr>
<tr>
<td>Germany</td>
<td>1.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.6</td>
</tr>
<tr>
<td>UK</td>
<td>0.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.7</td>
</tr>
</tbody>
</table>


Seigniorage has been calculated from lines 14a and 14c.

Also see notes to Table 1.

<sup>a</sup>: Excludes the year 2002.
<sup>b</sup>: Excludes the years 1998-2002.
<sup>c</sup>: Excludes the years 1999-2002.

As can be observed from the columns 2 and 3 of Table 1, the Southern European countries have been using both inflation and reserve–deposit ratio as instruments of seigniorage revenue generation.
Table 2 shows that the bank reserve ratios have increased significantly in three out of the four Southern European countries taken into consideration in the late 1980s but has come down over the next decade. Note in some ways Greece stands out to be an exception. The reserve deposit ratio has increased steadily over the early part of the 1990 and has declined only marginally in the years of our sample period. Even then the values are considerably higher when compared to Spain, Italy and Portugal. Over the years one of the basic features of financially repressed economies has been below market rate of interest on deposits and loans, but an interesting feature of these economies are that in some countries the required bank reserves increased in the late 1980s while, in most of these countries, the capital markets were being deregulated. Table 3 outlines the periods over which major interest rates were deregulated and credit ceilings were relaxed in some of the major European economies. The periods correspond to the phase–wise relaxation of the various interest rates and the credit ceilings.

<table>
<thead>
<tr>
<th></th>
<th>Spain</th>
<th>Italy</th>
<th>Greece</th>
<th>Portugal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-1986</td>
<td>15.8</td>
<td>15.5</td>
<td>22.1</td>
<td>20.5</td>
</tr>
<tr>
<td>1986-1991</td>
<td>19.3</td>
<td>17.2</td>
<td>19.6</td>
<td>26.4</td>
</tr>
<tr>
<td>1992-1997</td>
<td>9.0</td>
<td>10.6</td>
<td>26.0</td>
<td>15.3</td>
</tr>
<tr>
<td>1998-2002</td>
<td>3.0</td>
<td>2.3</td>
<td>23.5</td>
<td>7.1</td>
</tr>
</tbody>
</table>

Source: See Table 1.

In Gupta (2004d), we looked into an overlapping generation endowment-economy model characterized by tax evasion and asymmetric information between the government (the social planner) and the financial intermediaries. Using the framework, we tried to answer whether at all these high reserve-requirements are to discipline the banks, besides being motivated by maintaining a steady
source of seigniorage revenue for the social planner.

Table 3: Interest Rate Liberalization and Credit Ceiling Relaxation Dates

<table>
<thead>
<tr>
<th>Country</th>
<th>Interest Rate Liberalization</th>
<th>Credit Ceiling Relaxation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>1984-95</td>
<td>1959-66</td>
</tr>
<tr>
<td>Italy</td>
<td>1980-95</td>
<td>1973-83</td>
</tr>
<tr>
<td>Greece</td>
<td>1980-95</td>
<td>1982-87</td>
</tr>
<tr>
<td>Portugal</td>
<td>1984-95</td>
<td>1978-91</td>
</tr>
<tr>
<td>Belgium</td>
<td>1986-95</td>
<td>Until 1978</td>
</tr>
<tr>
<td>France</td>
<td>1980-95</td>
<td>1958-85</td>
</tr>
<tr>
<td>Germany</td>
<td>1980-95</td>
<td>None</td>
</tr>
<tr>
<td>U.K.</td>
<td>1980-95</td>
<td>1964-71</td>
</tr>
</tbody>
</table>

Sources: Tables 3.4, 4.1 and 5.1 in Caprio, Honohan and Stiglitz (2001).

Results from the model did not seem to support the hypothesis that bigger sizes of the underground economy and hence tax evasions cause economies to have higher values of reserve-deposit ratios. However, allowing for asymmetric information between the social planner and the banks indicates that, irrespective of the size of the probability of banking crisis, asymmetric information will always optimally cause the government to choose a reserve requirement very close to unity. So unless we explicitly categorize economies into safe and unsafe blocks based on positive or negligible (zero, in our case) probability of banking crisis, the model cannot explain the differences in reserve requirements based purely on the size of probabilities of bank failures across countries. This limitation of the endowment economy model motivated us to look into a production economy. The asymmetric information, moral hazard in our case, between the firms and financial intermediaries
is modelled through a standard costly state verification problem as in Townsend (1979), Gale and Hellwig (1985), and Williamson (1989). In such a framework, we derive the optimal policy choices for the consolidated government and in turn try and evaluate the preference importance of explicit and implicit taxation in tackling the problem of asymmetric information and simultaneously meeting the budget constraint.

Note in this paper we ignore government bonds and try to derive the preference of the planner between income taxation and seigniorage. For details regarding the budget constraint see Section 3. Note bonds are left out for a technical reason. In a world of no uncertainty incorporating government bonds in either the consumer or bank problem would imply plausible multiplicity of optimal allocations of deposits or loans and government bonds. Since the arbitrage conditions would imply a relative price of one between deposits or loans and government debt. One way to incorporate government bonds is to have the financial intermediaries hold government bonds as part of obligatory reserve requirements. Or alternatively assume, as in Sargent and Wallace (1984), that there exists a fixed ratio of government bonds to money. Given the unavailability of evidence regarding reserve requirements on government bonds in these economies, the need to incorporate bonds via the multiple reserve requirement argument was not compelling enough. The Sargent-Wallace (1984) method of incorporating public debt, however, can be viewed as a possible and interesting extension of the current paper. The rest of the paper is organized as follows: Besides the introduction and conclusion, Section 2 discusses the related literature and Section 3 is devoted in laying out the model formally. Section 4 and 5 lays out the equilibrium and the derivation of the optimal choices of the agents. Section 6 lays out the welfare criterion and Section 7 discusses the process of calibration in detail, and Section 8 derives the optimal choice of policy instruments.
2 Related Research

In Gupta (2004b and 2004c), using an infinitely-lived representative agents general equilibrium framework with consumers, firms, financial intermediaries and the government playing their respective roles in the growth process, we were able to show that liberalizing the domestic financial sector, portrayed in the form of a relaxation of the reserve–deposit ratio, results in a lower rate of inflation, both with closed and open economy assumptions.\(^3\) Given that liberalization of the financial sector can reduce inflation in the economy, it simultaneously raises some public-finance issues. Liberalization leads to loss of government revenue through seigniorage that was generated through the mandatory “high” reserve requirements on the financial intermediaries. Thus the process of liberalization clearly depends on the initial situation in the economy, in this case the position of the government budget.

Giovannini and De Melo (1993), relying on explicit open economy assumptions and stressing on the interactions of capital controls and financial repression, presents an “exploratory analysis of the theoretical underpinnings and the empirical relevance of the phenomenon of financial repression from a public finance perspective.” The authors show that financial repression is not an efficient policy when countries face no constraints in the use of different forms of taxation. However, whenever there are costs of administering certain types of taxes or whenever income redistribution is an objective of the government, an implicit tax on domestic financial markets may be part of an optimal taxation structure.

Besides Giovannini and De Melo (1993), systematic empirical investigation that financial repression is an important source of revenue for the government has been provided by Fry (1988),

\(^3\)It must be pointed out that studies by Espinosa and Yip (1996) and Basu (2001) indicate that the relationship between inflation and reserve requirements may not always be positive.
the World Bank (1989), Edwards and Tabellini (1991), Roubini (1991), Cukierman, Edwards and Tabellini (1992) and Ozler and Roubini (1994). Giovannini and De Melo (1993) considers the experience of 24 developing economies and showed that the revenue from financial repression can be quite substantial, both as a share of GDP and as a share of total government revenues. In some countries the figure reached amounts to over 5 percent of GDP and 30 percent of government revenue. Hence, reforms aimed at liberalizing the financial markets and removing capital controls will in many countries pose some relevant questions like: What is the size of the budgetary impact of the liberalization, and how can the revenue shortfall resulting from the liberalization be dealt with?

In a recent contribution to the existing theoretical literature, Roubini and Sala-i-Martin (1995) addresses this issue in a formal fashion. Using an endogenous growth framework with a benevolent government they suggest, “......the main reason why governments stay in the way of financial evolution is that the financial sector is the potential source of “easy” resources for the public budget.” In their model, by allowing the government “the power to follow policies of financial repression” they prevent the financial sector from operating at its full potential. The source of income stemming from government intervention was modelled through the inflation tax and the implication of financial development was interpreted as reducing the transaction costs of converting non-liquid assets to liquid assets, thus reducing the “need for people to carry money.” In such a set up, allowing the financial sector to develop would result in the reduction of the inflation tax base and hence the size of seigniorage but repressing the financial system would simultaneously have real effects by resulting in smaller physical capital accumulation for every level of private savings and hence affect growth adversely. Furthermore, allowing for the possibility of a given degree of tax evasion, the rate of growth of money and the income tax rate, “the choice of financial repression has two
different effects: on the one hand, it reduces income and therefore decreases the income tax base and on the other hand, it increases real money demand and therefore raises the inflation tax base.” The model thus indicates that governments subjected to large tax-evasion will “choose to increase seigniorage by repressing the financial sector and increasing the inflation rates.” This would, however, lead to lower levels of investment and growth rates given the amount of savings. So clearly there exists a trade-off issue to be addressed. The analysis, besides exhibiting the negative impact of financial repression on growth also indicates that high financial repression will be associated with high inflation rates, high seigniorage, and low economic growth.

The proposition that countries with inefficient tax systems and large tax evasion are more oriented towards the repression of the financial sector was motivated out of empirical evidence. McKinnon (1973, 1991) presents some early evidence that inefficient tax systems and high tax evasion are associated with economic systems that tend to tax excessively the financial sector (see also Fry, 1988).

Cukierman, Edwards and Tabellini (1992) using a formal econometric model provides empirical evidence, for a large group of developing countries, of a correlation between inefficient tax system, large seigniorage revenues, and high inflation rates. The authors argue that countries with a low tax base or high degree of political instability may tend to resort relatively more to seigniorage as an easy source of revenue. The authors also documented that seigniorage defined as increase in base money to total government revenues has ranged across countries from 1.7 percent to 28 percent, and between 1.8 percent and 19.4 percent for the countries we study.4 On the policy side, the need for structural reforms in the tax system as a way to permanently reduce the need for seigniorage revenues has been stressed by the World Bank in its structural adjustment programs (see World Bank, 1989).

4See Table 1.
All the above studies indicate that seigniorage revenue, raised either through mandatory reserve requirements or high inflation, is an important source of government revenue in many countries around the world. Reasonings have varied and have stretched from the implicit inflation tax being an easy source of revenue to the governments in some countries having to resort to it due to high tax evasion and political instability. The fact that the high reserve requirements in some economies can also portray an attempt on the part of the authorities to discipline the financial intermediaries and reduce the bail-out expenses in a world of asymmetric information has somewhat been ignored. This is more perplexing when one realizes that the possibility of asymmetric information in the credit market have been realized ever since the pioneering contributions by Keaton (1979) and Stiglitz and Weiss (1981). Since then, a lot of effort has been devoted to study the nature of informational asymmetry and analyze its impact on the macroeconomy, realizing that the financial sector tends to drive the growth behavior of the economy.\(^5\)

Our analysis, in this paper and Gupta (2004d), are in some way an extension of the analysis of Freeman (1987) and Bacchetta and Caminal (1992). Freeman presents a model of optimizing agents who choose to hold deposits at financial intermediaries which are required to hold fractional reserves of fiat money. The authors indicate that the combination of reserve requirements and inflation results in a lower steady state utility than a direct tax on deposits. The optimal monetary policy when reserves are required is to minimize reserve requirements and inflate without limit the stock of fiat money. Bacchetta and Caminal (1992), on the other hand, analyzes the effect of financial integration for two countries relying on the taxation of their domestic financial system. A two-country model with overlapping generations and explicit financial intermediation is used. Gov-

ernments are assumed to derive revenues from seigniorage and set optimally, but non-cooperatively, the rate of inflation and the level of required reserves on bank deposits. They conclude that financial liberalization leads to lower reserve ratios, higher inflation rates and larger stocks of government debt.

The extension, and hence the departure, of our analysis from the aforementioned two papers lies mainly in the fact that we present a theoretical model of a financially repressed economy subjected to informational asymmetry between agents. Moreover the model takes into account the possibility of tax evasion and tries to justify, at first, if simply evasion can explain the observed high reserve requirements in our chosen economies. The structure of the model makes it suitable to calibration and numerical analysis. To the best of our knowledge, such an attempt to look for reasons for the existence of “high” reserve requirements on the aforementioned ground of informational asymmetry, bank failures, bailouts and pressures on government budget, is the first first of its kind. Purely from the public finance perspective, our analysis builds on the the contributions of Giovannini and De Melo (1993) and Roubini and Sala-i-Martin (1995).

The analysis is to some extent motivated by the papers of Di Giorgio (1999), Aizenman and Turnovský (2002). Di Giorgio (1999) studies a simple productive economy where financial intermediaries are at work and a scope for regulatory intervention by a consolidated government–monetary authority is allowed given the fact that the process of financial intermediation is characterized by costly state verification (as in Townsend (1979); Gale and Hellwig (1985) and Williamson (1987)). As a regulatory policy, the banks are obligated to maintain mandatory reserve requirement on deposits. The level of costs associated to monitoring activity is interpreted as an indicator of the efficiency of the financial structure, since it is believed to reflect the existing legal environment, the organizational features and the functional structure of the intermediaries.6 The author indi-

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6See also Romer (1996) and Mattesini (1995).
cates that when the cost of monitoring is negligible, the optimal reserve coefficient tends to zero. However, the paper derives a critical level of monitoring cost beyond which the optimal reserve requirement will be different from zero. The optimal reserve requirement is shown to be strictly increasing in the costs of verification of the state. This result is indicative of the fact that financially developed economies have low costs associated with the activities of the financial intermediaries (costs of information processing and project evaluation, as well as costs of monitoring borrowers) and thus rationally should have optimal reserve requirements lower relative to economies with less efficient financial systems.\(^7\) The paper also provides an explanation as to why many countries have either eliminated or considerably reduced reserve requirements during the last decade.

Aizenman and Turnovsky (2002) characterizes in a two country world the effects of reserve requirements on financial loans in the presence of moral hazard on the lender side (the anticipation that the tax payer will bail out lending banks if large defaults occur), and sovereign risk on the borrower side. It is observed that more generous bailouts financed by the high income block encourage borrowing and increase the probability of default. The authors show that the introduction of a reserve requirement in either country reduces the risk of default and raises the welfare of both the high income block and the emerging market economies. In these circumstances, the lender’s optimal reserve requirement is shown to increase with the expected bailout. Such a policy induces the lender to internalize the expected tax payer cost of the bailout. Thus, a more generous bailout that is accompanied by an optimal adjustment in the lender’s reserve requirements exactly neutralizes its effects on welfare, leaving welfare in both countries unchanged. Unlike the case of the lender, the effect of the more generous bailout on the borrower’s optimal reserve requirement is ambiguous. The imposition of the reserve requirement may also improve the availability of information about the debt exposure of the emerging market economies, which by itself will reduce the

\(^7\)See Di Giorgio and Reichlin (1996) for a comparative study of reserve regimes in EU countries along these lines.
optimal lender’s reserve requirements, and may prevent drying up’ the market for sovereign debt.

Recently, Ganapolsky (2003) provides a general equilibrium model of a small open economy that rationalizes the pattern of reserve requirement, as an outcome of an optimal policy, and other macroeconomic variables in the aftermath of a bank run. The author points out that the conventional wisdom suggests that reserve requirements should be reduced in a bank run to provide liquidity to the financial system. However, evidences derived from a chosen sample small open economies show mixed results. In 48 out of the 94 sample economies the reserve requirement is found to go up. The model economy characterized by (i) imperfect capital mobility, (ii) costly banking system, and (iii) an externality affecting individual banks’ decisions, tries to provide an explanation to this contradictory behavior of the reserve ratio. The study on the face seems to attempt in rationalizing a view exactly opposite to the goal of our paper. We view reserve requirements as a mechanism to reduce the possibility of bank runs and try to provide a reason as to why reserve requirements in some economies are higher than the other based on the riskiness of the banking system. However, note the critical difference lies in the fact that this model traces out the path of reserve requirements post a bank run. Ganapolsky (2003) indicates that the path of the reserve requirement is closely related to the type of shock that the economy experiences and the initial conditions. If the shock, for example an output shock, keeps the opportunity cost of holding reserves unaffected, there are no changes in the optimal reserve requirements. On the other hand, when the interest rate is forced up, it will be less costlier to finance the run with the “hoarded liquidity”. Interestingly, the size of the risk premium tends to affect the reaction of the economy to the shock. The paper also indicates that the dynamics will be slightly different for a permanent and a temporary shock, and will depend critically on the economy’s access to foreign funds.

Our model closely follows that of Di Giorgio (1999), but unlike in the paper we model the
government budget constraint explicitly realizing that bank failures and bailouts given deposits are insured puts extra pressure on the budget and also allow for labor choice decisions in the model. Di Giorgio (1999) assumed that the cash reserves held by the banks serves the role of insuring the deposits. This in turn allows the intermediaries to repay their interest obligations even when the firm fails. Our concern is, however, different, we allow for deposit insurance explicitly and compare the role of seigniorage and explicit taxation in the face of positive probability of banking crises and bailout obligations of the government. In some sense, we test the hypothesis whether, in a world of uncertainty, the government is justified in maintaining reserve requirements for the financial intermediaries to reduce the possibilities of large bank failures. The bank failures might be highly destabilizing for a macro economy and in turn motivates government bailout, causing an increase in government expenditure and hence the size of the deficit. So to put it differently, we question whether one can associate higher reserve requirements with higher probability of crisis, once we control for other parameters in the model. Thus given that we are interested in seeking for the optimal mix of policy instruments the government would choose in order to meet the budgetary and bail out expenses, the need to explicitly model the government budget constraint is compelling.

Moreover, the production economy model is somewhat restricted in Di Giorgio (1999) in the sense that there does not exist a pure market for goods. This limitation of the model is handled by introducing labor-choices in the model. The labor decisions by the worker to earn wage provides the completeness to the demand decisions in the goods market. We however assume that there is only one factor of production, labor, and not capital as in Di Giorgio (1999), and the labor demand is constrained by the availability of loans.

Our analysis is also starkly different from Aizenman and Turnovsky (2002) especially in regard to its context and also the structure. Unlike a two-country world, involving a borrower and lender,
our analysis considers a closed economy subject to informational asymmetry. The need to maintain reserve requirements under such circumstances, is, however, to some extent motivated for similar reasons outlined in the Aizenman and Turnovsky (2002) paper.

3 Economic Environment

We study an economy with three types of agents: consumers, financial intermediaries and a consolidated government–monetary authority. Consumers are further categorized into two types: workers/depositors and entrepreneurs. The workers/depositors are endowed with one unit of labor which they supply inelastically, with some probability, to the firms earning a specific wage, which they allocate to savings to finance consumption during retirement. The entrepreneurs, on the other hand, are endowed with a fixed amount of resources and have access to production technology. Financial intermediation plays the dual role of providing depositors with a safe way of transferring resources into the future, given that deposits are insured, besides simultaneously being the external source of finance to entrepreneurs. Moreover, given that the financial intermediaries are obligated to hold a fraction of their deposits as cash reserves, they enhance the inflationary tax base of the consolidated government. Note that, this assumption helps in generating the demand for money in the model. The consolidated government balances its budget on a period to period basis using revenue from income tax, seigniorage and deposit insurance.

The economy is affected by ex post moral hazard due to costly state verification. The outcome of the investment projects of the entrepreneurs, financed by bank loans, are private information; however, banks can observe the same outcome if they are willing to incur some monitoring costs. Monitoring costs will be assumed to be proportional to loans. As in Di Giorgio (1999), the assumption of a linear monitoring technology wants to capture the idea that it is more costly to monitor
large borrowers in comparison to small ones. Implicitly, such an assumption emphasizes a positive correlation between borrower’s size and the associated demand for bank loans. Note that the size of the cost of verification of state is also a ‘proxy’ for the efficiency of the financial system. A developed financial system can be rationally assumed to have a lower cost of state verification.

3.1 Agents’ Behavior

3.1.1 Workers/Depositors, Entrepreneurs and Banks

Both workers/depositors and entrepreneurs and hence consumers within each class are a continuum with a population size normalized to one. They live for two periods and have positive endowments, labor in the case of the worker/depositor and a consumable good in case of the entrepreneur, when young but nothing when old. All workers/depositors and entrepreneurs have their preferences defined only over consumption when old.

All entrepreneurs are endowed with \( x \) units of perishable good.\(^8\) The entrepreneurs also possess a simple stochastic linear technology. The identical production technology across the entrepreneurs can be formalized as follows:

\[
y_{t+1} = \tilde{\beta} n_t \delta
\]  

(1)

with

\[
\tilde{\beta} = \begin{cases} 
\beta, & \text{with probability } q \\
0, & \text{with probability } 1-q
\end{cases}
\]

where \( y_{t+1} \) is level of output produced at time \( t + 1 \); \( n_t \) is the labor requirement at time \( t \); \( \delta \) denotes the labor share and; \( \tilde{\beta} \) is a random technology parameter and is independently and identically distributed.

\(^8\)The positive endowment is required for technical reasons, mainly to solve explicitly for labor demand and wage rate. See below Section 5 for details.
distributed across entrepreneurs. The technology is such that, by using one unit labor at time $t$, $\beta > 1$ units are produced at time $t + 1$ with probability $q$, and 0 with probability $1 - q$.

The worker/consumer is endowed with one unit of labor $n$ which they can supply inelastically to the firms, however with a positive probability of $\phi$, earning a wage $w$ in real terms. In the remaining $(1 - \phi_t)$ cases the workers/depositors cannot find employment and hence has no wage income. The workers/depositors hence can either work full-time with some probability $\phi_t$ or stay unemployed with a remaining probability of $(1 - \phi_t)$. The labor supply decision is demand determined and is based along the lines of the lottery system outlined in Hansen (1985). The motivation for modelling the labor supply decision in this manner emerges from the plausibility of not enough loans being available to finance the entire labor supply, in cases of very high reserve requirements. Note the probability, $\phi_t$, of working full-time is in turn endogenously determined by the labor demand from the labor market equilibrium. Even though the production process is stochastic, since the firms borrow ahead to pay at the time of hiring, there is no further uncertainty to the wage income of the workers/depositors, once he ends up with a job. The consolidated government taxes the wage income at the rate of $\tau$, but an exogenous fraction of $(1 - \alpha)$ is evaded by the workers/depositors.

The preferences of a worker/depositor born at time $t$ are summarized by the following utility function and can be written as:

$$U_t^d = u(c_{t+1}^d)$$

(2)

where $c_{t+1}^d$ denotes the consumption by an old agent born at time $t$. We assume that $u$ is twice continuously differentiable, and strictly concave; formally, $u'>0$, $u''<0$ and $\lim_{c \to 0}[u'(c)] = \infty$.

Defining $r_{dt+1}$ as real interest rate paid by the banks on deposits, the budget constraint of the
depositors can be explicitly laid out as follows:

\[ d_t \leq (1 - \alpha \pi_t)(w_t \phi_t) \quad (3) \]

\[ c^d_{t+1} \leq (1 + r_{d,t+1})d_t \quad (4) \]

where \( d_t \) is the real deposits of the depositors.

Let \( L \) and \( l \) be the nominal and real loans paid to any individual project that entrepreneurs can borrow from the banks, and \( n^d_t \) the demand for labor. Labor hiring is constrained by the available resources of financing:

\[ w_t n^d_t = x + l_t \quad (5) \]

When the project succeeds the entrepreneurs repay the nominal interest rate on loans \( R_{lt} \), while nothing is paid back when the project fails. And given that deposits are insured and the banks are not able to meet the obligations of the depositors, the government needs to step in and bail out the banks.

The entrepreneur maximizes his expected profit, given by the following expression:

\[ \max_L \Pi^e = q p_t \left[ \beta \left( \frac{x + l_{t-1}}{w_{t-1}} \right) \delta - \frac{(1 + R_{lt})}{p_t} p_{t-1} l_{t-1} \right] \quad (6) \]

Note to ensure that the firms do borrow to produce rather than merely consuming their positive endowment \( x \), we parameterize the model accordingly to ensure \( \Pi^e > x \), holds under all possible circumstances.\(^9\)

There is a finite number of competitive banks, which are price takers on their liabilities.\(^{10}\) Banks collect deposits, keep a fraction, \( \gamma \), as obligatory reserve requirements with the central bank and

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\(^9\) See the Section on calibration for further details.

\(^{10}\) As Di Giorgio (1999) points out this assumption is analogous to assuming that banks behave as Bertrand competitors when fixing the interest rate on deposits.
offer the remaining amount as loans to the entrepreneurs. From their balance sheet, we have

\[ L_t \leq (1 - \gamma_t)D_t \]  

(7)

where \( L \) and \( D \) are respectively the nominal quantities of loans and deposits. The level and conditions of intermediation activity are determined in the financial contract that we derive below.

3.1.2 The Financing Contract

We will assume the entrepreneur and banks to be both risk neutral. The bank offers a contract to the entrepreneur establishing both the amount of the loan and its cost. Since the outcome of the project is private information of the borrower, the entrepreneur will always have the incentive to declare bankruptcy even if the project is in fact successful. The bank then accordingly specifies the contract such that when bankruptcy is declared monitoring will take place. As in Bernanke and Gertler (1989) and Di Giorgio (1999), banks will optimally adopt a stochastic monitoring technology.

Let \( \lambda \) denote the probability of monitoring when bankruptcy is declared, and \( v \) be the punishment to the entrepreneur (in real terms) caught misreporting the production outcome. Using the revelation principle one can derive the optimal financial contract as the solution of the following problem:

\[
\max_{R_{Lt}, L, \lambda, v} \Pi_B = qR_{Lt}L_{t-1} - (1 - q)\lambda cL_{t-1} - qR_{dt}D_{t-1} - q\varepsilon_{t-1}D_{t-1} \\
\text{subject to} \\
l_{t-1} + m_{t-1} \leq d_{t-1} \\
m_{t-1} \geq \gamma_{t-1}d_{t-1} \\
qpt \left[ \beta \left( \frac{x + l_{t-1}}{w_{t-1}} \right)^\delta - \frac{(1 + R_{Lt})}{pt}p_{t-1}l_{t-1} \right] \geq p_tq\beta \left( \frac{x}{w_{t-1}} \right)^\delta
\]  

(8)
\[
q_p t \left[ \beta \left( \frac{x + l_{t-1}}{w_{t-1}} \right)^\delta - \frac{(1 + R_{Lt})}{p_t} p_{t-1} l_{t-1} \right] \geq q_p t \left[ \beta \left( \frac{x + l_{t-1}}{w_{t-1}} \right)^\delta - \lambda v \right]
\] (12)

\[
v \leq \beta \left( \frac{x + l_{t-1}}{w_{t-1}} \right)^\delta \quad (13)
\]

\[
0 \leq \lambda \leq 1 \quad (14)
\]

where \( \Pi_B \) is the expected profit of the bank; \( c \) is the proportion of loans devoted to the monitoring activity; \( \varepsilon \) is the premium on deposit insurance; \( R_d \) is the nominal interest rate on deposits, \( m \) is the real quantity of cash reserves held by the banks; and \( p \) is the price level.

The constraints given by equation (9) to (13) respectively indicates the feasibility constraint, the mandatory cash reserves constraint, the participation constraint of the firm, the incentive compatibility constraint and the fact that the selected punishment abide by the principle of limited liability. (14) is obvious.

In the optimal contract (11) has to be binding implying that \( \frac{(1 + R_{Lt})}{1 + \pi_t} l_{t-1} = \beta \left[ \left( \frac{x + l_{t-1}}{w_{t-1}} \right)^\delta - \left( \frac{x}{w_{t-1}} \right)^\delta \right] \), where \( 1 + \pi_t = \frac{p_t}{p_{t-1}} \), the rate of inflation at period \( t \). The incentive compatibility constraint (12) then requires that \( \lambda v \geq \frac{(1 + R_{Lt})}{1 + \pi_t} l_{t-1} \). Since \( \Pi_B \) is a decreasing function of the probability of monitoring, banks will set \( \lambda \) at the minimum level such that (12) holds. This implies that \( 0 < \lambda^* < 1 \) and that \( v \) is set at its maximum: from (13) \( v^* = \beta \left( \frac{x + l_{t-1}}{w_{t-1}} \right)^\delta \). Assuming that revealing truthfully gives him the same expected profit, the entrepreneur does not misreport the production outcome and hence, (12) is binding as well. This results in \( \lambda^* = \frac{l_{t-1}^* \left( \frac{(1 + R_{Lt})}{1 + \pi_t} \right)^\delta}{v^*} \). Given that banks are profit maximizers and \( qR_L > c \), under all circumstances, they will lend all funds at their disposal hence (9) and (10) binds and we have, \( l_{t-1}^* = (1 - \gamma_{t-1})d_{t-1} \). Note to ensure that the banks lend all their available resources we parameterize the model accordingly to ensure \( qR_L > c \), holds under all possible circumstances.\(^{11}\)

Thus in summary, the optimal financial contract offered by the competitive bank, given \( qR_L > c \),

\(^{11}\)See the Section on calibration for further details.
is:

(a) \( l_{t-1} = (1 - \gamma_t) d_{t-1} \),

(b) \( \frac{(1+R_L)^* \gamma_t}{1+\pi_t} l_{t-1} = \beta \left[ \left( \frac{(x+l_{t-1})}{w_{t-1}} \right)^\delta - \left( \frac{x}{w_{t-1}} \right)^\delta \right] \),

(c) \( \lambda^* = \frac{l_{t-1} \gamma_t}{v^*} \), and

(d) \( v^* = \beta \left( \frac{(x+l_{t-1})}{w_{t-1}} \right)^\delta \)

\( n_{t-1}^* \) and \( w_{t-1}^* \) is determined simultaneously from equation (5), the loan market equilibrium condition; the first order condition derived from equation (6) and; a linearized version of equation (11).

Note we linearize around the steady-state value of the labor endowment, \( \hat{n} \), which corresponds to the employment rates in respective economies, or put alternatively, 1 less the rate of unemployment.

### 3.2 Government

The government has a fixed “purposeless” spending of \( g \) units (per young person) each period. The revenue needed to fund this expenditure and the bail out costs when a firm fails comes from the revenue raised by the two wings of the government: the treasury and the central bank. The former collects income taxes from the young workers/depositors, a fraction \((1-\alpha)\) of which is evaded. The latter controls the nominal stock of money, \( M \), contributing to the government’s revenue needs by new creating money and the reserve requirements. Formally, the government budget constraint in real per capita terms can be written out as follows:

\[
g_t = \alpha \tau_t w_t \phi_t + \frac{M_t - M_{t-1}}{P_t} + q \varepsilon_t d_t - (1 - q)(1 + r_{dt+1}) d_t - (1 - q) d_t \tag{15}
\]

Or,

\[
g_t = \alpha \tau_t w_t \phi_t + \gamma_t \left( \frac{\mu_t}{1+\mu_t} \right) d_t + q \varepsilon_t d_t - (1 - q)(1 + r_{dt+1}) d_t - (1 - q) d_t \tag{16}
\]

Given that \( M_t = (1 + \mu_t) M_{t-1} \) and \( M_t = \gamma_t D_t \), where \( \mu_t \) is the growth rate of the nominal money stock. Note the first three terms respectively indicate the government revenue from tax,
seigniorage and deposit insurance given that the project is successful with probability $q$, while the last two terms respectively shows the bail out expenditure for the government when the firm and hence the bank fails, and the cost incurred by the government incase deposit insurance premium is subsidized, and not actuarially fair. Note an actuarially fair insurance would imply setting $\varepsilon$ equal to the probability of failure, $1 - q$. Without any loss of generality we will assume that $g_t = \kappa w_t \phi_t$.

4 Equilibrium

A valid perfect-foresight, competitive equilibrium for this economy is a sequence of prices $\{p_t, w_t, r_{dt}\}_{t=0}^{\infty}$, allocations $\{c^d_t, n_t, c^e_t\}_{t=0}^{\infty}$, stocks of financial assets $\{m_t, d_t\}_{t=0}^{\infty}$, and policy variables $\{\gamma_t, \mu_t, \tau_t, \varepsilon_t, g_t\}_{t=0}^{\infty}$ such that:

- Taking the labor endowment, $\tau_t$, $g_t$, $\beta$, $\gamma_t$, $\mu_t$, $p_t$, $w_t$ and $r_{dt}$ the depositors optimal savings and consumption behavior is characterized by (3) and (4);

- Taking the endowment, $\tau_t$, $g_t$, $\beta$, $\gamma_t$, $\mu_t$, $p_t$, $w_t$ and $r_{dt}$ the entrepreneurs optimal consumption behavior is characterized by (6);

- Banks maximize the return to deposits, taking, $\beta$, $\gamma_t - 1$, $\varepsilon_{t-1}^{12}$, $q$, $c$ and $\mu_{t-1}$ as given by (8);

- Goods, labor and money markets clear.

- The government budget constraint holds on a period-to-period basis.

5 Optimal Allocations

The profit maximization of the entrepreneur suggests that marginal product of labor is equal to the gross real interest rate on loans and hence yields the following condition:

\footnote{The deposit insurance premium $\varepsilon_t$ if not set at the actuarially fair level, $1 - q$, is assumed to be subsidized.}
\[
\beta \delta \left( \frac{x + l_{t-1}}{w_{t-1}} \right)^{(\delta - 1)} \frac{1}{w_{t-1}} = \frac{(1 + R_{Lt})^*}{1 + \pi_t}
\] (17)

Linearization of the binding-form of equation (11), yields:
\[
\frac{(1 + R_{Lt})^*}{1 + \pi_t} = \hat{n}^{(\delta - 1)} \frac{\beta}{w_{t-1}}
\] (18)

Realizing that \( \phi_t = n_t^d \) and using (5), (17) and (18), \( n_t^* \), the optimal level of labor hiring, is given by:
\[
n_t^* = (\delta)^{\frac{1}{1-\delta}} \hat{n}
\] (19)

Moreover using (5) and (19) \( w_t^* \) and the optimal real interest rate on loans \( (1 + r_{Lt})^* = \frac{(1+R_{Lt})^*}{1+\pi_t} \) is given by the following expressions
\[
w_t^* = \frac{x}{(1 - [(1 - \gamma_t)(1 - \alpha\tau_t)])} \frac{1}{(\delta)^{\frac{1}{1-\delta}} \hat{n}}
\] (20)
\[
(1 + r_{Lt})^* = \frac{\beta \hat{n} \delta^{\frac{1}{1-\delta}} (1 - [(1 - \gamma_t)(1 - \alpha\tau_t)])}{x}
\] (21)

The optimal choices of the worker/depositor can be derived directly from equation (5) and the budget constraints, and is given as follows:
\[
d_t^* = (1 - \alpha\tau_t)^{\frac{x}{(1 - [(1 - \gamma_t)(1 - \alpha\tau_t)])}}
\] (22)
\[
c_t^{d+1} = (1 + r_{dt+1})^{\frac{x}{(1 - [(1 - \gamma_t)(1 - \alpha\tau_t)])}}
\] (23)

Entrepreneurs consumption at time \( t + 1 \) is a random variable with the following distribution:
\[
c_t^{c+1} = \begin{cases} 
\beta \hat{n} \delta^{\frac{1}{1-\delta}} (\frac{1}{1 - [(1 - \gamma_t)(1 - \alpha\tau_t)]}), & \text{with probability } q \\
0, & \text{with probability } 1-q
\end{cases}
\] (24)

where \( c_t^{c+1} \) is the consumption of the entrepreneur at period \( t + 1 \).
\[ \lambda^* = \delta(1 - \gamma_{t-1})(1 - \alpha \tau_{t-1}) \] (25)

Note that (14) is automatically satisfied.

Free entry in the banking industry implies zero profits in the sector. By substitution of equation (5) and the set of optimal choices derived from the financing contract, equations (21) and (25), we have:

\[
(1 + r^*_dt) = \left\{ \begin{array}{l}
(\beta \hat{n}^i \delta^{1-x} (1-\gamma_{t-1})[1-(1-\gamma_{t-1})(1-\alpha \tau_{t-1})]) \\
+ \frac{\gamma_{t-1}}{1+\mu_{t-1}} - \left( \frac{1-q}{q} \right) \alpha \delta (1-\gamma_{t-1})^2 (1-\alpha \tau_{t-1}) - \frac{\varepsilon_{t-1}}{1+\mu_t} \end{array} \right\} (26)
\]

Moreover, in steady-state the money market clearing condition implies that \( \frac{p_t}{p_{t-1}} = \frac{1}{1+\mu_t} \).

6 The Welfare Criterion

In this simple economy, the objective of a benevolent government-monetary authority is to maximize the social welfare. The social welfare can be defined as an weighted average of the expected utility of consumption of both depositors and entrepreneurs. Here we restrict ourselves to a stationary economy, with no growth. Note changes in government policy tools not only affect the return on deposits, but also the future consumption of the entrepreneurs. Given that the entrepreneurs are risk-neutral, they maximize their expected consumption. The steady-state level of welfare for all future generations is obtained by substituting the equilibrium decision rules into the agents utility function, to yield the following social welfare function:

\[
\Omega = \left\{ \begin{array}{l}
\theta_u \left[ \left( \frac{\beta \hat{n}^i \delta^{1-x} (1-\gamma)[1-(1-\gamma)(1-\alpha \tau)]}{x} \right) \left( (1-\alpha \tau)^{-\frac{\varepsilon}{1+(1-\gamma)(1-\alpha \tau)}} \right) \right] \\
+ (1-\theta) \left\{ q \left\{ \beta \hat{n}^i \left[ \delta^{1-x} - \delta^{1-x} (1-\gamma)(1-\alpha \tau) \right] \right\} \right\} \end{array} \right\} (27)
\]
where $\Omega$ is the steady-state social welfare, and; $\theta \ (|1-\theta|)$ is the weight assigned to the welfare of the depositor (entrepreneur). The social planner maximizes $\Omega$ choosing $\tau$, $\gamma$, $\mu = \pi$ given $u$, $q$, $c$, $x$, $\alpha$, $\beta$, $\theta$, $\delta$ and $\varepsilon$, to determine the optimal choices of the policy variables, subject to the set of inequality constraints: $\tau_{min} \leq \tau \leq 1$, $\gamma_{min} \leq \gamma \leq 1$, $\mu \geq \mu_{min}$ and the government budget constraint (16) evaluated at the steady state. For the rationale of assigned minimum values of $\tau$, $\gamma$ and $\mu$, see below the section on calibration. A standard utility function of the following type is chosen for deriving the optimal values of the policy variables:

$$u(c_{t+1}) = \frac{e^{(1-\sigma)}}{1 - \sigma}$$

(28)

7 Calibration

In this section we attribute values to the parameters, most of them being country-specific. We select the parameter values for our benchmark model using a combination of figures from previous studies and facts about the economic experience for our sample economies between 1980 and 1998. Note, unless otherwise stated, the source for all data is the IMF – International Financial Statistics (IFS).

- $\sigma$: The risk-aversion parameter in the utility function is set to 1.\(^{13}\)

- $q$: The parameter measures the probability of success of the entrepreneurial project. Note $q$ is tied with the probability of the success of the banks as well. In other words, the probability with which the production process fails is equivalent to the probability of a banking crisis.

The probability of banking crisis for the economies of our concern, conditional on the fact

\(^{13}\)The policy experiments were repeated for $\sigma = \frac{1}{2}$ and $\sigma = 2$, but the qualitative nature of our results stayed the same. Our analysis, thus, is not contingent upon the value of the risk aversion parameter. The results have not been tabulated to save space, however, they can be made available upon request.
that the financial markets were liberalized in these economies, over the period of 1980 to 1998, were derived using a methodology that closely mirrors the one outlined in the Demirgüç-Kunt and Detragiache (2001) study to obtain the probability of banking crises in our chosen set of economies. A multivariate logit model of the following type was fitted to the panel data:

\[
\log L = \sum_{t=1}^{T} \sum_{i=1}^{n} \left\{ P_{i,t} \log[F(\beta'X_{i,t})] + (1 - P_{i,t}) \log[1 - F(\beta'X_{i,t})] \right\}
\] (29)

Note the probability that a crisis will occur at a particular time in a particular country is hypothesized to be a function of a vector of \( n \) variables \( X_{i,t} \), which includes the financial liberalization dummy and \( n - 1 \) control variables. \( P_{i,t} \) denotes the dummy variable that takes the value one when the \( i \)-th country experiences a banking crises at time point \( t \) and zero otherwise. \( \beta \) is the vector of \( n \) unknown coefficients and \( F(\beta'X_{i,t}) \) is the cumulative probability density function calculated at \( \beta'X_{i,t} \). Note to model \( F \) we use the logistic functional form.

Thus it must be realized that the estimated coefficients do not indicate the increase in the probability of crises following one-unit increase in the corresponding explanatory variables as in standard linear regression models. Instead, the coefficients capture the effect of a change in an explanatory variable on \( \log \frac{P_{i,t}}{1 - P_{i,t}} \). Therefore the sign of the coefficient does indicate the direction of the change and the magnitude depends on the slope of the cumulative distribution function at \( \beta'X_{i,t} \).

To construct the banking crises dummy we use the dates of banking crises reported in Demirgüç-Kunt and Detragiache (2001) and is reported in Table 4. The criteria used in the study to identify banking crises comprised of at least one of the following: “The ratio of non-performing assets to total assets in the banking system exceeded 10 percent; the cost of rescue operation was at least 2 percent of GDP; banking sector problems resulted in a large-scale nationalization of banks; extensive bank runs took place or emergency measures
such as deposit freezes, prolonged bank holidays, or generalized deposit guarantees were enacted by the government in response to the crisis.” In case the above set of criteria failed to identify the banking crises we followed a more stringent measure of banking crises as adapted by Ganapolsky (2003). Using monthly data on deposits a bank run was an episode where there was at least 5 percent reduction in total deposits during at least 2 months in a row and lasted until deposits started to recover again.

Given that in most countries the removal of interest rate controls were the centerpiece of the liberalization process, the financial liberalization variable is captured by a dummy (FINLIB) that takes the value 1 in a specific year and country if the interest rates have already been liberalized by then. Note Demirgüç-Kunt and Detragiache (2001) points out that proxying financial liberalization by real interest rates as in Bandiera et.al (2000) in a panel data structure would be misleading and a hence a dummy variable needs to be assigned. To identify the years of financial liberalization the first year in which some interest rates were liberalized has been chosen as the dates of interest rates liberalization for the countries in our sample and is reported in Table 3 and is repeated in Table 4 for the sake of convenience.

Using the criteria laid out above, Table 4 identifies dates of interest rate liberalization and the dates of banking crises for Spain, Italy, Greece and Portugal over the sample period of 1980-1998. However, using the same criteria, no crises could be identified over the same sample period for Belgium, France, Germany and U.K.
Table 4: Interest Rate Liberalization and Banking Crisis Dates

<table>
<thead>
<tr>
<th>Country</th>
<th>Interest Rate Liberalization</th>
<th>Banking Crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>1984-98</td>
<td>1983</td>
</tr>
<tr>
<td>Italy</td>
<td>1980-98</td>
<td>1990-94 and 1997</td>
</tr>
<tr>
<td>Portugal</td>
<td>1984-98</td>
<td>1986-89</td>
</tr>
<tr>
<td>Belgium</td>
<td>1986-98</td>
<td>None</td>
</tr>
<tr>
<td>France</td>
<td>1980-98</td>
<td>None</td>
</tr>
<tr>
<td>Germany</td>
<td>1980-98</td>
<td>None</td>
</tr>
<tr>
<td>U.K.</td>
<td>1980-98</td>
<td>None</td>
</tr>
</tbody>
</table>

Sources:

(a) Tables 3.4, 4.1 and 5.1 in Caprio, Honohan and Stiglitz (2001).

(b) Table 1 Ganapolsky (2003).

(c) Bayoumi (1993).

(d) Attanasio and Weber (1994).

(e) IMF- International Financial Statistics.

The control variables in the logistic regression can be broadly categorized into two sets. The first group captures macroeconomic developments that affects bank performance mainly through the level of non-performing loans and includes the rate of growth of real GDP (Growth), the change in external terms of trade (TOT Change), and the rate of inflation (Inflation). The real short-term interest rate (Real Interest Rate) is also introduced as a control variable because, whether financial markets are liberalized or not, banking sector
problems are generally associated with high real interest rates. Following Demirgüç-Kunt and Detragiache (2001) we use rate of interest on short-term government paper or a central bank rate as a measure the short-term interest rate.

The second group of control variables included define characteristics of the banking system, such as fragility to sudden capital outflows (M2/Reserves): measured by the ratio of M2 to foreign exchange reserves; liquidity (Cash/Bank): measured by the ratio of bank cash and reserves to bank assets; exposure to private sector (Private/GDP): measured by the ratio of loans to the private sector to GDP; and two-period lagged credit growth (Credit Growth$_{-2}$), which captures the fact that “high rates of credit expansion may finance an asset price bubble that, when it bursts, causes a banking crises.” Finally, GDP per capita (GDP/CAP) is used to indicate the level of development of the country. Note the terms in the brackets correspond to the definition of the variables in the logistic model. The estimates of the multivariate logit model are reported in Table 5. Note except for the external terms of trade all the measurements follow Table 4.9 in Demirgüç-Kunt and Detragiache (2001). For the terms of trade we use the ratio of import to export price as outlined in Zimmermann (1997).

One can make the following observations from Table 5: (a) Interestingly, unlike Demirgüç-Kunt and Detragiache (2001), the financial liberalization dummy is negatively, though not significantly, correlated with the probability of banking crises. This suggests that financial liberalization is not a factor leading to banking sector fragility; (b) The probability of banking crises tends to be associated with lower growth rates, adverse terms of trade changes, high real interest rates and high inflation; (c) Of the characteristics of the banking sector does not seem to be vulnerable to a speculative attack against currency but the credit growth lagged by two periods is significant at 1 percent level. Besides the liquidity measure and the
exposure to the private sector tends to affect the probability of crisis significantly in a positive and negative manner, respectively; (d) Finally, GDP per capita is significantly and negatively correlated to the probability of banking crises, suggesting that, other things equal, suggesting that developing countries are more vulnerable to banking crises.

Once the multivariate logit model was estimated the probability of banking crisis at crisis dates were estimated by using the procedure outlined above and in Table 4.3 in Demirgüç-Kunt and Detragiache (2001). The probability of success ranges between 0.5240 (Italy) to 1.0 (Belgium, France, Germany and the U.K.). For Belgium, France, Germany and the U.K., we however set the value of \( q \) at 0.939, which corresponds to the average probability of crisis for comparable economies of Europe, obtained in Demirgüç-Kunt and Detragiache (2001). The \( q \) chosen corresponds to the average of Sweden (0.033), Norway (0.031), and Finland (0.119).

- \( \delta \): The parameter measures the labor share in output. The value has been set to 0.6, for all the economies. A labor share of 60 percent is in conformity with the observed world average.\(^{14}\)

- \( c \): The parameter captures the proportional cost of monitoring. As Cooley and Nam (1998) points out that, in equilibrium, monitoring costs are incurred by financial intermediaries only when the entrepreneurs fail. Hence, these costs can be interpreted as costs of bankruptcy. Guffey and Moore (1991), examining data from trucking industry, provided an estimate for direct bankruptcy costs of around 9.12 percent. Among other studies of bankruptcy costs, Altman (1984) measured the bankruptcy costs of industrial firms, and the figure was 9.8 percent. However, Warner (1977) finds the direct bankruptcy costs for railroad firms to average around 5.3 percent. We follow Cooley and Nam (1998) and set \( c \) at 10 percent.\(^{15}\)

\(^{14}\)See Zimmermann (1997). Further an alternative value of \( \delta =0.7 \) was also used while conducting the policy experiments. qualitative nature of our results stayed the same.

\(^{15}\)Varying \( c \) does not change our results qualitatively.
• $x$: The parameter measures the endowment of the entrepreneur and without any loss of generality is set at 1.\footnote{The qualitative nature of our results remain unchanged with alternative choices of $x$}

### Table 5: Multivariate Logit Model Estimates

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth</td>
<td>-0.019</td>
</tr>
<tr>
<td>TOT Change</td>
<td>-15.309</td>
</tr>
<tr>
<td>Real Interest</td>
<td>0.116</td>
</tr>
<tr>
<td>Inflation</td>
<td>0.128</td>
</tr>
<tr>
<td>M2/Reserves</td>
<td>-0.044</td>
</tr>
<tr>
<td>Private/GDP</td>
<td>-6.484*</td>
</tr>
<tr>
<td>Cash/Bank</td>
<td>18.574*</td>
</tr>
<tr>
<td>Credit Growth_2</td>
<td>0.454**</td>
</tr>
<tr>
<td>GDP/CAP</td>
<td>-0.242**</td>
</tr>
<tr>
<td>FINLIB</td>
<td>-0.151</td>
</tr>
<tr>
<td>Percentage Correct</td>
<td>92.1</td>
</tr>
<tr>
<td>Percentage Crisis Correct</td>
<td>23.1</td>
</tr>
<tr>
<td>Model $\chi^2$</td>
<td>156.873**</td>
</tr>
<tr>
<td>AIC</td>
<td>210.717</td>
</tr>
</tbody>
</table>

Notes: ** and * indicates significance levels of 1 and 5 percent respectively.

A second set of parameters is determined individually for each country. Here, we use averages over the whole sample period to find values that do not depend on the current business cycle. These parameters are listed in Table 6, along with $q$.

• $UGE$: The parameter measures the size of the underground economy as a percentage of GDP.
The values are obtained from Schneider and Klinglmair (2004) and lies between 12.3 percent (France) to 28.3 percent (Greece).

- $\tau$: The parameter measures the taxes paid as a percentage of the GDP. The country-specific values lies between 22.2 percent (Greece) to 42.1 percent (Belgium).

- $\alpha$: The parameter measures the fraction of reported income. Note the calibrated value of the parameter hinges critically on the measurements of the size of the underground economy. The following method was used

$$\frac{TE}{Y} = UGE \times \tau$$

where $\frac{TE}{Y}$ is tax evasion as a percentage of GDP.

We have assumed that the effective average tax rate is the same in the official and the underground economy. Given that

$$(1 - \alpha) = \frac{TE}{[TE \times Y + \tau]}$$

The country-specific parameters lie between 0.78 (Greece) and 0.89 (U.K.), which implies that for Greece 22 percent of the taxes are evaded and for that of U.K. the value is 11 percent.

- $\gamma$: The parameter measures the reserve-deposit ratio and lies between 1.0 percent (Belgium) and 23.5 percent (Greece).

- $\mu=\pi$: The parameter measures the average rate of growth of money and is set equal to the country specific annual rates of inflation. The parameter value lies between 3.59 percent (Belgium) to 15.16 percent (Greece).

- $\varepsilon$: The annual deposit insurance premium is obtained from Demirgüç-Kunt and Sobaci (2001). Note for France and U.K. the deposit insurance is not mandatory and available by demand.
We set it at the average of the values of Belgium and Germany. Otherwise the country-specific values lies between 0.03 percent (Belgium) to 0.64 percent (Greece).

- \( \hat{n} \): The parameter measures the employment-rate, in the sense that it is one less the average rate of unemployment. The country-specific values lies between 80.05 percent (Spain) and 93.84 percent (Portugal). The figures imply that Spain has an unemployment-rate of 19.95 percent where as the average unemployment-rate for Portugal is 6.16 percent.

A third set of parameters are calculated from the model using the country specific data. The parameters are also reported in Table 6.

- \( \beta \): The technology parameter, is set at 50, given that \( \beta > 1 \). Such a choice of \( \beta \) ensures that \( qR_L e_c \) and \( \Pi^e >x \). Formally, the two conditions imply that

\[
\beta \geq \frac{1}{1+\eta} \left(1 + \frac{\eta}{q} \right) \left( \frac{x}{\hat{n} \delta_1 - \delta_1 \eta \left(1 - (1 - \gamma)(1 - \alpha \tau)\right)} \right)
\]

and

\[
\beta \geq \frac{x}{q \delta (\delta + \delta_1 - \delta_1 \eta \left(1 - (1 - \gamma)(1 - \alpha \tau)\right))},
\]

respectively. Note if the former holds so would the latter condition. To ensure that \( \beta \) is defined we set the lower limits of \( \gamma \), \( \tau \) and \( \mu \) at 1.0 percent, 22.7 percent and 3.6 percent. Moreover \( \hat{n} \) and \( q \) are set to 0.8005 and 0.524, with \( c=0.1 \) and \( \delta=0.6 \). These values correspond to the lowest values of the corresponding parameter observed in the data for these 8 economies. In some sense we carry out a change in location of the policy parameters. It must be realized we are more interested in analyzing the movements in the policy parameters rather than their absolute value.

- \( g \): The parameter in some sense provides an ordinal measure of the real government expenditure. Note the highest real government expenditure is normalized to 1 and the value of \( g \) for a specific economy correspond to the ratio of the real government expenditure of that particular economy with respect to the normalized economy. The value of \( g \) lies between 0.064 (Portugal) to 1 (France).
• $\kappa$: The parameter captures the ratio of government expenditures to the wage bill and is given by $\frac{2(1-(1-\gamma)(1-\alpha \tau))}{x}$. The country-specific values lie between 2.4 percent (Portugal) to 33.8 percent (France).

<table>
<thead>
<tr>
<th>Country</th>
<th>$q$</th>
<th>$\tau$</th>
<th>$UGE$</th>
<th>$\alpha$</th>
<th>$\gamma$</th>
<th>$\mu$</th>
<th>$\varepsilon$</th>
<th>$\hat{n}$</th>
<th>$g$</th>
<th>$\kappa$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>0.7982</td>
<td>25.5</td>
<td>22.3</td>
<td>0.82</td>
<td>14.10</td>
<td>7.52</td>
<td>0.10</td>
<td>0.8005</td>
<td>0.298</td>
<td>0.095</td>
</tr>
<tr>
<td>Greece</td>
<td>0.7356</td>
<td>22.7</td>
<td>28.3</td>
<td>0.78</td>
<td>23.50</td>
<td>15.16</td>
<td>0.64</td>
<td>0.9122</td>
<td>0.111</td>
<td>0.070</td>
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<tr>
<td>Italy</td>
<td>0.5240</td>
<td>36.3</td>
<td>26.2</td>
<td>0.79</td>
<td>13.70</td>
<td>8.59</td>
<td>0.20</td>
<td>0.8870</td>
<td>0.789</td>
<td>0.304</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.5392</td>
<td>27.7</td>
<td>22.3</td>
<td>0.82</td>
<td>19.80</td>
<td>13.04</td>
<td>0.10</td>
<td>0.9384</td>
<td>0.064</td>
<td>0.024</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.939</td>
<td>42.1</td>
<td>21.5</td>
<td>0.82</td>
<td>3.59</td>
<td>0.03</td>
<td>0.8778</td>
<td>0.156</td>
<td>0.055</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>0.939</td>
<td>37.3</td>
<td>14.8</td>
<td>0.87</td>
<td>2.0</td>
<td>4.54</td>
<td>0.04</td>
<td>0.8927</td>
<td>1.000</td>
<td>0.338</td>
</tr>
<tr>
<td>Germany</td>
<td>0.939</td>
<td>31.8</td>
<td>16.8</td>
<td>0.86</td>
<td>6.0</td>
<td>2.29</td>
<td>0.05</td>
<td>0.8879</td>
<td>0.221</td>
<td>0.151</td>
</tr>
<tr>
<td>UK</td>
<td>0.939</td>
<td>32.9</td>
<td>12.3</td>
<td>0.89</td>
<td>2.0</td>
<td>5.77</td>
<td>0.04</td>
<td>0.9129</td>
<td>0.761</td>
<td>0.234</td>
</tr>
</tbody>
</table>

Note: Parameters defined as above.

8 Optimal Policy Decisions

The constrained optimization of the objective function given by equation (27) yields the optimal values of the decision variables, $\tau$, $\mu$ and $\gamma$. The deposit-insurance premium is fixed at the country-specific levels observed in the data. The results corresponding to different weights ($\theta$) are reported in Table 7. The following observations can be made from the results:

• The results are somewhat erratic with lack of discipline. There is quite a lot of variability within and across countries. However, except for the extreme case when the social planner...
values only the welfare of the entrepreneur, the economies with higher probability of crisis, namely Spain, Greece, Italy and Portugal, have much higher income tax rates than that of Belgium, France, Germany and Greece, which have relatively lower probability of bank failures.

- The results does not overwhelmingly vindicate our hypothesis that countries with higher probability of crisis should have higher reserve requirements. Notice however, that the high income tax rates and the high reserve requirements in economies with higher probability of crisis ensures lower levels of available loans when compared to economies with relatively lesser probability of crisis.

- When the social planner assigns higher weight to the producers relative to the depositor/worker, the optimal reserve requirements are at unity or very close to it. Such observations, in some sense corroborate our findings for the endowment economy.

To better understand the movements in the optimal policy variables, we decided to look into the average economy – an economy constructed with the average values of the the parameters of the eight countries considered in our sample. We start off by examining the case when all income is reported and the probability of bank failure is set at the lowest level observed, that is $\alpha=1$ and $q=0.939$. And then compare the economy with the following three scenarios of the same average-economy: (a) $\alpha=0.83$ and $q=0.939$; (b) $\alpha=1$ and $q=0.6493$, and; (c) $\alpha=0.83$ and $q=0.6493$. Note the values of $\alpha$ correspond to the averages of the eight economies and that of $q$ the average values of Belgium, France, Germany and U.K. (0.939), and Spain, Italy, Greece and Portugal (0.6493). The comparison between the baseline average economy and (a), allows us to evaluate the importance of tax evasion on the sizes of policy parameters, most importantly on the reserve requirements and test if at all there exists a positive relationship between reserve requirements and tax evasion. The
comparison with (c) enable us to assess the importance of bank failure on reserve requirements and other policy variable. The experiment in (d) and the comparison with the baseline economy helps us in outlining the importance of both tax evasion and higher probability of crisis, separately and simultaneously, on the policy variables. The results are reported in Table 8.

Qualitative nature of the movements of the policy variables are the same as is observed for the eight countries. Moreover, comparing rows 1 and 2 of Table 8 provides us with a distinct evidence that higher degrees of tax evasion imply non-decreasing reserve requirements, except when θ = 0.5. However, as can be see from both rows 3 and 4, when compared to 1 and 2, except when θ = 0, higher probability of crisis yields higher income tax rates. Comparison between rows 3 and 4 does not seem to provide any clear indication to movements in policy parameters when higher degrees of tax evasion is coupled with higher probability of crisis. The experiment suggests that when controlled for other parameters economies with higher probability of crisis will have higher tax rates, except when the planner values the producer only.

Finally, in Table 9 we control for the tax rate and fix it at the economy wide average of 32.7 percent. The intuition of such an experiment can be believed to be a sequential movement of the treasury and the monetary wings of the planner. The treasury moves first and arbitrarily fixes the tax rate and then the monetary authority optimally chooses the money growth rates and the reserve requirement to meet the deficit. Again as before in Table 8 we compare the baseline economy corresponding to α = 1 and q = 0.939 with (a) α = 0.83 and q = 0.939; (b) α = 1 and q = 0.6493, and; (c) α = 0.83 and q = 0.6493. Clearly comparison between rows 1 and 2 suggest that higher degrees of tax evasion would imply higher reserve requirements. Moreover comparing rows 3 and 4 with 1 and 2 indicates that economies with higher probability of crisis has higher optimal money growth rates as well as reserve requirements.
Table 7: Optimal Policy Variables ($c = 0.1$, $\varepsilon = \bar{\varepsilon}$)

<table>
<thead>
<tr>
<th>Countries</th>
<th>$\theta = 0$</th>
<th>$\theta = 0.25$</th>
<th>$\theta = 0.5$</th>
<th>$\theta = 0.75$</th>
<th>$\theta = 1.0$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\tau$</td>
<td>$\mu$</td>
<td>$\gamma$</td>
<td>$\tau$</td>
<td>$\mu$</td>
</tr>
<tr>
<td>Spain</td>
<td>40.8</td>
<td>3.6</td>
<td>100.0</td>
<td>48.8</td>
<td>3.6</td>
</tr>
<tr>
<td>Greece</td>
<td>22.7</td>
<td>45.1</td>
<td>100.0</td>
<td>62.4</td>
<td>3.6</td>
</tr>
<tr>
<td>Italy</td>
<td>22.7</td>
<td>$\infty$</td>
<td>100.0</td>
<td>84.6</td>
<td>3.6</td>
</tr>
<tr>
<td>Portugal</td>
<td>22.7</td>
<td>97.6</td>
<td>100.0</td>
<td>56.0</td>
<td>9.1</td>
</tr>
<tr>
<td>Belgium</td>
<td>22.7</td>
<td>3.6</td>
<td>88.9</td>
<td>22.7</td>
<td>3.6</td>
</tr>
<tr>
<td>France</td>
<td>44.7</td>
<td>3.75</td>
<td>100.0</td>
<td>34.3</td>
<td>20.2</td>
</tr>
<tr>
<td>Germany</td>
<td>25.1</td>
<td>3.8</td>
<td>100.0</td>
<td>25.2</td>
<td>3.6</td>
</tr>
<tr>
<td>U.K.</td>
<td>22.7</td>
<td>17.9</td>
<td>100.0</td>
<td>26.8</td>
<td>12.2</td>
</tr>
</tbody>
</table>

Notes: Optimal values derived from constrained optimization of (27).
All values are in percentages.
See also Table 6.
See Table 4.3 in Caprio, Honohan, Stiglitz (2001).
Table 8: A Counterfactual Experiment \((c = 0.1)\)

<table>
<thead>
<tr>
<th>Countries</th>
<th>(\theta = 0)</th>
<th>(\theta = 0.25)</th>
<th>(\theta = 0.5)</th>
<th>(\theta = 0.75)</th>
<th>(\theta = 1.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(\tau)</td>
<td>(\mu)</td>
<td>(\gamma)</td>
<td>(\tau)</td>
<td>(\mu)</td>
</tr>
<tr>
<td>Average-Economy</td>
<td>22.7</td>
<td>3.6</td>
<td>99.4</td>
<td>22.7</td>
<td>3.6</td>
</tr>
<tr>
<td>Average-Economy</td>
<td>22.7</td>
<td>8.6</td>
<td>100.0</td>
<td>26.9</td>
<td>3.6</td>
</tr>
<tr>
<td>Average Economy</td>
<td>22.7</td>
<td>82.8</td>
<td>100</td>
<td>62.4</td>
<td>16.4</td>
</tr>
<tr>
<td>Average-Economy</td>
<td>22.7</td>
<td>96.6</td>
<td>100</td>
<td>59.2</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Notes: Optimal values derived from constrained optimization of (27).

All values are in percentages.

See also Table 6.
Table 9: A Counterfactual Experiment ($c = 0.1$, $\tau=32.7$)

<table>
<thead>
<tr>
<th>Countries</th>
<th>$\theta = 0$</th>
<th>$\theta = 0.25$</th>
<th>$\theta = 0.5$</th>
<th>$\theta = 0.75$</th>
<th>$\theta = 1.0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average-Economy</td>
<td>$\mu$</td>
<td>$\gamma$</td>
<td>$\mu$</td>
<td>$\gamma$</td>
<td>$\mu$</td>
</tr>
<tr>
<td>Average-Economy</td>
<td>3.6</td>
<td>75.8</td>
<td>3.6</td>
<td>76.1</td>
<td>3.6</td>
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<tr>
<td>Average-Economy</td>
<td>3.6</td>
<td>91.3</td>
<td>3.6</td>
<td>91.4</td>
<td>3.6</td>
</tr>
<tr>
<td>Average Economy</td>
<td>52.0</td>
<td>100.0</td>
<td>52.0</td>
<td>100.0</td>
<td>$\infty$</td>
</tr>
<tr>
<td>Average-Economy</td>
<td>69.6</td>
<td>100.0</td>
<td>69.6</td>
<td>100.0</td>
<td>$\infty$</td>
</tr>
</tbody>
</table>

Notes: Optimal values derived from constrained optimization of (27).
All values are in percentages.
See also Table 6.

So in summary, the paper can explain differences in reserve requirements based on probability of banking crisis only when we control for the tax rates. Otherwise, the results suggest that economies with higher probability of crisis should have higher income tax rates, except for the extreme case of $\theta=0$.

9 Conclusion and Areas of Further Research

The paper tries to explore one rationale behind the existence of financial repression. We assay whether there exists a plausible explanation as to why the reserve requirements in the economies of our concern, Greece, Italy, Portugal and Spain, are relatively higher compared to other developed European economies. Previously, in Gupta (2004d), we looked into an overlapping generation endowment-economy model with asymmetric information between the government (the social planner) and the financial intermediaries. Using the framework, we tried to answer whether at all these high reserve-requirements are to discipline the banks, besides being motivated by maintaining a steady source of seigniorage revenue for the social planner.
Results from the model did not seem to support the hypothesis that bigger sizes of the underground economy and hence tax evasions cause economies to have higher values of reserve-deposit ratios. However, allowing for asymmetric information between the social planner and the banks indicates that, irrespective of the size of the probability of banking crisis, asymmetric information will always optimally cause the government to choose a reserve requirement very close to unity. So unless we explicitly categorize economies into safe and unsafe blocks based on positive or negligible (zero, in our case) probability of banking crisis, the model cannot explain the differences in reserve requirements based purely on the size of probabilities of bank failures across countries. This limitation of the endowment economy model motivated us to look into a production economy. The asymmetric information, moral hazard in our case, between the firms and financial intermediaries is modelled through a standard costly state verification problem as in Townsend (1979), Gale and Hellwig (1985), and Williamson (1989).

The results from the model can be summarized as follows: (a) The social planner will always optimally choose higher tax rates for economies with positive probability of crisis, except for when he values the welfare of the entrepreneur only; (b) In most cases, when the social planner puts higher weight on the entrepreneur, the reserve requirements are set optimally at the 100 percent level, irrespective of the size of probability of bank failures; (c) The optimal reserve requirements for economies with higher probability of crisis tends to be higher than economies with lower probability of crisis only when one controls for the tax rates, and; (d) Tax evasion does seems to be positively correlated with reserve requirements. This is clearly evident when one controls for the tax rates. So the model, under certain conditions, does provide an explanation as to why and when reserve requirements might vary across countries, allowing for asymmetric information and the severity of the associated bank failures.
A plausible extension of the existing model would be to analyze the implications of endogenous tax evasion in a full-fledged production economy with capital. This would allow us to do away with the assumption of positive endowments of the producer. Moreover, one needs to observe if incorporating public debt as a policy variable for the government yields any difference to the results obtained. Future research should be oriented towards analyzing the role of open market operations along the lines of Sargent and Wallace (1984) and Bhattacharya and Haslag (2003) in such a framework. Besides, as Basu (2001) indicates, cross-country evidences tend to suggest that government expenditure on public good and infrastructure are highly correlated with revenue from seigniorage. Hence unlike in our case, public expenditure needs to be treated as “purposeful”. It would be interesting to look into optimal policy decisions and corresponding welfare analysis in such situations.

References


