Pillar I vs Pillar II under Risk Management

Loriana Pelizzon* Stephen Schaefer †

February 2004

NBER Project on the Risks of Financial Institutions and of the Financial Sector

*University of Padua. Postal: Dipartimento di Scienze Economiche, Via del Santo 33, Padova, Italy, Phone +39 049 8274154, Fax +390498274211, loriana.pelizzon@unipd.it

†London Business School. Postal: IFA, Sussex Place, Regent's Park London NW1 4SA, Tel. +44 207 272 5050, Fax +44 207 724 7875, sschaefer@london.edu

Pillar I vs Pillar II under Risk Management

1 Introduction

Under the New Basel Accord bank capital adequacy rules are substantially revised (Pillar I) but the introduction of two new dimensions to the regularity framework is, perhaps, of even greater significance. Pillar II increases the number of instruments available to the regulator: (i) intensifying the monitoring of the bank; (ii) restricting the payment of dividends; (iii) requiring the bank to prepare and implement a satisfactory capital adequacy restoration plan; (iv) requiring the bank to raise additional capital immediately. Pillar III enhances disclosure (that is, publicly available information). This paper focusses on Pillar II and asks how regulators should use the discretion that this new approach provides.

We construct a model of bank behavior in which banks manage their portfolios in the interest of their shareholders subject to the constraints that regulation imposes. These constraints include not only capital requirements but actions taken by the regulator under the new Pillar II; these include decisions on closure and recapitalization. The model is dynamic which means that banks are concerned about survival as well as exploiting deposit insurance and also allows banks to manage their risk dynamically. This last point is important for several reasons. Among these are that dynamic portfolio choice ("risk management") changes the impact of capital requirements and Pillar II discretion on bank risk taking and the relation between two simple measures of bank risk, namely the value of deposit insurance liabilities and the probability of default. Because, under risk management, these two measures may behave quite differently, we employ both when in studying the consequences of regulatory actions for bank risk.

Our paper will focus on the following questions:

(i) How should regulators use the enhanced discretion for intervention that Pillar II provides (closure rules, dividend restrictions, recapitalization, etc) while taking into account banks' ability to revise their portfolios dynamically?

(ii) How, taking account of banks' behavioral response, should the supervisory process be developed to address issues such as: the frequency and intensity of monitoring, the incentives that banks have to "cheat" (i.e., misreport their capital and risk positions) and the role of information disclosure?

(iii) What are the implications of points (i) and (ii) for the cost of deposit insurance and the probability of default?

2 The New Basel Accord: a brief description

In the early 1980's, as concern about the financial health of international banks mounted and complaints of unfair competition increased, the Basel Committee on banking Supervision initiated a discussion on the revision of capital standards. An agreement was reached in July 1988, under which new rules would be phased in by January 1993. The Basel accord of 1988 explicitly considered only credit risk and the scheme was based entirely on capital requirements. These requirements, still in force, comprise four elements: (i) the definition of regulatory capital, (ii) the definition of the assets subject to risk weighting, (iii) the risk weighting system, and (iv) the minimum ratio of 8%[1].

When the Accord was introduced in 1988, its design was criticized because too crude and for its "one-size-fits-all" approach[2]. Given these shortcomings, together with the experience accumulated since the Accord was introduced, the Basel Committee considered a revision of the current accord (Basel Committee (1999, 2001, 2003)).

[1]Following its introduction, the Accord has been fine-tuned to accommodate financial innovation and some of the risks not initially considered. For example, it was amended in 1995 and 1996 to require banks to set aside capital in order to cover the risk of losses arising from movements in market prices. In 1995 the required capital charge was based on the "standard approach" similar to that applied to credit risk. The standard approach defines the risk charges associated with each position and specifies how any risk position has to be aggregated into the overall market risk capital charge. The amendment of 1996 allows banks to use, as an alternative to the standard approach, their internal models to determine the required capital charge for market risk. The internal model approach allows a bank to use its model to estimate the Value-at-Risk (VaR) in its trading account, that is, the maximum loss that the portfolio is likely to experience over a given holding period with a certain probability. The market risk capital requirement is then set based on the VaR estimate. The main novelty of this approach is that it accounts for risk reduction in the portfolio resulting from hedging and diversification.

[2]The main criticisms were, among other things, (i) the capital ratio appeared to lack economic foundation, (ii) the risk weights did not reflect accurately the risk of the obligor and (iii) it did not account for the benefits from diversification. One of the main problems with the existing Accord is the ability of banks to arbitrage their regulatory capital requirements (see Jones (2000) and exploit divergences between true economic risk and risk measured under the Accord.

The proposed new accord differs from the old one in two major respects. First it allows the use of internal models by banks to assess the riskiness of their portfolios and to determine their required capital cushion. This applies to credit risk as well as to operational risk and delegates to a significant extent the determination of regulatory capital adequacy requirements. This regime is available to banks if they choose this option and if their internal model is validated by the regulatory authority. Second, by adding two additional "pillars", alongside the traditional focus on minimum bank capital, the new accord acknowledges the importance of complementary mechanisms to safeguard against bank failure. Thus, the new capital adequacy scheme is based on three pillars: (i) capital adequacy requirements (Pillar I), (ii) supervisory review (Pillar II) and (iii) market discipline (Pillar III).

With regard to the first pillar, the Committee proposes two approaches. The first, called "standardized" approach, adopts external ratings, such as those provided by rating agencies, export credit agencies, and other qualified institutions. The second approach allows the use of internal rating systems developed by banks, subject to their meeting specific criteria yet to be defined, and to validation by the relevant national supervisory authority. The internal ratings approach also gives some discretion to banks in choosing the parameters that determine risk weights, and consequently, in determining their capital requirements. The foundation approach, in contrast, provides little discretion[3].

As far as the second pillar is concerned, the proposals of the Basel Committee underline the importance of supervisory activity, such as reports and inspections. These are carried out by individual national authorities who are authorized to impose, through "moral suasion", higher capital requirements than the minimum under the capital adequacy rules. In particular, Pillar 2 emphasizes the importations of the supervisory review process as an essential element of the new Accord (see Santos (2001)). Pillar 2 encourages banks to develop internal economic capital assessments appropriate to their own risk profiles for identifying, measuring, and controlling risks. The emphasis on internal assessments of capital adequacy recognizes that any rules-based approach will inevitably lag behind the changing risk profiles of complex banking organizations. Banks' internal assessments of should give explicit recognition to the quality of the risk management and control process and to risks not fully addressed in Pillar 1. Importantly, Pillar 2 provides the basis for supervisory intervention to prevent unwarranted declines in a bank's

[3]In addition to revising the criteria for the determination of the minimum capital associated to the credit risk of individual exposures, the reform proposals advanced by the Committee introduce a capital requirement for operational risks, which is in turn determined using three different approaches presenting a growing degree of sophistication.

capital.

In the light of these objectives, the Basel Committee has articulated four principles: (1) Each bank should assess its internal capital adequacy in light of its risk profile, (2) Supervisors should review internal assessments, (3) Banks should hold capital above regulatory minimums, and (4) Supervisors should intervene at an early stage[4]. In particular Pillar II increases the number of instruments available to the regulator.

Supervisors should consider a range of options if they become concerned that banks are not meeting the requirements. These actions may include intensifying the monitoring of the bank; restricting the payment of dividends; requiring the bank to prepare and implement a satisfactory capital adequacy restoration plan; and requiring the bank to raise additional capital immediately. Supervisors should have the discretion to use the tools best suited to the circumstances of the bank and its operating environment. (New Accord: Principle 4: 717).

Finally, the third pillar is intended to encourage banks to disclose information in order to enhance the role of the market in monitoring banks. To that end, the Committee is proposing that banks disclose information on, among other things, the composition of their regulatory capital, risk exposures and risk-based capital ratios computed in accordance with the Accord's methodology. However, the Basel Committee does not clearly specify the necessary instruments available to regulators to encourage greater public disclosure of information, the importance of the role of the market as a subject capable of forcing banks to adopt a capitalization level that is consistent with their risk profile.

The descriptions of the second and third pillars are not as extensive or detailed as that of the first. Nevertheless, it is significant that for the first time in international capital regulation, supervision and market discipline are placed at the same point of the hierarchy as the regulatory minimum. In discussing the second pillar, supervisory review of capital adequacy, the proposal states that: "The supervisory review process should not be viewed as a discretionary pillar but, rather, as a critical complement to both the minimum regulatory capital requirement and market discipline."

[4] An application of this insight is the prompt corrective action scheme in effect in the US since the passage in 1991 of the Federal Deposit Insurance Improvement act. The scheme defines a series of trigger points based on a bank's capitalization and a set of mandatory actions for supervisors to implement at each point.

3 Advantages and main drawbacks of the New Accord

The Committee's proposals can be seen as trying to address the drawbacks of the previous capital adequacy scheme. In particular, we believe the following are the three most important advantages of the New Accord:

- More accurate assessment of risk, in particular credit risk
- Reduced opportunity for regulatory arbitrage
- Enhanced role for regulatory intervention and market discipline.

Introducing an extension to the current Accord, that concentrates only on capital requirements, Basel II appears to have taken into account the insight of the literature that in general it is advantageous to consider a menu approach rather than a uniform "one-size-fits-all" rule.

Nonetheless, it appears to us that the new Accord does have some significant weaknesses and, among these, we draw particular attention to the following.

- **Objectives**

A major problem in discussing developments in banking regulation, and financial regulation in general, is that there is little discussion, and certainly no consensus, on the objectives that the regulator should pursue. The two most commonly cited justifications for capital regulation are (i) the need to control the value of deposit insurances liabilities and (ii) the mitigation of systemic risks. While considerable attention has been paid to the first of these issues, formal discussion of the effect of capital requirements on systemic failure is almost non-existent. (Allen and Gale (2003))

- **What's the cost?**

There is no consensus on the costs that higher capital requirements impose on banks (and, ultimately, on consumers). This is a major stumbling block in any analysis of capital requirement because, if these costs were not significant while the costs of failure were significant, required capital would be set to sufficiently high levels so that the incidence of bank failure would be minimal. Certainly the US House of Representatives Committee on Financial Services is concerned about the costs imposed by capital requirements: "We are concerned that the bank capital charges created by Basel II, if implemented, could be overly onerous and may discourage banks from engaging in activities which promote economic developments"[5].

- **Bank behavior**

A stated goal of the New Basel Accord is to keep the overall level of capital in the global banking system from changing significantly, assuming the same degree of risk. However, the calculations conducted by the committee are conducted under ceteris paribus assumptions and did not attempt to take into account any behavioral response on the part of banks to the new Accord. One of the aims of this paper is to provide a framework within which the behavioral response of banks to changes in regulation might be studied. (Saidenberg and Schuermann (2003))

- **Credit Risk**

Although the new proposals have undoubtedly raised the level of the analysis of credit risk from the first Accord, there remain some important questions about how some aspects, e.g., the correlation of credit exposures, are treated. We do not address these issues here.

- **Cyclicality**

Although the new proposals have started to address the issue of the cyclicality of the IRB approaches, most of the questions of the so-called procyclicality debate remain without an answer.

[5] US House of Representatives Committee on Financial Services letter to the chairmen of the Federal Reserve and the FDIC, the Comptroller of the Currency and the Director of the Office of Thrift Supervision, 3 November 2003.

- **Imbalance**

Although Pillars II and III represent major innovations in the new Accord, there remains, as other others authors (see Saidenberg and Schuermann (2003), von Thadden (2003)) have pointed out, a substantial imbalance between the detail provided in Pillar I, on one hand, and Pillars II and III on the other. The focus of the Committee's attention seems clear.

- **Market vs regulator**

Pillar III seeks to "encourage market discipline by developing a set of disclosure requirements that allow market participants to assess key information about a bank's risk profile and level of capitalization" (Basel Committee on Banking Supervision: Overview of the New Basel Capital Accord). However, one of the main motivations for regulation of bank capital is that, in the absence of regulation, banks will choose their level of capital in the light of the private costs of failure and will not take into account the social (systemic) costs. It is not clear, therefore, that market discipline will lead to banks holding levels of capital that are consistent with regulatory objectives.

- **Institutional form, regulatory discretion and "the level playing field"**

The determination of regulatory capital standards should be viewed as the result of a trade-off between the cost of capital and systemic costs of failure. In this case it is necessary to determine – or at least have a view about – the variation in systemic costs of failure for different types of institution. For example, are the costs of failure different for large and small banks? Or for banks that are largely retail and those that are largely wholesale? It is surprising, to say the least, that the answer to all these problems should be 8%. If regulators are concerned about systemic risks then these should be central questions and yet they appear to be absent from the Basel II analysis. Instead it appears that regulators wish to remain neutral these questions, a stance well expressed by the "level playing field" principle. It appears to us, however, that the without addressing these issues many of the most important questions cannot be answered.

4 The model

4.1 Timing and assumptions

In our model a bank is an institution that holds financial assets and is financed by equity and deposits.

Bank shareholders and depositors: Shareholders are risk neutral, enjoy limited liability and are initially granted a banking charter. The charter permits the bank to continue in business indefinitely under the control of its shareholders unless, at the time of an audit, the regulator determines that it is insolvent. In this case the charter is not renewed, the shareholders lose control of the bank and the value of their equity is zero.

If the bank is solvent at time $t-1$, it raises deposits[6] D_{t-1} and capital kD_{t-1}, $k>0$ so that total assets invested are:

$$A_{t-1} = (1+k)D_{t-1}. \tag{1}$$

The deposits are one-period term deposits paying a total rate of return of r^d. Thus, at maturity the amount due to depositors is:

$$D_t = D_{t-1}(1+r^d). \tag{2}$$

At this point, if the bank is "solvent", the accrued interest, $r^d D_{t-1}$, is paid to depositors and deposits are rolled over at the same interest rate.

Regulators and audit frequency: We assume that audits take place at fixed times $t = 1, 2, ...$ The government guarantees the deposits and charges the bank a constant premium per dollar of insured deposits. This premium is included in the deposit rate [7] r^d.

Portfolio revisions and investment choice: Between successive audit dates there are n equally spaced times at which the portfolio may be revised. Setting $\Delta t \equiv 1/n$ the portfolio revisions dates, between audit dates t and $t+1$, are therefore:

$$t, t+\Delta t, t+2\Delta t, \ldots.., t+(n-1)\Delta t, t+1. \tag{3}$$

For simplicity we assume that the bank may choose between two assets: a risk free bond with maturity $1/n$, yielding a constant net return $\widehat{r}$ per period of length $1/n$ (r per period of length 1) and a risky asset yielding a gross

[6] We take the volume of a bank's deposits as exogenous.

[7] Equivalently, we may interpret this arrangement as one where the depositors pay the deposit insurance premium and receive a net interest rate of r^d.

random return $R_{t+j\Delta t}$ over the period $(t+(j-1)\Delta t)$ to $(t+j\Delta t)$[8]. Returns on the risky asset are independently distributed over time and have a constant expected gross return of $E\left[R_{t+j\Delta t}\right] \equiv (1+\widehat{a})$, where $\widehat{a}$ is the net expected return per period of length $1/n$. Notice that we assume that, at each portfolio revision date, the bank is allowed either to increase or decrease its investment in the risky asset, i.e. the risky asset is marketable.

Portfolio choice: Let $w_{t+j\Delta t}$ denote the percentage of the portfolio held in the risky asset at time $t+j\Delta t$ with the remainder invested in the "safe" security. We limit the leverage that the bank can take on by imposing a no-short selling constraint ($0 \leq w_{t+j\Delta t} \leq 1$) on both the risky and safe assets[9]:

$$0 \leq w_{t+j\Delta t} \leq 1 \; \forall \; t \in [0,\infty], \forall \; j \in [0,n-1]. \tag{4}$$

The bank's portfolio management strategy is represented as a sequence of variables $\Theta = (\theta_0, \theta_1, ., \theta_t, ., \theta_\infty)$ with:

$$\theta_t = \left(w_t, w_{t+\Delta t}, .., w_{t+j\Delta t}, .., w_{t+(n-1)\Delta t}\right) \text{ for all } 0 \leq t \leq \infty \tag{5}$$

and $0 \leq j \leq n-1$, where θ_t represents the strategy between audit dates t and $t+1$ and Θ the collection of these sub-strategies for audit dates $1, 2, \ldots, t, \ldots \infty$.

Intertemporal budget constraint: The intertemporal budget constraint is given by:

$$A_{t+(j+1)\Delta t} = \left[w_{t+j\Delta t}R_{t+j\Delta t} + (1-w_{t+j\Delta t})(1+\widehat{r})\right] A_{t+j\Delta t}, \tag{6}$$

and so the bank's asset value at the audit time $t+1$ is:

$$A_{t+1} = \prod_{j=0}^{n-1} \left[w_{t+j\Delta t}R_{t+j\Delta t} + (1-w_{t+j\Delta t})(1+\widehat{r})\right] A_t \tag{7}$$

Bank closure rule (transfer of control from shareholders to supervisor)

[8]This means that we do not address the issues related to portfolio diversification as in Boot and Thakor (1991).

[9]It may not be immediately apparent that a non negativity constraint on the risky asset would ever been binding. However, under the assumptions that we introduce below (limited liability) we show that the bank will be risk preferring in some regions and would short the risky asset if they could.

Bank solvency is determined by audit. The closure rule we consider in this paper is the so-called *threshold* rule: at an audit time t, the bank is declared insolvent if the audit value of the asset, A_t, is lower than $D_t - \phi$, the value of deposit liabilities including accrued interest minus a certain amount ϕ where $\phi \in [-kD; D_t]$; that is $D_t - \phi$ is the *threshold point* for the bank failure. If regulators determine that the bank is insolvent at time t it is also insolvent for all future periods $s > t$.

More formally, let the indicator variable I_t represent whether the bank is open ($I_t = 1$) or closed ($I_t = 0$) at time t:

$$I_t = \begin{cases} 0 \text{ if } \prod_{s=0}^{t-1} I_s = 0 \\ 0 \text{ if } \prod_{s=0}^{t-1} I_s = 1 \text{ and } A_t < D_t - \phi \\ 1 \text{ if } \prod_{s=0}^{t-1} I_s = 1 \text{ and } A_t \geq D_t - \phi \end{cases} \tag{8}$$

with $I_0 = 1$.

Dividend policy and capital replenishment: In our model we assume that the volume of deposits raised by the bank at each audit time t - if solvent - is constant and equal to D. If the bank is solvent at time t and $A_t - D(1 + r^d) > kD$, shareholders receive the excess $A_t - D\left[(1 + r^d) + k\right]$ as a dividend. If the bank is solvent and $A_t - D(1 + r^d) < kD$, shareholders contribute $kD - (A_t - D(1 + r^d))$ in the form of new equity (a negative dividend). These rules implies that, at the start of each period in which the bank is solvent it has the same volume of assets and the same leverage. Figure (1) gives a graphical representation of the dividend policy[10]. In summary the cash flow to shareholders at time t is:

$$d_t = \begin{cases} A_t - ([D(1 + r) + kD]), & \text{if } I_t = 1 \\ 0, & \text{otherwise.} \end{cases} \tag{9}$$

[Insert FIGURE (1) about here]

Pillar II provides regulators with some discretion over the actions they are able to take when, on an audit date, a bank has a capital deficiency

[10]In Pelizzon (2001) we show that equityholders has an incentive to inject capital when the bank is solvent but loss making.

($A < D(1+k)$) and the regulator therefore intervenes. At this point the regulator has two choices: closure, i.e., current shareholders lose control or to allow recapitalization. In our model, we attempt to capture this discretion with a variable, ϕ, that measures the regulators "forbearance". When $\phi > 0$ ("positive forbearance") the regulator chooses not to close the bank (i.e., allows recapitalization) even though bank is insolvent, i.e. $D - \phi < A < D$. When $\phi < 0$ ("negative forbearance") the regulator may decide to force closure (i.e., refuse to allow recapitalization) even though the bank is still solvent ($D - \phi > A > D$). Values of ϕ that are different from zero allow the regulator to separate the capital deficiency intervention point ($A < D(1+k)$) from the closure decision.

An interesting point here is that, as ϕ is increased from zero to a positive number, the exposure of the deposit insurer (a) increases because the closure rule is now less "conservative" and, (b) when the bank defaults, it does so with a larger loss. However, at the same time, when shareholders recapitalize they will reduces the probability of bank closure.

Shareholders incentives to recapitalize

- For negative values of ϕ shareholders have always an incentive to recapitalize.
- For some ("large") positive values of ϕ there will be some cases where $A > D - \phi$ but where the shareholders do not have an incentive to recapitalize. This raises two questions: (i) what is the value of ϕ such that the shareholders just have an incentive to recitalist when $A = D - \phi$. We denote this value as ϕ^*. Shareholders have an incentive to recapitalize when $(D - A)$ is lower than the franchise value. Therefore, shareholders will always recapitalize if $\phi < \phi^*$.
- There is an interesting distinction here between the case with asset rents and the case without. With asset rents, the franchise value could be large enough so that, for all values of ϕ the shareholders would have an incentive to recapitalize. In this case, the larger the value of ϕ the lower the PVDIL. However, in the case where the F derives solely from deposit insurance, the larger the value of ϕ the lower the PVDIL. With only deposit insurance rents and $\phi > 0$ the PVDIL first increases and than decreases but π decreases. So issue for regulator has to do with the optimal tradeoff between these two output measures. Question: what happens if ϕ is subserviently large that when $D - \phi < A <$

$D-\phi^*$ shareholders have no incentive to recapitalize? Assuming that (a) shareholders cannot be forced to contribute capital and (b) that deposits remain insured then the outcome is identical to that when $\phi = \phi^*$. Without loss of generality, we therefore assume that the regulator always chooses a $\phi < \phi^*$.

The policy defined by equation (9) is exogenous to the model and is adopted for simplicity[11]. In particular, we do not claim that this policy is optimal, e.g. in the sense that it maximizes the value of equity.

This assumption does however imply that the distribution of future dividend is the same at each audit point and this greatly increases the tractability of the problem of calculating the value of equity and the franchise value.

4.2 The problem

The problem faced by the bank is to choose the investment policy θ_t^*, (i.e. the percentage $w_{t+j\Delta t}^*$ invested in the risky asset at each time $t + j\Delta t$) that maximizes the value of equity:

$$\theta^* \in \arg \max_{\{\theta_t\}_{t=0}^{\infty}} S_0 = \sum_{t=1}^{\infty} (1+r)^{-t} E\left[d_t\left(\theta_t\right)\right] \tag{10}$$

subject to (4) and where dividends, d_t, are defined in (9).

This problem is time invariant at any audit because, if the bank is solvent at time t, then, since the distribution of future dividends is identical at $t+1$, the portfolio problem faced by the bank is also identical at each audit time if the bank is solvent. This means that the value of equity at time t, conditional on solvency, is given by[12]:

$$S_t = \begin{cases} \sum_{t+1}^{\infty} (1+r)^{-(s-t)} E\left[d_s\right] = (1+r)\left\{E\left[d_{t+1}\right] + S_{t+1}\right\} \text{ if } I_{t+1} = 1 \\ 0 \text{ if } I_{t+1} = 0 \end{cases}, \tag{11}$$

[11] A similar dividend policy has been assumed in the banking literature by Suarez (1994), Hellman et al. (2000) and, with $k = 0$, by Allen and Gale (2000).

[12] Note that d_{t+1} and $S_{t+1}$are functions of the portfolio strategy θ_t but, for sake of notational clarity, we suppress this dependence.

is (i) constant at each audit time where the bank is solvent and (ii) given by the following expression[13]:

$$S(\theta^*) = \frac{E\left[d(\theta^*)\right]}{r + \pi(\theta^*)} \tag{12}$$

where $\pi(\theta^*)$ is the probability of default at next audit. Thus, the value of equity is equal to the expected dividend divided by the sum of risk free rate and the probability of default. In other words, the value of equity has a character of a perpetuity where the discount rate is adjusted for default[14]. Equation (12) also highlights the conflicting incentives that shareholders face in choosing the optimal portfolio composition. On one hand increasing exposure to the risky asset increases the expected dividend and so increases $S(\theta^*)$ while at the same time it increases the probability of insolvency, i.e. $\pi(\theta^*)$, and so decreases $S(\theta^*)$. At the optimum these two effects: (i) exploiting the deposit insurance put and (ii) preserving future rents just offset.

Finally we define the franchise value as the difference between the equity value (12) and the value of capital kD, i.e.:

$$F\left(\theta^*\right) = S\left(\theta^*\right) - kD \tag{13}$$

5 Bank's optimal portfolio management

In this section we describe the main features of the bank's optimal portfolio management policy. Our main result is that, even when the bank earns rents only from deposit insurance, it nonetheless has an incentive to manage its portfolio dynamically, i.e. to engage in risk management.

[13]For details see appendix A.

[14]A similar relation obtained in a number of models of defaultable bonds (see Lando (1997) and Duffie and Singleton (1999))

5.1 Static multiperiod model

Merton (1977) shows that the put option represented by deposit insurance provides an incentive for the bank to choose the maximum level of risk for its asset portfolio. We first extend this result to the case where the bank revises its portfolio only at each audit date, i.e. a "static multiperiod model". Thus, the portfolio weights $w_t, w_{t+\Delta t}, .., w_{t+j\Delta t}, .., w_{t+(n-1)\Delta t}$ are constant over time and equal to w, say and thus the bank does not engage in risk management. Equation (12) now becomes:

$$S(w) = \frac{E\left[d(w)\right]}{r + \pi(w)} \tag{14}$$

where $E\left[d(w)\right]$ denotes the expected one-period dividend, and $\pi(w)$ the one-period probability of default given the portfolio decision w.

Using (9), (13) and (14) it is straightforward to show that the franchise value of the bank can be written as:

$$F = \frac{E\left(Put\right)}{r + \pi(w))} = PVDIL, \tag{15}$$

where "*Put*" represents the payoff on a one-period option held by the bank on the deposit insurance scheme, i.e.:

$$\begin{aligned} E_{t-1}\left(Put\right) &= \int_0^{D_t-\phi} (D_t - A_t) f(A_t) dA_t \equiv E\left(Put\right) \qquad (16) \\ &= \int_0^{D_t-\phi} (D_t - \phi - A_t) f(A_t) dA_t + \int_0^{D_t-\phi} \phi f(A_t) dA_t \end{aligned}$$

Equations (15) and (16) show that when the bank earns rents only from deposit insurance its franchise value is simply the present value of a defaultable stream of payments, each of which is equal to the value of a conventional put option with strike $(D - \phi)$ plus value of a digital put that pays ϕ when $A < D - \phi$.

Indeed, the liability of the deposit insurer is zero when $A > D - \phi$. When $A < D - \phi$ the liability is $D - A$. This can be written as $[(D - \phi) - A] + \phi$, in other words the liability is equal to the payoff on a conventional put option with strike $(D - \phi)$ plus the payoff on a digital put that pays ϕ when $A < D - \phi$.

[Insert FIGURE (2) about here].

This means that when the deposit insurer increases ϕ the value of the put is reduced but the value of the digital put increases. The sign of ϕ determines whether the payoff on the digital put is paid by the deposit insurer to the shareholder or vice versa.

[Insert FIGURE (3) about here].

5.1.1 The case of lognormally distributed asset

To provide direct comparability with Merton (1977) we analyze this case under the assumption that the portfolio is entirely invested in a risky asset with a lognormally distributed gross rate of return that has a volatility parameter $\sigma \in [0, \overline{\sigma}]$ that is under the control of the manager. Thus R_t is given by:[15]

$$R_t = (1 + r)e^{\left(\sigma z_t - \frac{\sigma^2}{2}\right)} \tag{17}$$

where z_t is a unit normal Gaussian i.i.d. process.

In this case the optimal strategy is given by the following Lemma.

LEMMA 1: In a stationary multiperiod setting when:

- *the gross rate of return on the asset portfolio is lognormally distributed with volatility parameter $\sigma \in [0, \overline{\sigma}]$,*
- *no portfolio revision is possible between audit dates,*
- *the bank earns no rents from either its assets or its deposits,*

[15] Here, for tractability as well as for comparability with Merton we assume (i) a lognormal distribution for the risky asset portfolio and (ii) that the portfolio choice variable is the volatility parameter of this distribution.

the optimal portfolio has the maximum possible volatility, i.e. $\sigma = \overline{\sigma}$.

Proof.

To be done

■

Lemma 1 shows that even though deposit insurance rents generate a franchise value that the bank has an incentive to preserve, the optimal strategy in a multi-period Merton model with no portfolio revision between audits is nonetheless unchanged even if the threshold point is not just when assets are equal to deposits (as in Pelizzon and Schaefer (2003)) and the bank chooses the portfolio with the highest possible level of risk.

5.2 Dynamic multiperiod model.

We now introduce the possibility of portfolio revision and assume that the bank, solvent at time t, may revise its portfolio at times t, $t + \Delta t$, $t + 2\Delta t$, .. up to the next audit date $t + 1$.

Figure (3) shows the solution to the portfolio optimization problem when the bank is able to revise its portfolio 12 times between audit dates[16].

[Insert FIGURE (4) about here].

Panels (a), (b) and (c) show the optimal investment in the risky asset as a function of A/D at revision dates 5 (panel (a)), 8 (panel (b)) and 11 (panel (c)). We consider three different situations: $\phi = 3$ (forbearance), $\phi = 0$ (recapitalization if the bank is solvent) and $\phi = -3$ (early closure). Panel (a) shows that at date 5 the optimal portfolio is entirely invested in the risky asset if supervisors allow forbearance or recapitalization. In contrast, if the regulator decides to close the bank, if it is close to default but still solvent, the optimal solution switches for the boundary to an interior solution. At date 8 (panel (b)) the optimal solution switches from the boundary to an interior solution and, for a wide range of values, the investment in the risky asset is substantially less than 100% for $\phi = 0$ and $\phi = -3$. The strategy is similar to the one described in Pelizzon and Schaefer (2003) The portfolio

[16] Starting with an arbitrary franchise value at audit date $t + 1$ we solve for the franchise value at date t using backward induction and a multi-nominal approximation to the log-normal distribution (with 100 points). We than iterate until the franchise values at dates t and $t + 1$ are equal.

strategy at date 11 (Panel (c)) is similar to the date 6 strategy but more extreme for all the different closure rules but at different trigger points.

Figure (4) compares the distribution of the asset value at the audit date for three different closure rule.

[Insert FIGURE (5) about here].

5.2.1 Risk management and bank risk

One of the main objectives of this paper is to analyze the impact of banks' risk management activities on their riskiness. As we have seen risk management may change in the distribution of asset returns and this has important implications for bank risk. To assess bank risk we employ two measures: the probability of default at the next audit, π, and the PVDIL.

As mentioned above, these two measures, although related, are distinct. In the case with no portfolio revision and lognormally distributed asset returns, both π and PVDIL are monotonically increasing in volatility and there is a relation one to one between these two measures. However, risk management, i.e., portfolio revision, changes the shape of the distribution of asset values (as shown in the previous Figure). In this event, the one-to-one relation between π and PVDIL is no longer guaranteed.

[Insert TABLE (1) about here].

Table (1) compares π and PVDIL with and without portfolio revision.

Comments

In the following, the base case is taken as $\phi = 0$.

- in the case with $\phi < 0$ (i.e. early closure) the probability of default, π , increases and PVDIL decreases. However, the impact of early closure is lower if the bank revises its portfolio between audit.
- in the case with $\phi > 0$ (i.e. forbearance) PVDIL increases and π decreases. Here the difference between the cases with and without portfolio revision is smaller than in the case with early closure. This because forbearance reduces the disciplinary effect of the franchise value.

- In the case without portfolio revision (n=1) the bank always chooses the highest possible level of asset volatility. With portfolio revision the asset risk is, in some states, lower than the maximum and so the average risk is also lower. We might expect, therefore, that both π and PVDIL would be lower in the latter case. In fact, as the Table shows, while the probability of default is indeed lower, the PVDIL is higher. As mentioned above, this occurs because the shape of the distribution of asset value in these two cases is different. The rents earned by the bank are equal to the losses of the deposit insurance agency and so, to exploit this source of rents to the maximum, the bank uses risk management to increase the expected loss in the case where the bank does default while simultaneously increasing the probability of survival, $1 - \pi$, and therefore the length of time the bank expects to receive dividends before default.

- The opportunity to revise its portfolio is more valuable to the bank – in terms of PVDIL – when ϕ is negative. This result arises because, with increased forbearance, the bank has a lower incentive to manage its portfolio.

- Our analysis shows that the value of the deposit insurance is affected both by banks' ability to engage risk management and by the degree of regulatory forbearance. Ignoring these effects is likely to lead to an understatement of the cost of deposit insurance.

6 Capital rules

Under the early Accord a bank's required capital was a linear function of the amount invested in risky assets. More recent rules rely on the VaR (Value-at-Risk) framework. In our model we assume that capital requirements are proportional to the amount invested in the (one) risky asset. Thus our approach is obviously consistent with the early Accord. Moreover, because there is only one risky asset, the portfolio VaR depends simply on, w_j, the amount invested in the risky asset and thus our characterization of capital rules is also consistent with the more recent VaR based approach.

We assume a VaR based capital rule in which the required level of capital is proportional to the volatility on the portfolio value $K_R = \alpha VaR(A)$, where K_R is the required capital given the portfolio composition of bank's asset. In our framework this may be written as:

$$k_R = \lambda w_j \frac{A_j}{D_j} \tag{18}$$

where k_R is the required amount of capital expressed as a percentage of deposits and λ is a constant.

This rule is the one used in the paper. Under this rule the bank's investment in the risky asset at each portfolio revision date, w_j, is constrained according to:

$$w_j \leq k_j \frac{D_j}{A_j} \frac{1}{\lambda} \equiv \overline{w}(k_j, \frac{D_j}{A_j}, \lambda) \tag{19}$$

where $\overline{w}$ represents the maximum permissible investment in the risky asset for a given ratio of deposits to assets and percentage of capital k_j defined as:

$$k_j = \frac{A_j - D(1 + r^d)^{1/n}}{D}. \tag{20}$$

One of the main objectives of our paper is to analyze the effects of capital regulation on bank risk taking. However, our analysis to this point assumes an environment that is entirely unregulated except for periodic audits when, if $D - \phi > A$, it is closed. Between audits, however, we have assumed that the bank has complete freedom to choose the risk of its portfolio even if insolvent.

In practice banks are obliged to observe capital requirements continuously through time and face censure, or worse, if they are discovered, even ex-post, to have violated the rules. However, if (i) asset prices are continuous, (ii) capital rules are applied continuously through time and (iii) capital rules force banks to eliminate risk from their portfolio when their capital falls below a given (non negative) level, a bank's probability of default becomes zero.

With continuous portfolio revision the only way to avoid this unrealistic conclusion is to assume – perhaps not unrealistically – that banks are able to continue to operate, and to invest in risky assets, even when the value of their assets is below that of their liabilities, i.e. banks are able to "cheat".

In the paper we consider three different ways to "cheat":

1. *One-Period CR*: CR binding only when there is an audit, i.e.., at all other times the bank faces no constraints on the risk of its portfolio. Irrespective of its portfolio composition prior to audit, any solvent bank can reorganize its portfolio to meet capital requirements but is constrained to hold this portfolio only until the next portfolio revision date. In all other periods the portfolio is unconstrained.

2. *Backward Looking CR*: Between two audit dates, the maximum exposure of the bank to the risky asset is determined by its level of capital at the earlier audit date.

$$w_j \leq k\frac{D}{A}\frac{1}{\lambda} \equiv \overline{w}_k(k, \frac{D}{A}, \lambda) \tag{21}$$

3. *Lower Bound CR*: Between two audit dates, the maximum exposure of the bank to the risky asset is the greater of (i) the level determined by its capital at the earlier audit date and (ii) the exposure based on its actual capital at the time.

$$w_j \leq \max(k_j\frac{D_j}{A_j}\frac{1}{\lambda}; k\frac{D}{A}\frac{1}{\lambda}) \equiv \overline{w}_m \tag{22}$$

It is worth noting that these rules are different only in the case when banks are able to engage in risk management since, otherwise, banks choose their portfolios only on the audit date when, in all three cases, they comply with capital requirements.

We now ask how the introduction of capital requirements affects risk taking when banks are able to engage in risk management.

CASE 1: One period Capital Requirement

[Insert TABLE (2) about here].

Comments

- For any ϕ, CR produces the strongest effects on PVDIL in the case without portfolio revision. With portfolio revision the introduction of CR has almost no effect.

- Without portfolio revision PVDIL is not monotonically increasing with ϕ.
- An increase of CR (i.e. λ from 8% to 10%) reduces both PVDIL and π. However, the strongest results are obtained when there are no portfolio revisions. This result is not surprising since, in the limit, the bank's risk goes to zero.

CASE 2: Backward Looking Capital Requirements

[Insert TABLE (3) about here].

Comments

- Compared with the "one-period CR" rule, the "backward-looking" rule reduces PVDIL and π and the opportunity for portfolio revision has a smaller impact than in the previous case. Moreover, even with portfolio revisions PVDIL is not monotonically increasing with ϕ.
- With $\phi = 5$ we have that $\phi^* < \phi$ and so shareholders have no incentive to provide capital, therefore regulators will never choose this level of ϕ.
- With the "backward-looking" rule an increase in CR reduces PVDIL and π with and without portfolio revision.

CASE 3: Lower Bound Capital Requirement.

[Insert TABLE (4) about here].

Comments

- The results with the "Lower-bound CR" rule are almost the same as in the previous case.

General Comments

- Capital requirements have minimal effects when banks engage in risk management if the control on capital requirements is performed only at audit time.
- CR have stronger effects if there is at least a “soft inspection” (the “backward-looking” rule) even between audit.
- When there are CR the option to recapitalize when the bank is insolvent will be exercised only for low values of ϕ.
- The results are strongly influenced by the value of k, i.e. the level of capital deficiency at which regulator intervenes.

References

Allen F. and D. Gale (2000), Bubbles and Crises, The Economic Journal, 110, 236-255.

Allen F. and D. Gale (2003), "Capital Adequacy Regulation: In Search of a Rationale", Economics for an Imperfect World: Essays in Honor of Joseph Stiglitz, edited by R. Arnott, B. Greenwald, R. Kanbur and B. Nalebuff, Cambridge, MA: MIT Press, 83-109.

Basel Committee on Banking Supervision (1988), International Convergence of Capital Measurement and Capital Standards.

Basel Committee on Banking Supervision (1999), A New Capital Adequacy Framework, Consultative Paper.

Basel Committee on Banking Supervision (2001), The New Basel Accord: Consultative Package.

Basel Committee on Banking Supervision (2003), The New Basel Capital Accord: Consultative Package.

Boot and A. Thakor (1991) Off-Balance Sheet Liabilities, Deposit Insurance and Capital Regulation, Journal of Banking and Finance 15, 825-846.

Estrella E. (2000), Regulatory Capital and the Supervision of Financial Institutions: Some Basic Distinctions and Policy Choices, Federal Reserve Bank of New York.

Hellman T., K. Murdock and J. Stiglitz (2000), Liberalization, Moral Hazard in Banking, and Prudential regulation: are Capital Requirements Enough?, American Economic Review, 147-165.

Jones D. (2000), Emerging Problems with the Basel Capital Accord: regulatory capital arbitrage and related issues, Journal of Banking and Finance, 24, 35-58.

Merton R. (1977), An Analytic Derivation of the Cost of Deposit Insurance and Loan Guarantees, Journal of Banking and Finance 1, 3-11.

Pelizzon L. and S. Schaefer (2003), Do Bank Risk Management and Capital Requirements reduce risk in Banking?, WP London Business School.

Saidenberg M. and T. Schuermann (2003), The New Basel Capital Accord and Questions for Research, Wharton FIC 03-14.

Santos J. (2001) Bank Capital Regulation in Contemporary Banking Theory: a Review of the Literature, Financial Markets Institutions and Instruments 10, 2, 41-84.

von Thaddend E. (2004), Bank capital adequacy regulation under the new Basel Accord, Journal of Financial Intermediation, forthcoming.

Table 1: **Comparison between dynamic strategies and no portfolio revisions**

This Table shows the value of deposit insurance and the probability of default with and without portfolio revisions. Pillar II - regulator discretion - is captured by the variable, ϕ, that measures the regulators "forbearance". When $\phi > 0$ ("positive forbearance") the regulator chooses not to close the bank (i.e., allows recapitalization) even though the bank is insolvent, i.e. $D - \phi < A < D$. When $\phi < 0$ ("negative forbearance") the regulator may decide to force closure (i.e., refuse to allow recapitalization) even though the bank is still solvent ($D - \phi > A > D$). Values of ϕ that are different from zero allow the regulation to separate the capital deficiency intervention point ($A < D(1 + k)$) from the closure decision. The parameters used are: $D = 100$, $k = 5\%$, n equal respectively to 1 and 12, $r = 5\%$, $\sigma = 10\%$.

ϕ	No RM		RM	
	$PVDIL$	π	$PVDIL$	π
-3	4.10	0.43	5.69	0.21
-1	5.16	0.36	6.42	0.19
0	5.68	0.33	6.75	0.18
1	6.18	0.29	7.07	0.16
3	7.11	0.23	7.60	0.15
5	7.89	0.17	8.04	0.14
8	8.50	0.11	8.51	0.11

Table 2: **One period Capital Requirement**

This Table shows the value of deposit insurance and the probability of default when Capital Requirement is binding only when there is an audit, i.e., at all other times the bank faces no constraints on the risk of its portfolio. Pillar I - capital requirement - is represented by parameter λ. Pillar II - regulator discretion - is captured by the variable, ϕ, that measures the regulators "forbearance". When $\phi > 0$ ("positive forbearance") the regulator chooses not to close the bank (i.e., allows recapitalization) even though bank is insolvent, i.e. $D - \phi < A < D$. When $\phi < 0$ ("negative forbearance") the regulator may decide to force closure (i.e., refuse to allow recapitalization) even though the bank is still solvent ($D - \phi > A > D$). Values of ϕ that are different from zero allow the regulator to separate the capital deficiency intervention point ($A < D(1+k)$) from the closure decision. "*" indicates that shareholders have no incentive to provide capital. Therefore regulator will never choose this level of ϕ. The parameters used are: $D = 100$, $k = 5\%$, n equal respectively to 1 and 12, $r = 5\%$, $\sigma = 10\%$.

λ	ϕ	No RM		RM	
		$PVDIL$	π	$PVDIL$	π
	-3	1.12	0.37	5.42	0.21
	-1	2.24	0.26	6.23	0.19
	0	2.75	0.21	6.61	0.18
8%	1	3.21	0.17	6.88	0.17
	3	3.80	0.10	7.43	0.15
	5	3.75*	0.05	7.83	0.14
		$PVDIL$	π	$PVDIL$	π
	-3	0.25	0.33	5.39	0.21
	-1	1.41	0.21	6.19	0.19
	0	1.89	0.16	6.48	0.18
10%	1	2.27	0.11	6.80	0.17
	3	2.49*	0.05	7.35	0.14
	5	1.89*	0.02	7.78	0.14

Table 3: **Backward Looking Capital Requirements**

This Table shows the value of deposit insurance and the probability of default when between two audit dates, the maximum exposure of the bank to the risky asset is determined by its level of capital at the earlier audit date. Pillar I - capital requirement - is represented by parameter λ. Pillar II - regulator discretion - is captured by the variable, ϕ, that measures the regulators "forbearance". When $\phi > 0$ ("positive forbearance") the regulator chooses not to close the bank (i.e., allows recapitalization) even though bank is insolvent, i.e. $D - \phi < A < D$. When $\phi < 0$ ("negative forbearance") the regulator may decide to force closure (i.e., refuse to allow recapitalization) even though the bank is still solvent ($D - \phi > A > D$). Values of ϕ that are different from zero allow the regulator to separate the capital deficiency intervention point ($A < D(1+k)$) from the closure decision. "*" indicates that shareholders have no incentive to provide capital. Therefore regulator will never choose this level of ϕ. The parameters used are: $D = 100$, $k = 5\%$, n equal respectively to 1 and 12, $r = 5\%$, $\sigma = 10\%$.

λ	ϕ	No RM		RM	
		$PVDIL$	π	$PVDIL$	π
	-3	1.12	0.37	2.13	0.17
	-1	2.24	0.26	2.94	0.14
	0	2.75	0.21	3.19	0.13
8%	1	3.21	0.17	3.50	0.12
	3	3.80	0.10	3.86	0.10
	5*	3.75*	0.05	3.75*	0.05
		$PVDIL$	π	$PVDIL$	π
	-3	0.25	0.33	1.15	0.14
	-1	1.41	0.21	1.87	0.11
	0	1.89	0.16	2.14	0.10
10%	1	2.27	0.11	2.36	0.09
	3	2.49*	0.05	2.55*	0.05
	5	1.89*	0.02	1.85*	0.02

Table 4: **Lower Bound Capital Requirement**

This Table shows the value of deposit insurance and the probability of default when, between two audit dates, the maximum exposure of the bank to the risky asset is the greater of (i) the level determined by its capital at the earlier audit date and (ii) the exposure based on its actual capital at the time. Pillar I capital requirement is represented by parameter λ. Pillar II - regulator discretion - is captured by the variable, ϕ, that measures the regulators "forbearance". When $\phi > 0$ ("positive forbearance") the regulator chooses not to close the bank (i.e., allows recapitalization) even though bank is insolvent, i.e. $D - \phi < A < D$. When $\phi < 0$ ("negative forbearance") the regulator may decide to force closure (i.e., refuse to allow recapitalization) even though the bank is still solvent ($D - \phi > A > D$). Values of ϕ that are different from zero allow the regulator to separate the capital deficiency intervention point ($A < D(1+k)$) from the closure decision. "*" indicates that shareholders have no incentive to provide capital. Therefore regulator will never choose this level of ϕ. The parameters used are: $D = 100$, $k = 5\%$, n equal respectively to 1 and 12, $r = 5\%$, $\sigma = 10\%$.

λ	ϕ	No RM		RM	
		$PVDIL$	π	$PVDIL$	π
	-3	1.12	0.37	2.19	0.19
	-1	2.24	0.26	2.98	0.15
	0	2.75	0.21	3.29	0.14
8%	1	3.21	0.17	3.59	0.12
	3	3.80	0.10	3.94	0.10
	5	3.75*	0.05	3.97*	0.06
		$PVDIL$	π	$PVDIL$	π
	-3	0.25	0.33	1.13	0.14
	-1	1.41	0.21	1.87	0.12
	0	1.89	0.16	2.19	0.11
10%	1	2.27	0.11	2.42	0.09
	3	2.49*	0.05	2.59*	0.06
	5	1.89*	0.02	1.98*	0.02

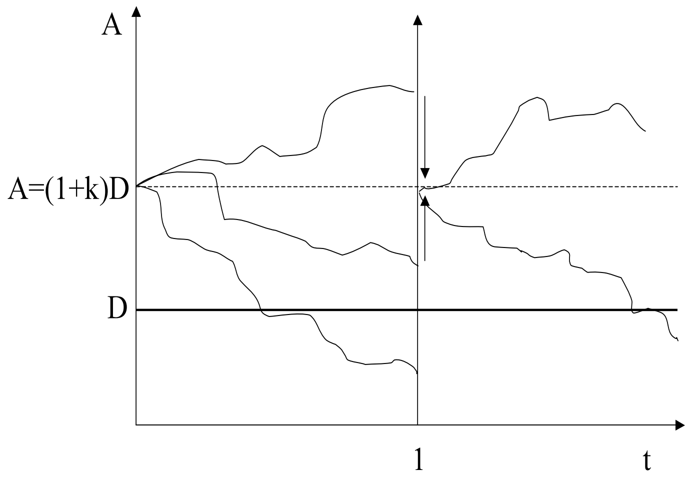

Figure 1: **Dividend policy and capital replenishment**

This Figure plots three potential paths of asset value on the period $t-1$ to t and the corresponding cash flow at audit time t. If at time t, $A < D$ the bank default and shareholders neither receive dividend nor contribute capital. If $A > D(1+k)$, the bank pays a positive dividend and if $D < A < D(1+k)$ shareholders provide capital. If $A > D$ the volume of assets at the start of next period t to $t+1$ is the same as at $t-1$.

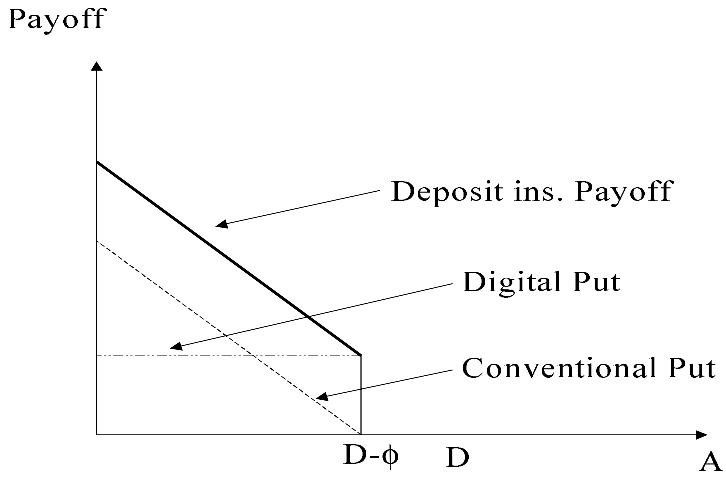

Figure 2: **One period deposit insurance payoff under positive forbearance**

This Figure plots the payoff of the one period deposit insurance given by (i) the payoff of a conventional put option with strike $(D - \phi)$ plus (ii) the payoff of a digital put that pays ϕ when $A < D - \phi$. Since $\phi > 0$ (positive forbearance) the payoff on the digital put is paid by the deposit insurer to the shareholder.

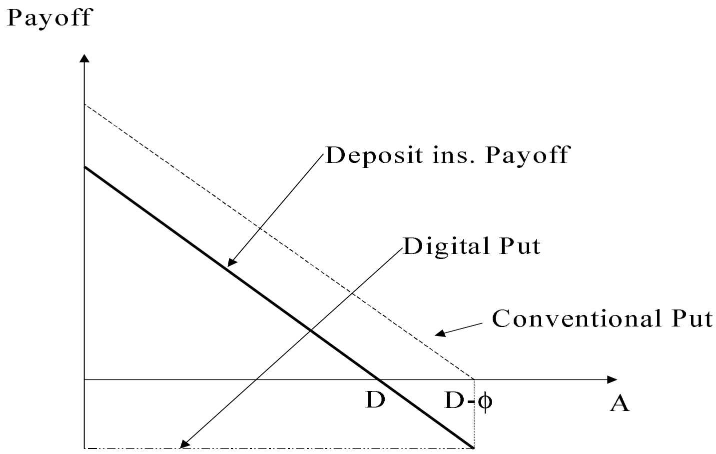

Figure 3: **One period deposit insurance payoff under negative forbearance**

This Figure plots the payoff of the one period deposit insurance given by (i) the payoff of a conventional put option with strike $(D - \phi)$ plus (ii) the payoff of a digital put that pays ϕ when $A < D - \phi$. Since $\phi < 0$ (negative forbearance) the payoff on the digital put is paid by the shareholders to the deposit insurer.

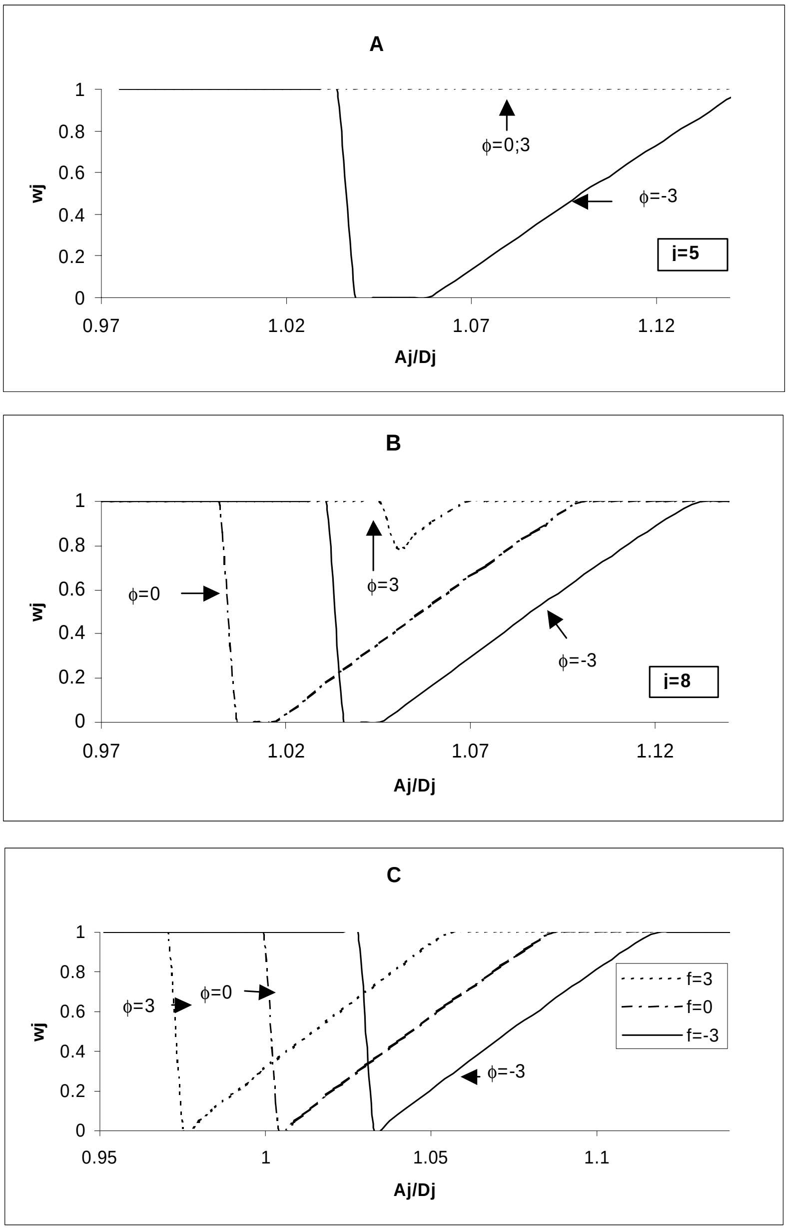

Figure 4: **Optimal portfolio strategies**

This Figure plots the optimal strategies conditional on time to audit and forbearance, ϕ. We consider an audit frequency of one year. The parameters used are: $D = 100$, $k = 5\%$, $n = 12$, $r = 5\%$, $\sigma = 10\%$.

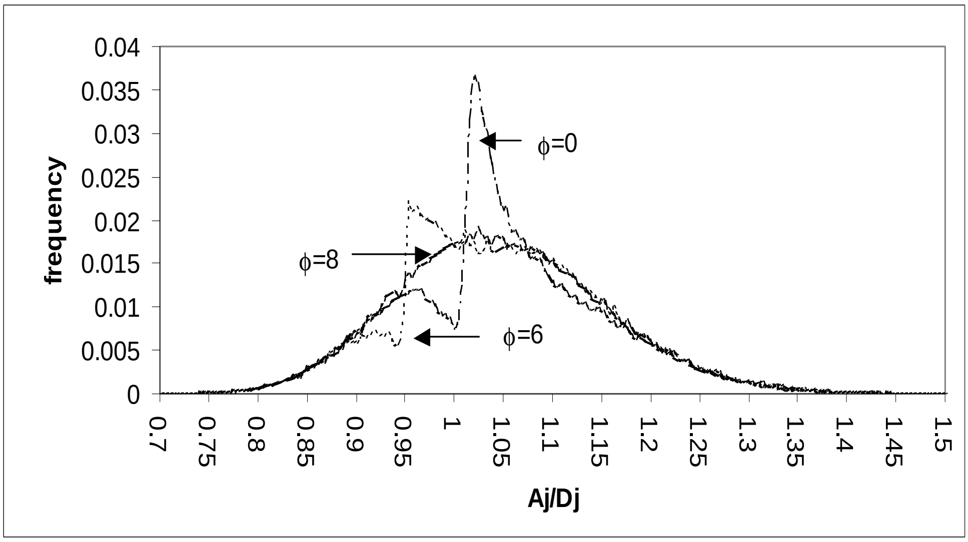

Figure 5: **Bank asset distribution**

This Figure plots the distribution of the asset value at the audit date for different levels of forbearance, ϕ. The parameters used are: $D = 100$, $k = 5\%$, $n = 12$, $r = 5\%$, $\sigma = 10\%$.