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Capital Adequacy and Competition
in a Pure Model of Banking

Patrick Honohan

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Abstract

Banks are seen as having informational advantages in the market for risky securities. The competitive implications of these advantages are explored in a model of asset prices. The impact of capital adequacy requirements on shareholders and borrowers is explored.

The paper concludes with a brief extension to the analysis of required liquidity ratios and of competition between banks which are subject to different regulatory regimes.

I am indebted to J. Eichberger and F. Milne for helpful discussions during a productive visit to the Australian National University.
CAPITAL ADEQUACY AND COMPETITION IN A PURE MODEL OF BANKING

by

Patrick Honohan

University College Dublin
and
Australian National University

1. Introduction

(a) Object of the paper.

Increasing concern over the risk and consequences of bank failure has resulted in more attention being given to the issue of regulatory control and supervision for banks. At the same time, it is recognised that regulation can distort competition between banks and nonbanks, or between banks operating under different regulations.

The purpose of this paper is to show how some of these problems can be addressed within the context of a model of a well developed capital market. This framework seems particularly suited to analysing questions of capital adequacy, where the risk structure both of the assets and liabilities of the bank arise simultaneously. On the other hand, the framework largely abstracts from the important issues of reserves management and liquidity.

(b) Different views of banking.

In recent years, emphasis has shifted away from studying the role of banks in the money transmission process and the related issues of liquidity management [1]. Now there is greater interest in the lending role of banks (Bernanke,
1983), and in the dynamic issues of deposit runs (Diamond and Dybvig, 1983).

We justify our emphasis on the static capital market considerations by reference to Fama's (1985) assertion that what makes banks special is their ability to assess the riskiness of certain classes of loans. Banks, argues Fama, have access to continuing sources of information from their customer relations of a type which is not available to nonbanks.

A complementary approach to the question: "what makes banks special?" has been suggested by Diamond (1984). He sees the essential function of financial intermediaries as availing of economies of scale and of diversification to perform monitoring functions on the ex post observance of debt contracts. This aspect is not captured in our model.

(c) Capital adequacy

A particular focus of this paper is the effects on bank behaviour of the imposition of capital adequacy ratios. There is already a literature in this area. Santomero and Watson (1977) discussed the possibility of excessive capital standards having regard to the opportunity cost of equity funds. Mingo and Wolkowitz (1977), also assuming an upward sloping supply of equity schedule, considered the impact on bank portfolio decisions of regulation which took the form of requiring a minimum "quality" of loans; they concluded that an increase in loan quality requirements would result in more bank capital, but a smaller overall balance sheet with higher quality loans. Koehn and Santomero (1980), and Lam and Chen (1985), working with a mean-variance trade-off, concluded that under certain circumstances, higher capital adequacy requirements could result in an increased risk of collapse.
It is noteworthy that most of the literature has not addressed the question of bank behavior from the standard finance theory approach of market value maximisation [2], according to which the bank's portfolio and capital decisions will be designed to maximize the stock market value of the bank. This approach allows a clear analysis of the underlying determinants of bank profitability and of the bank's decisions in regard to equity capital.

(d) Structure of the paper.

Section 2 presents an abstract model of a smoothly functioning capital market in which banks have informational advantages. The competitive position of banks vis-à-vis nonbanks is explored, distinguishing between the case of monopolist, oligopolist and perfectly competitive banks. While it is possible to present a parallel analysis in terms of a factor pricing model of the capital market, this paper uses the Arrow-Debreu contingent commodities framework [3].

In section 3 we use the model to analyse the impact of capital adequacy requirements, and show how our approach leads to some different conclusion.

In sections 4 and 5 we sketch in outline how the model framework may be used to analyse the competitive impact of required liquidity ratios, and of the competitive distortions induced by multiple regulatory regimes (such as may happen under the EBC Commission's proposals for free trade in financial services in Europe).
2. The Model

(a) The structure of information.

We suppose that there are just $N$ possible states of the world [4]. In period 1, when decisions regarding portfolio choice are being made, it is not known which of these $N$ states is the actual one; that is revealed only in period 2 when the payoffs occur. Corresponding to each state of the world we may define the elementary security $i$ as the $N$-vector consisting of zeros everywhere except in the $i$'th position where there is a 1. If $\Omega^*$ is the space of all real-valued $N$-vectors and $F$ is the $\sigma$-field generated by the elementary securities, we assume that there exists a non-atomic measure space of securities $(\Omega^*, F, \mu)$. Each security $w \in \Omega^*$ corresponds to an $N$-vector $x(w)$ of payoffs (per unit measure), with one payoff for each state of the world. Thus the $N$ elementary securities are those which pay 1 (per unit measure) in state $i$, and nothing in other states, $i=1, \ldots, N$.

A standard competitive Arrow-Debreu framework [5] would have these securities traded in equilibrium at prices which correspond to a base of elementary security prices $\pi_i$. Thus the competitive equilibrium price of security $w$ would be

$$\pi'x(w) \equiv \sum_i \pi_i x_i(w).$$

(Conventionally, we measure the securities so that $\pi'x > 0$). Also, the total price of the set of securities $F \in F$ would be:

$$\pi'[\mu x \, d\mu].$$

We now introduce an incompleteness of information. This is done in a partial equilibrium way: we assume that the imperfection of information - and the potential for
imperfect competition which results - is not so large as to
distort materially the competitive equilibrium pricing for
the assets about which there is full information.

Specifically we assume that there is a subset \( \Omega \subset \Omega^* \) such
that, given \( w \in \Omega \), it is not possible for all agents to
observe the payoff vector \( x(w) \). However, there is a
(countable) partition \( A \) of \( \Omega \), such that for all \( w \in \Omega \), each
agent can observe to which \( A \in A \) the security \( w \) belongs.
Furthermore, though he cannot identify which element is
which, each agent knows the measure \( \mu \) and in particular he
knows the value of:

\[
\pi'(\|Ax \, d\mu). 
\]

The distinction which we will make between banks and other
agents is that banks can observe \( x(w) \) for all \( w \), but non-
banks cannot. (We need not assume that the sellers of the
securities \( w \in \Omega \) observe \( x(w) \), but only that they are price-
takers and sell their security to the highest bidder.)

(b) The objective of the bank.

At the start of period one, the bank comprises the
information, as discussed above and an owner. The owner of
the bank can sell two types of security, the equity and
deposits. Apart from whatever is retained by the (original)
owner, the receipts from sale of these securities may be
applied to purchases of (nonnegative quantities of other
securities (corresponding to "loans"), and this imposes a
balance sheet constraint on the total value of securities
bought:

\[
V > \int a(w) \, d\beta - d, \quad (1)
\]
where \( V \) and \( d \) are the amounts received from sale of equity and deposits respectively; \( a(w) \) is the unit amount paid for asset \( w \), and \( \beta(w) \) is the measure of security \( w \) bought by the bank, so that the right hand side is the total amount spent in acquiring the portfolio of loans. It is convenient to think of deposits as being the numeraire, so that \( d \) is the quantity of deposits.

In period two, the bank is liquidated. For the moment we will assume that deposits are a riskless asset, so that they command the competitive riskfree rate of return of \( (\Sigma \pi_1 - 1) \equiv (r-1) \). Then in period two, \( rd \) is paid to the depositors, with a residual payment to equity holders of:

\[
|\lambda_1(w)\,d\beta - rd.
\]

If all agents (i.e. not just the bank) could observe \( x(w) \), the period-one competitive market value of such a period-two payoff would be,

\[
\pi'[|\lambda_1(w)\,d\beta - d.
\]

It will be convenient to define

\[
\lambda_0 = \pi'[\int \lambda x \, d\mu] / \int \lambda \, d\mu.
\]

\( \lambda_0 \) is the mean payoff from a security \( w \) given only the information that \( w \in A \).

The bank's objective (i.e. the objective of the bank's owner) is to maximise the surplus, i.e. the amount that can be withdrawn from the sale of equity. Thus the maximand is:

\[
V - |\lambda a(w)d\beta + d.
\]
Writing the stock market's perception of the period-one value of the securities portfolio as \( Z \) and the period-one value of the deposit liabilities as \( D \), the amount \( V \) raised by the sale of equity will, as already discussed, equal \( Z - D \). In the case of riskless deposits \( D = d \), \( d \) being as mentioned the amount received by way of deposits. If the total outlay on the securities is \( L \), then the surplus \( S \) left for the owner is:

\[
S = V - (L - d) = Z - L + (d - D), \tag{3}
\]

and because the deposits are riskless,

\[
S = V - L.
\]

Note that the balance sheet equity is no greater than, and may be less than, the amount paid for the equity. Any difference goes to the original owner and reflects the value of the special information which he has.

(c) The competitive bank.

One case to consider is where there is a large number of banks and they operate in a competitive price-taking way. Competition between the banks will mean, first of all, that each bank will have to pay the full-information price for each of the securities \( w \in \Omega \). Thus, for the competitive banking system,

\[
a(w) = \pi'x(w), \tag{4}
\]

Nonbanks will not be able to compete with these keen prices, for reasons which are amplified in the next section, except for the \( w^* \) (of negligible measure) such that

\[
\pi'x(w^*) = \min_{w \in \Omega} \{\pi'x(w)\}.
\]
Therefore, as also discussed below for the monopolistic bank, nonbanks are effectively shut out of the market for securities \( w_\Omega \).

Furthermore, the bank owners will not be able to make any surplus in the sale of their shares; accordingly:

\[
V = \pi'(x(w)d\beta - d. \tag{5}
\]

Note that this does not determine the value of \( V \) and \( d \) separately, only their sum. However, the assumption that the deposits are riskfree implies that

\[
\min \{ (x(w)d\beta - rd) \} \geq 0 \tag{6}
\]

which implies a lower bound for \( V \).

\( \text{(d) The monopolistic bank.} \)

Suppose there is a single bank, and that nonbanks are numerous and behave competitively. The monopolistic bank has a chance to convert its informational advantage into a surplus for the owner.

In particular, consider the market for securities \( w \) which are members of a particular set \( A \in A \). If the bank is not in the market, risk-neutral nonbanks will not be prepared to pay more than the expected value \( \pi'x_\Omega \) per unit of any security \( w \in A \). But it is easy to see that, if the bank is in the market, it will pay the same price \( p^w \) for any \( A \)-security that it buys. Clearly, the bank will not acquire securities with values \( \pi'x(w) \) less than the price paid \( p^w \), and it will acquire all securities on offer with values greater than \( p^w \); on the other hand the bank will be unable to buy any of the \( A \)-securities for less than \( p^w \). By
selecting only high valued securities in A, the bank's behaviour reduces the average value of the securities left for nonbanks to buy, and the nonbanks know this \( [6] \). The result, if \( \min_{w} (\pi'(x(w))) < p^o \), and if nonbanks are not to pay more than the mean value of the securities left to them, is that \( p^m < p^o \). But this cannot be an equilibrium: the bank will wish to lower the price paid until \( p^o = p^m \).

Accordingly, the only possible equilibrium price for securities in A is

\[
p^o = p^m = \min_{w \in \Omega} (\pi'(x(w))). \tag{7}
\]

In this case, as in the case of perfect competition, nonbanks are effectively shut out of the market for securities \( w \in \Omega \). (Actually we have not said enough to guarantee that (7) will be an equilibrium. Nonbanks might try to upset it by offering a higher price; the usual presumption in this situation is that the monopolist's ability to match any such higher price, imposing losses on the nonbanks is enough to inhibit entry \( [7] \)).

The value of the monopolistic bank's portfolio is thus equal to the total full-information value of the securities \( w \in \Omega \),

\[
\pi'(x(w)) \, d\mu = \pi'|_{x(w)} \, x(w) \, d\mu.
\]

How much will the bank's equity sell for? While the bank has monopoly power in the market for securities \( w \in \Omega \), the assumption that the banking system can be treated in a partial equilibrium way allows us to take it that bank equity is traded competitively. The value of the payoff to the equity holders is

\[
\pi'|_{x(w)} \, d\mu - d;
\]
and as this must be the sale price of the equity, the value of the objective function (i.e. the owner's surplus) is:

\[ S = V - L = \pi' \int a(w) \, d\mu - |a(w)| \beta = \sum a(a' \, \lambda x(w) - p^e(A)) \, d\mu = \sum a(a \lambda x(A) - p^e(A)) \mu(A). \] (8)

Note that, even though the buyers of shares cannot identify individual \( w \in \Omega \), nevertheless these expressions are nonstochastic. Equation (8) does not take account of the bank's participation in any other securities \( w \in (\Omega \setminus \Omega) \). It will be clear that any such participation where the bank has no monopoly power can yield no additional surplus and may therefore be neglected.

Note that the value of the objective function in no way depends on the quantity of deposits issued (though as in the competitive case there will be a maximum quantity issuable if the deposits are truly risk-free). This is a Modigliani-Miller type proposition for our bank: if deposits are risk-free, and in the absence of taxation, the deposit-equity ratio is a matter of indifference for the bank. This would seem to contradict the conventional wisdom that increasing the capital adequacy requirement imposes a burden on the owners of the bank.

(d) The imperfectly competitive banking industry and the nonbank fringe.

In the next section we will discuss the nature of imperfect competition between banks; here we assume that this results in each security \( w \in \Omega \) being priced by banks at a discount \( \theta \) relative to its full information value (the discount \( \theta \) being the same for each element \( A \in A \)). Thus the banks will offer to pay \( p^e(w) \) for such a security, where
\[ p^\nu(w) = (1 - \theta) \pi' x(w). \]  \hspace{1cm} (9)

Now there is some chance for the nonbanks to compete in this market, because (taking one element \( A \in \mathcal{A} \) for example) by setting their price at \( p^\nu A = (1 - \$) \pi' \mathcal{X}_A \), the nonbanks will acquire a portfolio comprising the set of securities \( w \in \mathcal{A} \) such that

\[ \pi' x(w) / \pi' \mathcal{X}_A \leq (1 - \$) / (1 - \theta); \]  \hspace{1cm} (10)

as the other securities will be bought by the banks at the higher prices \( p^\nu w \). We denote this set \( \mathcal{A}\{\$, \theta\} \). If the nonbanks are to be viable, the discount \( \$ \) must not be too small, as it must compensate for the adverse selection of securities with low values resulting from the banks' ability to discriminate. In fact, the mean value of the securities in the portfolio \( \mathcal{A}\{\$, \theta\} \) must not fall short of what the nonbanks are paying for them, i.e. \( p^\nu A = (1 - \$) \pi' \mathcal{X}_A \):

\[ \pi' \left[(1 - \$) \mathcal{X}_A - \int_{A \in \mathcal{A}\{\$, \theta\}} x(w) \, d\mu\right] \leq 0. \]  \hspace{1cm} (11)

Competition between nonbanks will ensure equality in (11), and the resulting equilibrium value of \( \$ \) may be denoted \( \$^*(\theta) \). It is not hard to see that \( \$^* \) is a decreasing function of \( \theta \); for, when \( \theta' < \theta \),

\[ \mathcal{A}\{\$, \theta'\} \subseteq \mathcal{A}\{\$, \theta\} \]  \hspace{1cm} (12)

and the mean value of securities in the larger set \( \mathcal{A}\{\$, \theta'\} \) exceeds that in \( \mathcal{A}\{\$, \theta\} \). Therefore at \( \{\$, \theta'\} \) the nonbanks are paying less than full market value for the portfolio. Accordingly, competition between nonbanks will lower the discount \( \$ \), leading to

\[ \$^*(\theta') < \$^*(\theta') \text{, for } \theta' > \theta'. \]  \hspace{1cm} (13)
Since individual nonbanks may not acquire identical portfolios, it is reasonable to ask whether the question of risk aversion must be addressed in arriving at conclusions such as that above. Certainly an assumption of risk-neutrality will be enough to guarantee these conclusions, but there is also the possibility of diversification in a market as complete as we have assumed. Now, the risk here arises simply from the sampling variation of each nonbank's share of the set $\Lambda \cap \mathcal{B}(\mathcal{G}, \theta)$. Such risk can be fully diversified in an efficient market. Accordingly, the nonbanks, acting in the interest of their shareholders will optimally behave in a risk-neutral manner in regard to this risk).

It follows from (12) that the set of securities acquired by the banks shrinks as $\theta$ is increased. Thus, for $\theta' < \theta'$:

$$B(\mathcal{G}(\theta'), \theta') \leq B(\mathcal{G}(\theta'), \theta') \leq B(\mathcal{G}(\theta'), \theta')$$

(14)

(The first inequality in (14) repeats (12), while the second results from (13)). In particular therefore, if we adopt the notation $B(\mathcal{G}) = B(\mathcal{G}(\theta), \theta)$, the aggregate value of the banks' portfolio may be written:

$$Z(\theta) = \pi' \mathcal{E}(\mathcal{G} \times \mathcal{W}) \, d\mu,$$

(15)

where $\delta Z/\delta \theta < 0$. If the stockmarket investors know $\theta$, as well as the measure function $\mu$, this will also represent the aggregate stockmarket valuation of the banks' portfolios.

The outlay on this portfolio is simply $(1 - \theta)$ times this expression. The aggregate value of the banks' objective functions (with riskless deposits) is thus

$$S = \theta . Z(\theta),$$
(e) Imperfect competition between banks.

Assuming that all of the banks are the same, and that there is a finite number \( N \) of banks \( (8) \), allows us to explore what the outcome of imperfect competition might be. Our analysis of the strategic interaction between banks is preliminary in nature, and it is planned to amplify the discussion considerably in future work.

As usual in the case of oligopoly there is a multiplicity of possibilities. Collusive outcomes would tend toward the monopolistic structure of prices, while a Bertrand type of equilibrium could be close to the competitive situation already discussed.

If the banks are to benefit from their superior information vis-à-vis the nonbanks it seems from general considerations that they will have to either restrain their volume of lending below what occurs in the competitive case, or succeed in discriminatory pricing, or both. In this context, discriminatory pricing would correspond to different values for the ratio: \( a(w)/x'x(w) \), which is the price per unit of value received by the bank (and is the same as the \( \theta \) of the previous section).

In the spirit of traditional theories of focal-point pricing, we will confine ourselves to the analysis of non-discriminatory pricing choosing \( \theta \) as the strategic variable, and taking it that each bank has the same price \( \theta \) in equilibrium. From the discussion of the previous section, we know that the banks face a downward sloping demand curve \( Z(\theta) \) for the value of securities which can be bought by them at any given value of \( \theta \). Kreps and Scheinkman (1983) have shown how output restraint, combined with price competition, can result in Cournot outcomes, and with their approach in mind, it is not unreasonable to examine what the Cournot
equilibrium would mean in our case. In this the analogue to the industry demand curve would be $Z(\theta)$, the price $\theta$, marginal cost zero. With identical firms, the Cournot equilibrium price is a decreasing function of the number of firms and of the absolute value of the elasticity of demand.

(a) The case of risk-free deposits.

Capital adequacy requirements [9] are imposed in order to reduce the risk that banks may fail. But, especially where the preexisting risk of failure is small or non-existent, can the imposition of capital adequacy requirements reduce welfare? In particular, can the imposition of, or an increase in, such requirements either reduce the return to the owner, increase the risk of failure, or adversely affect the borrower?

In the case where deposits were risk-free before the imposition of the new requirements, it seems from our analysis that the answer in all three cases is no.

That is because neither the value of the banks' objective functions, nor their decisions with regard to price offered for securities, and the actual securities bought, depended in any way on the share of deposits in the financing of the portfolio. Note that the capital to loans ratio corresponds in our model to:

\[ \alpha = 1 - \frac{d}{l} \langle w \rangle \ d\beta. \]  \hspace{1cm} (15)

But this merely determines the maximum quantity of deposits as

\[ d \leq (1 - \alpha) \langle w \rangle \ d\beta. \]  \hspace{1cm} (16)

As already discussed in the previous section, an increase in the value of deposits issued reduces, pound for pound, the part of the proceeds of the equity sale required to purchase the portfolio of securities. At the same time it reduces, pound for pound, the amount that can be raised from the sale
of equity. The combination of these two effects results in there being no change in the surplus, that is, the part of the equity sale that can be withdrawn and need not be spent on the purchase of securities.

While it may not be surprising that the imposition of, or an increase in, capital adequacy requirements can do little to benefit the depositors if the deposits are already riskfree, it may be a little surprising that it does no harm to the shareholders, or to global welfare, in contrast to the model of Santomero and Watson (1977). It is also noteworthy that, in contrast to the model of Kohn and Santomero (1980), there is in our model no possibility that increased capital requirements could result in an increased risk of failure [10]. We now turn to the case of risky deposits to see whether these conclusions survive the introduction of risk.

(b) Risky, uninsured deposits.

By risky deposits we mean a situation where the bank is not in a position to meet demands for encashment of deposits. Banks can fail in two distinct types of situation. First, and arguably the most important, because the underlying value of their assets has fallen below the face value of their deposits. Second (and this is the case analysed by Diamond and Dybvig (1985), for example), it is possible, even in a rational world, that a run of depositors could develop which could result in failure, even though the underlying value of the assets exceeded liabilities. The difficulty here would arise because of illiquidity: the bank might not be able to realise the full value of the assets at short notice.
Our model of a complete full-information market is not designed to capture the second type of failure involving illiquidity. Accordingly we will discuss the first type, though some of what is said will apply to both types. We do not assume that there is any deadweight cost to bankruptcy (cf. Kareken and Wallace, 1978), nor any special penalty such as discussed by Diamond (1984).

Clearly, if there is some significant probability that the bank may fail, the true value of its deposit liabilities falls short of what they would be worth if riskless. Thus if we continue to assume that a unit of deposits pays $r$ in period 2 in the event that the bank has not failed, a quantity of deposits $d$ (promising to pay in aggregate $rd$ if the bank does not fail) has present value $D < d$.

In other words, to persuade depositors to place the deposits when only the risk-free rate $r$ is being offered by way of interest, the bank must offer discounts or other inducements [11]. We could alternatively model these as deposits sold at par but bearing a higher rate of interest than the risk-free rate. The essentials of such an an analysis would be the same.

Formally, in state of the world $i$, the aggregate sum available to depositors will be

$$y_i = \text{Max} \{rd, \int x_i(w) \, d\$\}.$$  

And the market value of this aggregate sum is $D = \pi'y$.

Clearly,

$$\text{Min} \int x_i(w) \, d\$ < rd \Rightarrow \pi'y < d.$$
The mean deficiency of the bank is the probability-weighted sum of terms of the form:

\[ \max \{0, \lambda X_t(w) d\beta - rd\}. \]

An individual depositor may be acquiring something other than a proportionate share of this sum, however, depending on how one sees the procedure of failure. From certain points of view the fact that depositors who withdraw early get full payment while those who try to withdraw late get nothing is important. This fact contrasts with the position of debt-holders of a nonbank (and is associated with the phenomenon of runs). For two reasons it is of less significance in our model. First, from a formal point of view there are only two dates in our model, with no time for a bank "run" to develop. Second, the risk of being late in the queue is a diversifiable one, and in our complete market we can assume that it imposes no discount on the market price of deposits over and above that imposed by the mean deficiency.

Consider two possible capital ratio decisions for a bank given a particular portfolio \( \beta \) whose market value is \( Z \) and whose cost to the bank is \( L \): the first is all equity financing; the second a high level of deposit financing involving risk, i.e. \( \pi'y < d \). In the first case, the value of the bank's objective \( S \) equals the amount raised from the sale of shares (which, for an all equity bank is simply \( Z \)) less the cost of the portfolio \( L \).

In the second case the sale of risky deposits raises \( D \) which can be placed towards the cost of the portfolio \( L \), leaving only \( (L - D) \) to be used from the sale of equity. The
purchasers of the equity can look forward to receipt in state of the world $i$ of

$$\min (0, \int x_i(w) \, d\beta - r_d) = \int x_i(w) \, d\beta - y_i.$$  

Thus the amount that can be raised from sale of equity is:

$$V = \pi' \int x(w) \, d\beta - \pi'y = Z - D, \tag{17}$$

which means that the surplus is the same as for the all-equity bank: $S = (Z - D) - (L - D)$. The Modigliani-Miller reasoning carries over (as we would expect) to the case of risky deposits.

Therefore neither the bank's objective function nor its behaviour in regard to selection of the portfolio of securities can be affected by the imposition of a capital adequacy requirement, even if the bank's deposits were risky before the imposition of the requirement. The fact that this risk is perceived by depositors, causing them to place the deposits only at a discount relative to risk-free deposits, ensures that the bank's shareholders cannot gain from the existence of deposit risk.

(c) Insured deposits

It is when there is an external guarantee, as might be provided by a Government guaranteed deposit insurance scheme, that there may be an incentive for the bank's shareholders to increase the proportion of deposit financing. Thus consider the possibility that deposits are considered riskfree by depositors even though

$$\min \int x_i(w) \, d\beta < r_d. \tag{18}$$
Then the bank can raise \( d \) from the sale of deposits, while, by the same reasoning as led to equation (17), the amount raised from sale of equity is \( V = Z - D \), with \( D = \pi'y < d \). Then the bank's surplus \( S \) becomes:

\[
S = (Z - D) - (L - d) \\
= (Z - L) + (d - D) \\
= (Z - L) + d(1 - D/d).
\] (19)

Now, even if the ratio of market to face value of the deposits' \( D/d \) is fixed, the sale of deposits actually increases the surplus of the bank. Secondly, the more deposits that are sold, the more likely the bound (18) is to be satisfied, and the more states \( i \) will also result in bank failure so that \( D/d \) is a non-increasing function of \( d \). Finally, a different choice of portfolio \( \beta \) might lead to a smaller value of \( D/d \), so that portfolio choice and the pricing of securities may also be affected by the wedge that has been placed between the value of the deposit to the depositor and the value of the deposit liability from the bank's point of view. [12]

In this case of insured deposits, therefore, capital adequacy requirements will have real effects. A higher ratio reduces the bank's surplus (cf. equation (19)). And it also reduces the bank's incentive to opt for portfolios which, at a given value, have low payoffs in some states of the world, i.e. risky portfolios.

For a given portfolio \( \beta \), an increase in the capital adequacy requirement (corresponding to a reduction in \( d \)) cannot increase the probability that (18) will be satisfied. More generally, because of the assumed completeness of markets, an increased capital requirement cannot increase the probability of failure even after the bank has adjusted its portfolio \( \beta \) to the new requirement. This highlights the
contrast between the model of this paper and that of Koehn and Santomero (1980).

We have ignored the possible existence of an insurance premium paid by the bank for the deposit scheme. As shown by Merton (1977), Eichberger (1987) and others, it may, given enough information, be possible to design premium schedules for deposit insurance which would eliminate the incentive effects which arise out of the existence of a deposit scheme. Essentially such premiums should, in our framework, equal the gap \((d - D)\). Payment of that premium would bring the surplus \(S\) back into equality with \((Z - L)\). But even with a premium schedule of this type there will in general be some bank failures and the deposit insurance scheme will therefore not be inactive.

Instead of charging a variable insurance premium one could impose sufficiently severe capital adequacy requirements as to ensure that \((18)\) does not hold. In that case the deposit insurance scheme would never actually be called on, and the premium would be zero. However it might be that the capital adequacy ratio needed to eliminate deposit risk could be 100 per cent.

Our modelling framework is not suited to analysing the unique liquidity characteristics of deposits. Our assumption indeed is that riskless deposits are equivalent to other riskfree securities. Prohibition of deposits, as would be implied by an all-equity requirement, would in reality impose welfare losses not measured by our model.
4. Reserve Asset Costs

In this section and the following are sketched some further applications of the general approach. More detailed treatments of these matters will be provided in a subsequent paper.

(a) Some liquidity requirements do not affect the surplus.

In many countries monetary authorities require banks to hold a quantity of riskfree (and liquid) assets in proportion to the quantity of deposits issued. This is done for reasons of monetary policy and also to guard against the possibility of bank runs of the type, discussed above, which are related to illiquidity rather than insolvency. Neither of these dynamic considerations can be illuminated by our essentially static equilibrium model. However we can ask what difference liquidity ratios (reserve requirements) make to the competitive position of banks and to equilibrium in the market for the securities in which the banks have an informational advantage?

In order to address this question we must decide how to model required liquidity ratios in our framework. Clearly the value of the bank's surplus cannot be altered by the issue of additional risk-free deposits in order to finance the holding of a traded riskfree asset. Therefore, in response to the imposition of a liquidity ratio $R$, the bank can achieve the same surplus by issuing more deposits in an amount equal to $R/(1-R)$ of the previously planned level. The additional resources can then be invested in a riskfree asset, the remainder of the portfolio being as before.

Furthermore, in the case where deposits are risky it is also possible for the bank to make adjustments which alter neither the value of its surplus or its risk portfolio $R$. 

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Specifically, the imposition of a liquidity ratio will best be met by (a) no change in the quantity of deposits, (b) purchase of riskfree assets to the required amount. Then the sale of equity will realize just enough more to finance the purchase of riskfree assets while leaving the surplus unaffected. We must look further to find any more significant effect from the imposition of liquidity ratios.

In some monetary policy regimes the required liquid reserves must be held in a form which yields a lower than market rate of return, such as central bank deposits. In this case there is clearly a real change: the bank's surplus declines at the previous portfolio β, and β may therefore itself be adjusted in response to the imposition. Since the effects wash out when the required reserves yield a market rate of return, the effect of liquidity ratios on bank surplus and on its choice of risk asset portfolio is the same as if a tax or other additional cost per pound of deposits issued had been imposed. This additional cost is commonly known as the reserve asset cost. The point being made here is that this cost fully summarises the impact of the required liquidity ratios.

(b) Impact of reserve asset cost on bank portfolio choice.

For the case of risk-free deposits, the reserve asset cost places a wedge between the net proceeds of the issue of deposit liabilities and their value to the depositors. Thus if we write the implied tax rate as ρ, the surplus (cf. equation (3)) is now:

\[ S = (V - L) - \rho d. \]

The same reasoning applies to the situation of uninsured risky deposits.
In contrast to the situation discussed in Section 3, where the insurance of deposits in the presence of a risk of failure introduces an incentive for banks to increase their proportion of deposit financing, the reserve asset cost tends to induce less reliance on deposit financing. Indeed, in this case our model predicts 100 per cent. reliance on equity financing.

For insured deposits with a risk of failure it may be realistic to generalise the analysis allowing some positive dependence of the reserve asset cost on the quantity of deposits. The expression for surplus becomes:

\[ S = (V - L) + d(1 - \rho(d) - D/d). \]  

(20)

We first consider the constant reserve asset cost \( \rho(d) = \rho \). Because of the convexity (discussed in Section 3 above) of \( d(1 - D/d) \), a constant reserve asset cost, though it discourages deposit use in itself, cannot outweigh the incentive for reliance on deposit financing if there are no capital adequacy requirements. Sufficiently high capital adequacy requirements, combined with sufficiently high reserve asset cost may, however once again give a prediction of 100 per cent. equity financing. However, the most realistic situation is presumably the other corner solution with deposits at the maximum allowable under capital adequacy requirements.

If the reserve asset cost per unit of deposits increases with the quantity of deposits, an interior solution for the deposit quantity may be reached where the reserve asset cost equals the gain \( \rho(d) = D/d \).

As discussed in Section 2, it would be necessary to explore issues of taxation and of bankruptcy costs to complete the analysis of the chosen mix of deposits and equity financing.
(c) Competitive impact of reserve asset costs.

Suppose the bank is in a position where the optimal financing of additional portfolio costs involves more deposit financing. And further suppose that, for any given risk portfolio \( \beta \), the impact on the bank's surplus of issuing additional deposits is negative (for example because of reserve asset costs). Then, by comparison with the conclusions of Section 2 above, there are qualitative differences in the competitive situation of the bank.

First, if the bank is a single monopolist, there may now be a chance for nonbanks to gain some share of the market for securities \( w \in \Omega \) about which they are not fully informed. After all, the bank may no longer be satisfied to pay \( \pi' x(\omega) \) for a security when reserve asset costs have to be incurred. Therefore, even for the discriminating monopolist, a maximum ratio \( (1 - \theta) \) will exist between the amount the bank is willing to pay for any given security and its full information market value. This means that, by offering to pay

\[
p^{\text{MB}} = (1 + \lambda) \min_{w \in A} \pi' x(w),
\]

nonbanks can capture all of the set of positive measure given by:

\[
\{ w \in A: \pi' x(w) \leq p^{\text{MB}} / (1 - \theta) \}.
\]

Provided \( \lambda \) is not too large, the nonbanks will break-even with this offer.

A parallel point applies to the case of the competitive bank.
It should be stressed, however, that our conclusion in this subsection depends on the reserve asset cost not being offset by other considerations as the previous subsection implied might happen.
5. Competition from Abroad

(a) Integrated Capital Markets

Opening access for foreign banks to the domestic banking market may cause distortions of competition if the regulatory regime applying to the entrant banks is different to that which prevails here. This situation is of current policy importance because of the proposals of the European Commission in regard to completion of the internal market in financial services. Broadly speaking, these proposals are based on the principle of "home country regulation", according to which a bank abides by regulations set out in its country of incorporation, rather than in the country where it is operating. The details of these proposals remain to be worked out, and it is possible, even likely, that the final shape of free trade in financial services in Europe will be quite different from what has been adumbrated so far. Furthermore, a process of convergence of regulatory requirements can be detected in Europe and throughout the industrial world. If this process continues or accelerates, the distortions resulting from trade between institutions subject to regulation from different national authorities will become less serious.

Similar problems may arise even within a single country where different classes of bank are subjected to different regulatory requirements. The dividing line between banks and nonbanks in our sense and from the point of view of regulatory arrangements may not be the same.

It is therefore important to establish what distortions are likely to be caused by differences in regulation. First we deal with an integrated capital market, which could be just one country, or several countries where the absence of capital controls and efficient institutional arrangements
allow the Arrow-Debreu prices to prevail for uncertain prospects throughout the market. Once again we address the question of capital adequacy requirements and liquidity ratios.

What happens if a foreign entity purchases an existing bank, but by virtue of the residence of the new owner the bank is now subject to regulation from abroad? It follows from our earlier discussion that the substitution for an existing bank of an entrant bank with lower capital adequacy requirements can make no difference to the competitive situation, so long as the lower capital adequacy requirements are still so high as to make the riskiness of deposits negligible.

On the other hand if there is a higher possibility of failure because of the lower capital ratio, then the deposits of the entrant cannot compete at par with those of the incumbents unless they are covered by a deposit insurance scheme. The reasoning of Section 2 leads us to the conclusion that these differences in deposit risk will be fully capitalised and can give the entrant no competitive advantage.

The impact of differing reserve asset costs is more difficult to assess, as is the question of differing treatment for deposit insurance. It is certainly possible that there may be competitiveness implications here. There are parallels with the analysis in Section 4 of the competition between nonbanks on the one hand and banks suffering reserve asset costs on the other.
(b) Segmented capital markets

The persistence of controls restricting the movements of capital between different countries, including some European countries, raises a different set of questions about competition between banks owned by residents of different countries. In particular, there is no reason why the Arrow-Debreu prices for elementary securities should be the same in both countries.

Thus a bank with Spanish owner, and issuing shares only in Spain, but competing with Portuguese banks in Portugal, will have reference to the Spanish Arrow-Debreu prices (say $\sigma$) when evaluating its surplus; whereas the Portuguese bank will have reference to the Portuguese prices $\pi$. Allowing a handful of Spanish banks into the Portuguese market will not be enough to equalise these prices. Whereas there are $N$ states of the world, and hence $N$ securities would be needed to achieve a complete market, the only security each bank is transmitting from its country of operation into its home capital market is its own equity.

In general, the Spanish banks will acquire securities $w$ for which:

$\nu'(w) > \pi'(w)$,

and vice versa. If there is more than one Spanish bank operating in Portugal, we would not expect them all to acquire identical portfolios. The $N$-dimensional risk means that each bank can choose a differentiated product (the risk-characteristics of their own equity) for which there is a distinct downward sloping demand curve at home.

Accordingly the presence of foreign banks operating in segmented capital markets should result in patterns of
differentiation rather than in a dominance of either foreign or domestic banks.

Our analysis here ignores, of course, technological and cost advantages which might exist between banks in different countries. It also ignores the formidable information barriers which may preclude the applicability across international frontiers of the kind of market completeness which we have assumed throughout.
1. See Baltensperger (1980) for a classification and discussion of theories of the banking firm.


3. As in Kareken and Wallace (1978). Note that the Arrow-Debreu model is based on assumptions which are not always fully satisfied in what follows here.

4. The assumption of a finite number of states is mainly for clarity of notation: a continuum of states would require double integrals.

5. See footnote 3 above.

6. Though we assume throughout that the nonbanks cannot acquire any further information about w. Thus, in particular, if the bank were paying different prices for different securities, as will become relevant in a later section, we assume that the nonbanks have no way of verifying any information which they might receive about particular price offers for particular securities.

7. But see Gellman and Salop (1983) for an analysis of this problem.

8. See Hannan (1979) for evidence of barriers to entry in banking.


10. Santomero and Watson (1977), assumes supply and demand schedules with conventional slopes, while Koehn and Santomero (1980) is based on the idea of maximising a mean and variance objective function.

11. We could alternatively model these as deposits sold at par but bearing a higher rate of interest than the risk-free rate. The essentials of such an an analysis would be the same.

12. Cf. Kareken and Wallace (1978), Buser, Chen and Kane (1981). Notice here that the risk of failure (combined with deposit insurance) provides an incentive to increase the debt-equity ratio, in contrast to a familiar story in corporate finance where the risk of failure (combined with deadweight bankruptcy costs) provides the opposite incentive.