Financial development and reserve requirements

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Abstract

Many countries have either eliminated or considerably reduced reserve requirements during the last decade. This paper derives the optimal reserve requirements of a simple economy with production and financial intermediation subject to costly state verification, and shows that one motivation for the widely observed reduction in the level of mandatory reserves is linked to the process of financial markets development. © 1999 Elsevier Science B.V. All rights reserved.

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1. Introduction

Reserve requirements have traditionally been considered important for two distinct purposes: as an instrument to protect depositors from bank runs and...
crises, and as a key monetary policy instrument. Recently the latter function gained priority because of the development of other tools that can be activated for deposit protection, like the Federal Deposit Insurance Corporation (FDIC) in the USA, or the more or less explicit coverage provided by domestic regulatory agencies of the banking sector in other countries. 1

As a monetary policy tool, reserve requirements are useful because they create a larger banks’ demand for reserves and reduce the need for central bank interventions by contributing to stabilize money-market interest rates, especially when the principle of averaging provisions is used; moreover, reserve requirements make the money-market multiplier more stable and predictable, and thus help controlling money and credit expansion. 2 Finally, they provide a source of revenue for the central bank (seigniorage).

In the 1990s, however, there has been a widely spread decline in the use of reserve requirements across industrial countries. 3 Some countries as Belgium, Denmark and Sweden in Europe, and as Canada and New Zealand have completely eliminated reserve requirements; in the UK and the Netherlands, reserve requirements are still in place, but are very low. In other countries where mandatory reserves have traditionally been used (USA, Italy, Germany, France and Spain), the level of reserve regulation has been considerably reduced. Table 1 provides a synthetic description of these recent changes in the industrial countries where a reserve regime is still at work: the reserve coefficients have been reduced everywhere, and the size of reserve requirements as a percentage of GDP also declined by far in all countries but Australia, where it was already low.

1 See Dewatripont and Tirole (1994). These regulatory agencies are not necessarily branches of the central bank (Goodhart and Schoenmaker, 1993).
2 See Brunnert and Meltzer (1990), Borio (1997).

Table 1
Reserve requirements in selected industrial countries: Recent changes

<table>
<thead>
<tr>
<th>Countries</th>
<th>Reserve coefficients (range)</th>
<th>Size (%GDP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Austria</td>
<td>4.5–9</td>
<td>3.0–5</td>
</tr>
<tr>
<td>France</td>
<td>0.5–5.5</td>
<td>0.5–1</td>
</tr>
<tr>
<td>Germany</td>
<td>4.15–12.1</td>
<td>1.5–2</td>
</tr>
<tr>
<td>Italy</td>
<td>22.5–25</td>
<td>15</td>
</tr>
<tr>
<td>Japan</td>
<td>0.12–2.5</td>
<td>0.05–1.3</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Variable</td>
<td>Variable</td>
</tr>
<tr>
<td>Spain</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>UK</td>
<td>0.45</td>
<td>0.35</td>
</tr>
<tr>
<td>US</td>
<td>3–12.0</td>
<td>3–10.0</td>
</tr>
</tbody>
</table>

Sources: Borio (1997), EMI and Central banks economic bulletins.
Two factors are to be considered responsible for the diminished role of mandatory reserves as a monetary policy instrument. First, over the last decade, many central banks have shifted their operative procedures to the control of short-term interest rates rather than of bank reserves; and reserve requirements are naturally less essential as part of an interest-rate strategy rather than as part of a reserve strategy. Second, in many countries the monetary authorities are no longer allowed to issue high-power money for the permanent financing of public deficits. The need for providing a relevant channel of absorption of the monetary base is reduced when the central bank reobtains full control of its supply.

Since reserve requirements act as a tax on banks, they also put depository institutions in a situation of competitive disadvantage with respect to other financial intermediaries. In many countries, this concern became somehow more important to the authorities as non-bank intermediaries evolved over time and gained relevant quotas of the credit market. Finally, financial innovation by itself can make reserve requirements less effective, by creating new instruments that are close substitutes of the assets subject to the reserve coefficients.

This paper formalizes another plausible motivation for the observed reduction in reserve requirements. This is simply due to the process of financial development and the realization of more efficient outcomes in the financial intermediation sector that have characterized most industrial countries in the last decade.

We study a simple productive economy where financial intermediaries are at work and where a scope for regulatory intervention by a consolidated government–monetary authority derives from the fact that the process of financial intermediation is characterized by costly state verification (as in Townsend, 1979; Gale and Hellwig, 1985; Williamson, 1987). As regulatory policy, we consider the establishment of a reserve coefficient on bank deposits, basically a tax on financial intermediation. The level of the costs associated to monitoring activity can be interpreted as an indicator of the efficiency of the financial system, as it reflects the legal environment, the organizational features and the functional structure of intermediaries. We will show under which conditions the regulator will want to impose a tax on the activity of financial intermediaries, i.e. when the optimal reserve coefficient is positive. Moreover, in this case, the optimal reserve requirement is showed to be strictly increasing in the costs of

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4 See the comprehensive review in Borio (1997). Bernanke and Mihov (1995) describe an empirical methodology to model and estimate the central bank operating procedures.

5 In Europe, as a consequence of the Maastricht Treaty.

6 This was particularly evident in the US, where since the 1970s banks constantly promoted new instruments in order to circumvent the existing regulation, on reserve requirements or else (regulation Q).

7 See also Romer (1996) and Mattesini (1995).
verification of the state. In financially developed economies, characterized by low costs associated to the activity of financial intermediaries (costs of information processing and projects evaluation, as well as costs of monitoring borrowers), the reserve coefficient should then be lower with respect to economies where the financial system is less efficient. 8 Also, in growth models with a positive feedback of capital accumulation on the efficiency of the financial system, 9 this would imply a diminished role for reserve regulation over time.

Section 2 describes the model, while the optimal reserve coefficient is derived and analyzed in Section 3. Few concluding remarks follow.

2. The model

We study an economy with three agents: consumers, financial intermediaries (banks) and a consolidated government–monetary authority. Consumers are of two types: entrepreneurs and depositors. All consumers are endowed with a fixed amount of resources, but only entrepreneurs have access to a production technology. Financial intermediation has a crucial role since, on one side, it provides depositors with a safe way of transferring resources to the future while, on the other side, banks provide external finance to entrepreneurs who need it to implement their investment projects. 10

The economy is affected by ex post moral hazard due to costly state verification. Bank loans finance entrepreneurs’ investment projects whose outcome is private information of the borrower; however lenders can observe the same outcome if they accept to pay some costs associated with a monitoring activity. Monitoring costs are assumed to be proportional to loans. 11 We consider these costs for state verification as a proxy for the efficiency of the financial system or financial market imperfections. They provide a motivation for the intervention of the regulator in the economy.

2.1. Agents’ behavior

Both depositors and entrepreneurs are uniformly distributed in the [0, 1] interval: consumers within each class are a continuum with population size nor-

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8 See Di Giorgio and Reichlin (1996) for a comparative study of reserve regimes in EU countries along these lines.

9 See Bencivenga and Smith (1991), Greenwood and Jovanovic (1990) and Boyd and Smith (1995) for models linking finance and growth.

10 Here, we simply assume the existence of banks. However, these could be endogenously derived as a consequence of the ex post moral hazard problem, as in Diamond (1984).

11 The assumption of a linear monitoring technology wants to capture the idea that it is more costly to monitor large borrowers with respect to small ones. Implicitly, we are assuming a positive correlation between the borrower’s size and his or her demand for bank loans.
malized to one. They live for two periods, and have positive endowments when young; however their preferences are only defined over consumption when old.

All entrepreneurs are endowed with $W$ units of a perishable consumption good ($0 < W < 1$), and with a simple investment project represented by a stochastic linear technology. The technology is such that, by investing one unit of the consumption good at time $t$, $x > 1$ units are produced at time $t + 1$ with probability $q$, and 0 with probability $1 - q$. More formally, let $\tilde{x}$ be the random marginal product of capital of a single technology, where $\tilde{x}$ is i.i.d across entrepreneurs and let $\tilde{y}_{t+1}$ be the level of output at time $t + 1$. Then:

$$\tilde{y}_{t+1} = \tilde{x}K_t$$

with

$$\tilde{x} = x \quad \text{w.p.} \quad q,$$

$$\tilde{x} = 0 \quad \text{w.p.} \quad 1 - q.$$

Depositors are endowed with $1 - W$ units of the consumption good in their first period of life, and have access to savings in the form of bank deposits. Real deposits, $D_t$, will then be

$$D_t = 1 - W.$$  

Call $r$ the real interest rate paid by banks on deposits; each depositor at time $t + 1$ will receive $r_{t+1}(1 - W)$ units of the good for consumption.

Let $L$ be the loan to any individual project that entrepreneurs can borrow from banks. Capital investment is constrained by the available sources of financing:

$$K_t = W + L_t.$$  

When the project succeeds, entrepreneurs pay a gross interest rate $R$ on the amount borrowed, while nothing is due in the case of failure, which is interpreted as a bankruptcy state.

There is a finite number of competitive banks, which are price takers on their liabilities. $^{12}$ Banks collect deposits, keep a fraction of these as mandatory reserves and offer the difference as loans to entrepreneurs. From their balance sheet, we get that

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$^{12}$ This assumption is analogous, in this context, to the assumption that banks behave as Bertrand competitors when fixing the interest rate on deposits. In fact, given the linearity of production, the interest rate on loans is bounded above by the constant marginal product of capital. Bertrand competition on deposit rates imply that the latter be fixed exactly at the equilibrium level we derive below (Eq. (5)) as a simple consequence of free entry in the banking industry. In general, it is not true that Bertrand competition in the intermediation sector produces the walrasian competitive outcome. See Yanelle (1989).
$$L \leq (1 - \beta)(1 - W)$$

with $0 \leq \beta \leq 1$ the reserve coefficient established by the regulator.

The level and conditions of intermediation activity are determined in the financial contract that we derive below.

2.2. The financing contract

Consider two representative and risk neutral players, an entrepreneur and a bank. 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 entrepreneur, he or she will have an incentive to declare bankruptcy even if the project turns out to be successful. The bank has then to specify in the financing contract that when bankruptcy is declared monitoring will take place. As in Bernanke and Gertler (1989), banks will optimally adopt a stochastic monitoring strategy.

Let $p$ denote the probability of monitoring when bankruptcy is declared, and $V$ the punishment to the entrepreneur who is caught misreporting the outcome of production. The revelation principle allows us to derive the optimal financial contract as the solution of the following problem:

$$\max_{R,L,p,V} \Pi_b = qR_tL_{t-1} - (1 - q)\pi cL_{t-1} + \beta \rho D_{t-1} - r_tD_{t-1},$$

s.t.

(i) $L_{t-1} \leq (1 - \beta)D_{t-1},$

(ii) $q[z(W + L_{t-1}) - R_tL_{t-1}] \geq qzW,$

(iii) $q[z(W + L_{t-1}) - R_tL_{t-1}] \geq q[z(W + L_{t-1}) - \pi V],$

(iv) $V \leq z(W + L_{t-1}),$

(v) $0 \leq \pi \leq 1,$

where $\Pi_b$ are banks’ expected profits, $c$ the proportional cost associated with monitoring activity, $\beta$ the reserve requirement, and $\rho$ the real rate of interest paid on reserves by the government-monetary authority. The constraints (i)–(iv) require that the bank satisfies its balance sheet (i), that the firm accepts the contract ((ii), the “participation constraint”) and does not find profitable to misreport the outcome of the investment project ((iii), “incentive compatibility”), and that the selected punishment does respect the principle of limited liability (iv); (v) is obvious.

In the optimal contract, (ii) has to be binding, implying that $R_t^* = z$. Incentive compatibility (iii) then requires that $\pi V \geq zL_{t-1}$. Since $\Pi_b$ is decreasing in the probability of monitoring, banks will set $\pi$ at the minimum level such that (iii) holds. This implies that $1 > \pi^* > 0$ and that $V$ is set at its maximum: from (iv) $V^* = z(W + L_{t-1})$. Assuming that the entrepreneur does not misre-
port the outcome of production when truthful revelation gives him the same expected profit, (iii) binds too and we obtain \[ \pi^* = L'_{t-1}/W + L^*_{t-1}. \]

It is easy to verify that, if \( xq > c \), banks will lend all their disposable funds. Hence, \( L^*_{t-1} = (1 - \beta)D_{t-1} \). We have then proved the following proposition.

**Proposition 1.** If \( xq > c \), the optimal financial contract offered by competitive banks is

\[ L^*_{t-1} = (1 - \beta)D_{t-1}, \quad R^*_t = x, \quad \pi^* = L^*_{t-1}/W + L^*_{t-1}, \quad V^* = x(W + L^*_{t-1}). \]

Free entry in the banking industry implies zero profits in this sector. By substitution of the set of optimal choices in \( \Pi_b \), we get

\[ r_t = \beta \rho + xq(1 - \beta) \times \{1 - c(1 - q)(1 - \beta)(1 - W)/xq[W + (1 - \beta)(1 - W)]\}, \]

which implies that consumption of depositors is \( C^d_{t+1} = r_{t+1}(1 - W) \).

Entrepreneurs’ consumption at time \( t+1 \) is a random variable with the following distribution:

\[ C^e_{t+1} = xW \text{ w.p. } q, \]
\[ C^e_{t+1} = 0 \text{ w.p. } 1 - q. \]

### 2.3. Equilibrium

Market clearing requires aggregate consumption plus aggregate investment to be equal to the aggregate resources of the economy, given by endowments and aggregate production less the resources wasted in the monitoring activity. Then,

\[ \bar{C}_t + K_t = 1 + \bar{y}_t - (1 - q)\rho eL_{t-1}, \]

where with \( \bar{C} \) (\( \bar{y} \)) we denote aggregate consumption (output). From Eq. (7), \( \rho = 1 \). The net real return on reserves is zero, while the return on deposits can be rewritten as a function of the reserve coefficient:

\[ r(\beta) = \beta + xq(1 - \beta) \times \{1 - c(1 - q)(1 - \beta)(1 - W)/xq[W + (1 - \beta)(1 - W)]\}. \]

\[ \text{Note that (v) is also satisfied.} \]
3. The optimal reserve coefficient

In this simple economy, the objective of a benevolent government-monetary authority is to maximize social welfare; this can be seen as a weighted average of the expected utility of consumption of both depositors and entrepreneurs. The instrument to achieve this target is the reserve coefficient. Changes in the reserve coefficient only affect the return on deposits, while entrepreneurs’ future consumption is independent of \( b \). This implies that, when choosing the optimal reserve coefficient, the regulator only cares about the effect of changes in \( b \) on depositors’ future consumption. Since depositors’ consumption is given by

\[
C^{D} = r(\beta)[1 - W]
\]

the problem reduces to choosing the feasible value of \( \beta \), such that the real return on deposits is the highest. The regulator’s problem is then

\[
\max_{\beta} r(\beta),
\]

where \( r(\beta) \) is given by Eq. (8), and under the constraint that \( \beta \in [0, 1] \).

We will focus on the case that \( aq > 1 \). By differentiation of Eq. (8),

\[
r'(\beta) = 1 - aq - c(1 - q)(1 - W) \\
\times (1 - \beta) \left[ \frac{(1 - W)(1 - \beta) - 2(1 - \beta(1 - W))}{[1 - \beta(1 - W)]^2} \right].
\]

Moreover, one can easily show that \( r''(\beta) < 0 \).

From Eq. (10) it is evident that, if \( c \) is close to zero, the optimal solution is \( \beta^* = 0 \). However, \( \beta^* \) may be positive if monitoring costs are sufficiently high.

**Proposition 2.** If \( c > (aq - 1)/(1 - q)(1 - W^2) \), then \( \beta^* \in (0, 1) \).

**Proof.** Since \( r''(\beta) < 0 \), there is a unique global maximum. From Eq. (10), notice that \( r'(1) < 0 \), implying that \( \beta^* \neq 1 \). Moreover,

\[
r'(0) = 1 - aq - c(1 - q)(1 - W)[(1 - W) - 2]
\]

so that \( r'(0) > 0 \) if \( c > (aq - 1)/(1 - q)(1 - W^2) \). In this case \( \beta^* \in (0, 1) \).

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14 Alternatively, the government could directly collect resources from depositors and lend them to entrepreneurs, thus completely displacing financial intermediation. Here, we assume that banks have a better monitoring technology with respect to the government.

15 Hence, the role of reserve requirements in this framework is basically that of deposit protection more than that of monetary policy instrument.

16 The opposite case \( aq < 1 \) implies a technology with a negative net real return on capital: it is trivial that the optimal policy is to set \( \beta^* = 1 \) and substitute a pure transferring scheme (social security) to all other forms of activity.
One can also show that the optimal internal reserve coefficient is

$$\beta^* = \frac{1}{1 - W} \cdot \frac{W}{1 - W} \sqrt{\frac{c(1 - q)}{\theta}},$$  

where $\theta = 1 + c(1 - q) - \alpha q$.

Proposition 2 stems from the two different roles assigned to mandatory reserves in the present framework. On one side, a positive reserve coefficient subtracts resources from production, thus negatively affecting agents’ future consumption opportunities. On the other side, by reducing the amount of intermediation, reserves do also reduce banks’ monitoring activity, which is costly and leads to a depletion of the economy’s resources. When the regulator selects the optimal reserve coefficient, this trade-off has to be considered. In fact, although reserves are characterized by a lower rate of return with respect to loans invested in production, they allow to avoid the cost associated with lending activity.

From Eq. (12) it is easy to prove

**Proposition 3.** When $\beta^* \in (0, 1)$, the reserve coefficient is increasing in the level of monitoring costs.

**Proof.** Differentiate Eq. (12) to obtain

$$\frac{d\beta^*}{dc} = - \frac{W}{1 - W} \cdot \frac{1}{2} \left( \frac{c(1 - q)}{\theta} \right)^{-1/2} \left( \frac{(1 - q)(1 - \alpha q)}{\theta^2} \right) > 0.$$  

Therefore, in the case of a productive economy $\beta^*$ is positive only if $c$ is sufficiently high. In this case, the optimal reserve coefficient is higher when monitoring costs increase. However, financially developed economies facing low costs associated with the activity of financial intermediation should be imposed lower (possibly zero) reserve requirements.  

4. Concluding remarks

This work aimed at suggesting another possible rationale to the widely observed recent trend towards reducing reserve requirements in most industrial countries. The diminished role of reserve requirements in the 1990s (Table 1) has been already justified by underlying some different important factors.

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17 Even though measuring the degree of financial development remains a difficult task, simple correlations between a preliminary index of financial development and the intensity of reserve regulation in EU countries are coherent with the conclusion of this paper (see Di Giorgio and Reichlin, 1996).
These go from the simple observation that most central banks switched their operating procedures to short-term interest rate control, to the reduced need of a large demand channel for high-power money which follows higher central bank independence, and to the regulators’ desire to remove a distortionary tax on the activity of some financial intermediaries. Here, we used a simple model to argue that the optimal level of reserve requirements is also likely to be inversely linked to the degree of financial development of an economy. In a model where the process of financial intermediation is affected by costly state verification, we define as financially developed those economies where the monitoring costs associated to lending are low. In other words, we look at the efficiency of the financial system in processing information, evaluating projects and monitoring borrowers as an important determinant of a modern and developed economy.\textsuperscript{18} We show that a rationale to regulate lending activity, for example by establishing a minimum reserve coefficient, is provided by the inefficiency of the financial system as proxied by the costs associated with the working of the credit market. While higher costs require more severe regulation, there exists a threshold under which the optimal reserve coefficient is unambiguously zero. Therefore, the observed reduction in reserve requirements throughout industrial countries can be also viewed as a natural consequence of the higher efficiency recently gained by these countries’ financial systems.

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References


\textsuperscript{18} The analysis of the link between financial and economic development was started by Goldsmith (1969), Mc Kinnon (1973) and Shaw (1973). Bencivenga and Smith (1991), Greenwood and Jovanovic (1990) and King and Levine (1993), among many others, have investigated the topic in a modern theoretical framework.


