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Why is equity capital expensive for opaque banks?

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Why is equity capital expensive for opaque banks?

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Abstract

Bank managers often claim that equity is expensive relative to debt, which contradicts the Modigliani-Miller irrelevance theorem. This paper combines dividend signalling theories and the Diamond-Dybvig bank run model. An opaque bank must signal its solvency by paying high and stable dividends in order to keep depositors tranquil. This signalling may require costly liquidations if the return on assets has been poor, but not paying the dividend might cause panic and trigger a run on the bank. The more equity has been issued, the more liquidations are needed during bad times to pay the expected dividend to each share.

Keywords: Bank run, Capital adequacy, Signalling, Dividends, Irrelevance theorem

JEL classification numbers: G21, G35, D82

The views expressed in this paper are those of the authors and do not necessarily reflect the views of the Bank of Finland.

1 Introduction

Banking differs from other industries in many ways. One of the most obvious differences is the funding structure. If one looks at the annual reports of companies in manufacturing or non-financial services, corporate debt almost never accounts for 90 – 97 % of the balance sheet total. Such an extreme leverage is the norm rather than an exception among banks. If the government did not impose capital adequacy regulations on banks, the leverage might be even more extreme. Why is banking so different from other industries? Bank managers consider equity "expensive", but why does equity become more "expensive" in relative terms if it is used to finance loans instead of, say, machinery? This paper intends to present a potential explanation to this phenomenon.

The tendency to perceive equity "costly" seems to contradict the irrelevance theorem of Modigliani and Miller (1958). This theorem is based on a number of assumptions. For instance, it is assumed that the value of assets is not affected by the structure of the liability side of the balance sheet. This assumption is not necessarily valid in banking. For instance, Diamond and Rajan (2001) propose that weak solvency may be a strategic commitment against debtors' attempts to renegotiate loan contracts. Calomiris and Kahn (1991) propose that depositors' possibility to make withdrawals might induce the banker not to abscond with the funds. Some other explanations focus on the specifics of bank liabilities. Debt issued by banks has got both preferential fiscal treatment and implicit and explicit government guarantees (Admati et al 2010). In some continuous time models, such as Belhaj (2010), a limited liability company, which is not necessarily a bank, must choose between either protecting past profits against bankruptcy by distributing them to shareholders or protecting future profits by keeping enough financial buffers to survive difficult times. Different explanations to bank aversion to strong capitalisation are not mutually exclusive.

One of the best known theoretical models on banking was presented by Diamond and Dybvig (1983). In this model a deposit run can be triggered by self-fulfilling expectations. Each depositor finds it optimal to withdraw savings from the bank if other depositors do. The run forces the bank to liquidate assets prematurely, and investments that would be productive never yield any return. If a run takes place, depositors who do not withdraw may lose their savings. The standard version of the model has got two Nash equilibriums. The Pareto inferior equilibrium with the run can be triggered by a 'sunspot' that would be irrelevant if no attention were paid to it. The model has been developed further by making the run endogenous and by allowing for partial runs (See Goldstein and Pauzner 2005).

The idea of using dividends to signal profitability was briefly discussed already by Miller and Modigliani (1961, p 430). A seminal theoretical contribution in the field of dividend signalling was presented by Bhattacharya (1979); paying dividends is wasteful because of tax reasons, but if paying them is less expensive for profitable firms than for less profitable ones, dividends are a credible signal and they enhance the market value of the firm. Recent empirical evidence in favour of this approach is presented by e.g. Al-Yahyaee et al (2011).

There seem to be no theoretical models on dividends as signals in banking, but empirical findings corroborate the view that the issue is important. This literature is reviewed in section five. A central implication of the Diamond-Dybvig (1983) model is that the viability of a bank depends on creditors' beliefs. Whatever the impact of dividend signalling on firm value might be in general, the effect must be particularly strong in banking because in no other industry the profitability and viability of an undertaking depends as clearly on how counterparties perceive it.

This paper presents a new theoretical explanation by combining previous theories on bank runs and dividend signalling. The original Diamond-Dybvig model was intended to explain why and how banks convert short-maturity deposits to long-term investments, and what kinds of risks are involved. The model in the sequel, instead, explains why modern banks may be reluctant to issue equity. A highly opaque bank must pay dividends in order to keep creditors tranquil. The bank needs to hold extra liquidity instead of illiquid yet return generating assets in order to be able to make large dividend payments irrespective of profitability. Paying dividends may require costly liquidations if the return on bank assets is poor, but not paying increases the risk of panic among depositors and counterparties. The dividend has got value as a Spencian signal because profitable institutions can finance larger payments than unprofitable ones. Depositors understand that the dividend is a useful source of information. The number of times the costly signal must be sent equals the number of shares issued. Sending the dividend signal during bad times is impossible or very costly if a lot of equity capital has been issued. If the bank is opaque, it is not possible to say what the true leverage of the institution is, and observers pay attention to the easily observable dividend per share, not to the ratio of dividends to risks or assets.

Section two presents the assumptions of the model. Sections three and four analyse two different versions of the model. Section five compares the findings of the theoretical analysis and some previous empirical observations. Section six discusses the findings.

2 Assumptions

There is a bank. The bank is a monopoly. It can acquire funding from investors with two financial instruments.

1) Short-term deposits with a fixed interest rate.
2) Permanent equity capital. Equity holders are the residual claimants.

There is a given number (N, $N>>0$) of uncoordinated investors. The bank knows how numerous they are and where to find them, but no investor knows how many other investors exist. Each investor has got one unit of monetary savings to be invested in either bank equity or deposits. Each investor can also keep the sum as risk-free currency.

There are two kinds of investors. Type A investors know they will need no means of payment before the planned closure of the bank at stage five (see below) because they will experience no liquidity shock at stage four. They accept both equity investments (E) and deposit contracts (D). Type B investors run the risk of being subject to a liquidity shock at stage four and they derive no utility from consumption at any later stage, and they do not accept equity. The number of type B investors who may be subject to a liquidity shock is $N\Omega$, and the probability of a shock is λ ($0<\lambda<1$) for each of them. The value of Ω is not public knowledge but the value of λ is. Investors of same type have completely identical preferences.

Things happen in the following order.

1) *Funding;* The bank observes the liquidation value (Z, $0<Z<1$) of its assets. The liquidation value is a non-verifiable random draw from a known distribution. Customers know the distribution it is coming from but not its value. The bank contacts privately each investor. The bank observes the type of each investor and offers either a deposit contract or the possibility to invest in equity. It chooses and publicly announces a fixed interest rate δ it promises to pay its depositors. Each deposit contract is similar. Each share is similar. An investor can either accept the offer of the bank or reject it. The bank cannot verify its funding structure.

2) *Investments;* The bank decides how much to invest in an illiquid yet productive asset and how much to keep as liquidity buffers (L) consisting of currency. Liquidity buffers earn no return. The sum of investments (I) and liquidity must equal the sum of equity and deposits ($I+L = E+D$). The bank cannot verify the amount of investments it has made.[1]

[1] Given that investors know the model, being able to observe I would help them to understand possible values of N, which would help them to deduce the leverage of the bank, reducing its opacity. In, fact, proposition 3 and the equation (i) of appendix 2 can be used to present a precise condition for possible values of N.

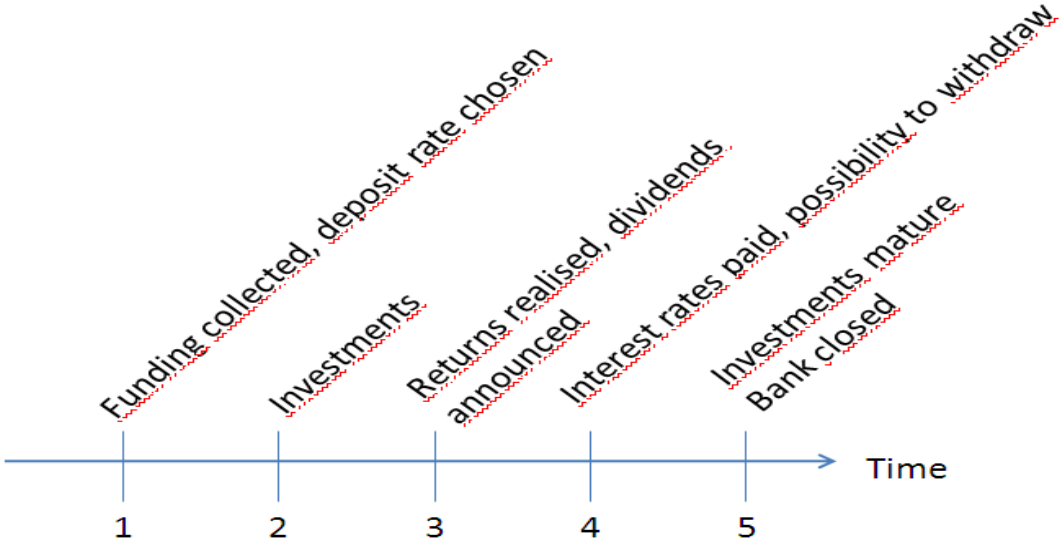
3) *Returns realised;* The bank observes the quality of investments made at stage 2 but it cannot verify its observation. There are two possible outcomes; normal return or no return. In most cases, with probability θ, the return on investments is normal, and the bank receives in cash the sum α ($0<\alpha<1$) per one unit of investments. The values of θ and α are publicly known. With a small probability $1-\theta$ there is no return. The bank decides and announces how much dividends will be paid at stage four. The promised dividend per one unit of equity is public information.

4) *Withdrawing;* Each depositor is paid the interest rate δ $(0<\delta<1)$ per one unit of deposits. The bank withdrawal desk opens; each depositor is offered the possibility to withdraw until the desk closes. Some type B investors notice they have been subject to a liquidity shock and they withdraw their savings. Dividends promised at stage three must be paid. Depositors become suspicious if the promised dividend is low or not paid in full. Only non-suspicious depositors not subject to a liquidity shock will renew the deposit, provided they do not observe abnormal withdrawals by others. If the bank has got an insufficient amount of currency (=L+return on assets) to pay interest payments and withdrawals, it is forced to sell some of its investment assets, or possibly all of them. Assets can also be liquidated to pay the dividend. The bank gets only Z units of currency per one unit of liquidated assets. If the bank is unable to pay all withdrawals, those who come last to withdraw get nothing. The withdrawal desk is closed at the end of stage four.

5) *End;* Investments mature. Each unit of investments not liquidated at stage four is now worth the original investment 1. If possible, depositors are paid the sum they deposited and again the interest rate δ per one unit of deposits. Any residual is divided between equity holders.

The rather extreme structure of the funding market is intended to capture the idea that the structure of bank liabilities is chosen by the bank, and the original source of funding does not depend on the type of instrument. This approach is consistent with the concept of "cost of equity" for the bank. The real-life analogue of a depositor may be an institutional investor who has invested in short maturity instruments issued by an off-balance sheet vehicle guaranteed by the bank.

FIGURE 1



It is never possible to pay all the withdrawals at stage four without liquidating assets if all the savings of investors have been invested at stage two ($\alpha<\Omega\lambda$ => $1>\Omega>\alpha/\lambda$). It cannot be profitable to make an investment and to liquidate it at stage four; $\alpha < (1-Z)$. No investor can invest in the asset directly. For instance, there might be a relatively large minimum investment no individual could make alone. The bank cannot offer any other types of financial contracts than above described short-term deposits and permanent equity.

The probability of the normal state is high. To be more precise, $\theta > \frac{1-Z}{1-Z+\alpha Z}$. As will be seen in the proof of proposition 2, at least in the first version of the model this condition induces the bank not to prepare itself for the unlikely event of bad times. The bad state is so unlikely that it is not rational to prepare for it.

Two different versions of the model are analysed.

1) There may be an exogenously given dividend η_g. If this dividend is not paid, a run takes place and all depositors try to withdraw. Both the bank and its customers know the value of η_g. This dividend is higher than any deposit rate the bank might offer ($\eta_g>\delta$), consistently with at least some casual empirical observations on banks' dividend policies. [2]

[2] The OECD (2010, p. 11) published the list of the ten largest banks in the euro area in 2006. In the light of data found in annual reports, the non-weighted average ratio of dividends to the book value of shareholders' equity in this group was 8.7 % during last year before the financial crisis. The median was 7.0 %. The annual average interest rate on non-collateralised three months

2) Alternatively, the probability of run (r) is a decreasing function of the dividend η.

When depositors decide whether to renew the deposit at stage four, they react to the dividend per share, not to the total amount of dividends. This is a meaningful assumption if and only if the bank is so opaque that the true leverage of the institution is non-verifiable. Otherwise it would be possible to calculate the amount of dividend payments per risk-weighted assets, which would be more indicative of the state of the bank. In real life, the number of shares is probably known, but creditors do not know how much money market instruments have been issued via off-balance sheet vehicles, what kinds of complicated derivatives contracts the bank has made and what the return on equity and a corresponding dividend yield would be under favourable circumstances.

The bank is risk neutral and it minimises $E(\psi)$, which is the expected value of the loss relative to the hypothetical case where the bank could simply invest all the savings of its financiers, issue nothing but equity and never liquidate anything at stage four, which would be possible if no financiers faced the risk of being subject to a liquidity shock (Ω=0). The loss ψ consists of the expected value of unrealised revenue from undone investments ($\theta\alpha L$) and the expected value of losses caused by premature liquidations of assets at stage four, which equals

$$E(\psi) = \theta\alpha L + (1-Z)*E(H) \qquad (1)$$

where H = premature asset liquidations. Profit maximisation is a standard assumption in most models on corporate decision making, but it is unclear how the bank would maximise profits when the amount of equity capital is chosen. Should the bank choose maximal capitalisation in order to substitute dividends for interest payments, because interest payments are not counted as profits whereas dividends are? Would it pursue an infinite ROE by issuing no equity at all, even though there would be no shareholders who would benefit from profits? Or would it have a more complicated objective function?

Even though the model is strongly inspired by the original Diamond-Dybvig model, there are a number of differences. The original model assumed no other funding instrument than deposits, and all consumers were identical and risk averse. The return of investments held till maturity was risk-free and materialised at the end of the project. Moreover, the bank had got no signalling device. Assets could be liquidated without destroying them, and nothing but the revenue was lost. In this paper there are two kinds of financial contracts, two kinds of

interbank loans, the Euribor rate, was 3.1 % in 2006. In no bank of the sample the dividend yield on shareholders' equity was as low. Hence, the market is used to bank dividends higher than the rate of interest banks pay on their debt, or at least was prior to August 2007.

investors, risk aversion plays no role, and the bank actively uses a signalling device. Moreover, the return on investments is random, possible revenue materialises at an earlier stage and assets cannot be liquidated prematurely at their full value.

3 Solving the model – threshold dividend

It is assumed that the run will take place with certainty unless an exogenously given relatively high minimum dividend η_g is paid. This value may be determined by dividends paid by the bank in the past; at least previous empirical findings imply that a dividend cut may be a negative signal that triggers strong reactions in the market (see section 5). Alternatively, the expected dividend may be determined by other (possibly foreign) banks' standard practices. Paying a higher dividend would not affect depositors' behaviour, but paying less would trigger a run. This exogenous threshold value may be based on past experience. It is not a pure sunspot because the relevance of this trigger is not entirely due to the attention paid to it.

The analysis is restricted to cases where $\eta_g E<D-\lambda\Omega N;$ hereafter this condition is called the indebtedness condition. If this condition is not satisfied the amount of deposits and other types of short maturity debt after normal withdrawals is so small that the bank would need more currency to pay the expected dividend than to pay its panicking depositors in a run. Such an institution could exist, but nobody would call it a bank. Whenever the share of depositors who are potentially subject to a liquidity shock (Ω) is large enough, the bank cannot rely exclusively or almost exclusively on equity capital, and the indebtedness condition must be satisfied.

The run can arise as a Pareto inferior quasi-sunspot equilibrium at stage four. If a run occurs, the bank must liquidate a large part of its assets, and possibly all of them, which causes outright losses. It is easy to demonstrate that the bank tries to avoid the run at any cost.

Proposition 1: If the indebtedness condition is valid, not paying the dividend is never a less costly alternative than paying it.

If the bank pays normal withdrawals and interest rates at stage four, but the dividend is not paid, a run occurs. In this case the liquidation cost equals

$$\text{Max}\{ [(1+\delta)D-L-\alpha' I](1-Z)/Z \ , 0\} \qquad (2)$$

$\alpha' \in (\alpha,0)$, depending on the return on investments.

The corresponding liquidation cost, when the run is prevented by paying the dividend, is

$$\text{Max} \{ [\eta_g E-L-\alpha' I+\Omega\lambda N+\delta D](1-Z)/Z, 0\} \qquad (3)$$

(3) cannot be greater than (2) if the indebtedness condition is satisfied.

$$\eta_g E+\Omega\lambda N<D \Leftrightarrow \eta_g E-L-\alpha' I+\Omega\lambda N+\delta D < (1+\delta)D-L-\alpha' I \qquad (4)$$

If the bank is unable to pay all the depositors, the loss caused by not paying the dividend equals $I(1-Z)$, which is the highest liquidation cost that could be observed. No alternative can be more costly.

QED

At stage 2 the bank must choose how much currency to hold. Because a significant part of depositors will withdraw anyway ($\Omega\lambda$ >1), cases where no currency hoarding or liquidations would be needed can be ruled out. The mere return on assets cannot be high enough to cover withdrawals because by assumption $\alpha<\Omega\lambda$. The bank has got the following options at stage 2.

1) It may hoard enough currency to be able to pay the dividend, interest on deposits and withdrawals without liquidating assets even when the investment yields no return. In this case, the amount of currency must satisfy

$$L\geq\delta D+\eta_g E+N\lambda\Omega \qquad (5)$$

2) Alternatively, it may hoard enough currency to be able to pay the dividend without liquidating assets if and only if the return on assets is normal.

$$\delta D+\eta_g E+N\lambda\Omega > L \geq \delta D+\eta_g E -\alpha I +N\lambda\Omega \qquad (6)$$

3) It may hold a very limited amount of currency, implying that some investments will be liquidated even in the normal state.

$$L < \delta D +\eta_g E+N\lambda\Omega-\alpha I \qquad (7)$$

Making investments that need to be liquidated in any case is not rational because by assumption $\alpha < (1-Z)$, and the third alternative can be ignored. It is more interesting to analyse whether the bank would decide to prepare itself to pay the expected payments even in the bad state without liquidations.

Proposition 2: The optimal amount of currency hoarded at stage two is barely sufficient for dividend and other payments without liquidations at stage four under normal asset return.
PROOF: See Appendix 1

The result is basically intuitive. The bank is always prepared to make all the necessary payments at least in the good state. If the bad state were relatively likely (i.e. theta low), it would find it optimal to hoard enough currency to be prepared even for the bad state, but by assumption, theta is close to 1. Consequently, in expected value terms it is not rational to prepare for the unlikely. Because currency yields no return, the bank does not want to keep any extra balances. The revenue on investments is never sufficient to cover all the payments, and some liquidity hoarding is needed.

Everyone behaves rationally, given the strategy of the counterparty. If the dividend is not paid, each depositor understands the bank is in trouble (proposition 1). The revenue has not materialised and the liquidation value of assets (Z) must be low because the bank is unable to send the reassuring signal by liquidating. Moreover, the bank may have already wasted a significant part of its assets on paying regular interest and deposit withdrawals. The quasi-sunspot makes every depositor believe everybody else the tries to withdraw. The indebtedness condition implies that if the bank cannot pay the dividend, it certainly cannot pay all the panicking depositors in the run. Therefore, a rational depositor reacts to non-payment by running to the withdrawal desk because being among the first to withdraw is the only possibility to get anything. This behaviour is consistent with the beliefs of other depositors. The outcome is a Perfect Bayesian Equilibrium. The dividend is a kind of quasi-sunspot rather than a pure sunspot. Its value is exogenous, but being able to pay it is indicative of the state of the bank.

Proposition 3:Let the indebtedness condition be valid. The expected value of the total loss ψ increases if the amount of equity capital increases at the cost of deposits.
PROOF: See Appendix 2

This result basically implies that equity is expensive. Paying the dividend under normal circumstances is expensive because the bank must hoard non-productive

currency. In most cases this means loss of investment revenue. If the bad state materialises, the bank tries to save what can be saved and mimic normal profitability by liquidating assets in order to maintain the dividend and the illusion of normal profitability. This is costly, and the more equity capital has been issued, the more liquidations are needed to pay the dividend expected by the market.

4 Optimising the dividend

4.1 Assumptions

It can be demonstrated that in a less extreme structure the optimal dividend is higher if bank assets earn the expected return. Moreover, the bank prefers to be thinly capitalised. The assumptions of the model are now modified in the following way. The bank can choose any dividend η it prefers; there is no specific threshold value. If the dividend is low, the probability of the run increases. A low dividend induces the most nervous depositor not subject to a liquidity shock to withdraw. Those who know this individual in person observe the combination of withdrawing and lack of liquidity shock. This observation makes them believe a run has begun, and they follow suit. Those who in turn know these 'contaminated' depositors will join the run, and the panic spreads in the social network. The bank knows each depositor and it knows how the probability of a run depends on the dividend. Increasing the dividend reduces the probability of run (P).

$$P = P(\eta); \quad 0 \leq P \leq 1 ; \quad P' < 0; \quad P'' > 0 \qquad (8)$$

After stage one, investors cannot observe any other management decisions than the dividend. The share of other investors who would not accept equity investments (Ω) and the liquidation value of assets (Z) are not known by investors. Investors do not know whether investments actually turned out to generate the revenue α at stage three. The bank, instead, can observe these non-verifiable variables, even though it does not know before stage three whether investments were a success or a failure. Parameters α, λ and θ are known by all.

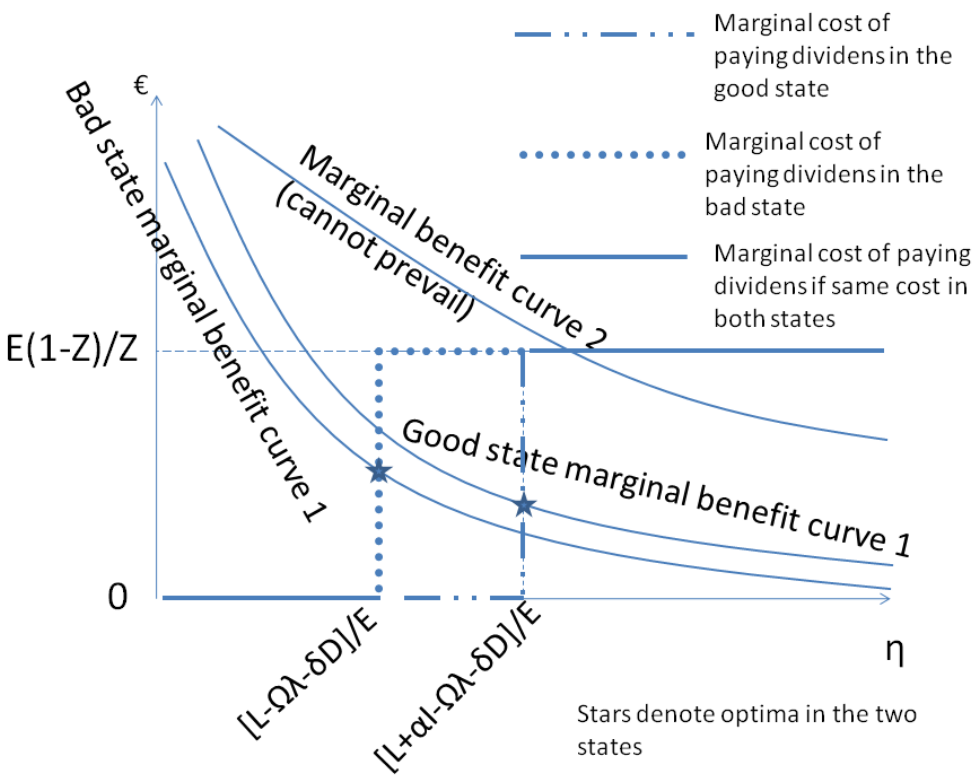
4.2 Analytical results

Proposition 4; The optimal dividend is higher if bank investments yield the return α than if they do not.

PROOF: See Appendix 3

This result is probably clarified by Figure 2. The marginal cost of paying dividends is zero until dividends must be financed at the margin by liquidating assets, which happens at a lower level of dividends if investments have generated no revenue to be distributed. In the good state the cost of paying dividends is zero until $\eta = [L+\alpha I-\Omega\lambda-\delta D]/E$. In the bad state the marginal cost is zero until $\eta = [L-\Omega\lambda-\delta D]/E$. Beyond this point the marginal cost of dividend payments is determined by the loss caused by premature liquidations. The benefit from avoiding the run may be marginally lower in the bad state than in the good state with each dividend; some costly liquidations are needed in the bad state anyway to finance any given dividend, implying that there is less to lose if a run takes place and the bank is forced to liquidate its whole balance sheet. The marginal cost curve and the marginal benefit curve of dividend payments cross at a lower level of dividends in the bad state. There can be no cases where the amount of currency chosen by the bank at stage 2 would be insufficient to enable the dividend payment that will be made in the good state; it is always cheaper to be prepared and to keep enough currency than to buy assets that will be liquidated anyway. Hence, marginal benefit curve 2 in figure 2 cannot prevail; the bank would hoard more currency, shifting the point $(L+\alpha I-\Omega\lambda-\delta D)/E$ to the right. Thus, the dividend is indicative of the state of the bank and not a pure sunspot.

FIGURE 2



4.3 Simulations

The optimal decisions of the bank were simulated with eight different combinations of possible values for parameters observables to depositors. The number of investors is 200 in each simulation.

The bank knows its customers well enough to know that the probability of the run is

$$r = -2\left[\frac{\eta-\delta}{1-\delta}\right]^{1/20} + \left[\frac{\eta-\delta}{1-\delta}\right]^{1/10} + 1 \quad \text{when } \delta<\eta<1 \qquad (9)$$

If $\delta \geq \eta \Rightarrow r=1$; If $\eta \geq 1 \Rightarrow r=0$.

When $\eta=\delta$, the run is a certainty but the marginal effect of η on r is infinitely strong. The marginal impact weakens very fast with higher values of η. When $\eta=1$, the marginal impact is zero and $r=0$. This functional form is basically ad hoc, but it satisfies the conditions (8). In each set of simulations variables not observed by depositors (Ω and Z) are chosen for each simulation separately from the following distributions.

$$\left.\begin{aligned} Z &= rnd1(1-\theta)/(1-\theta+\alpha\theta) + (1-rnd1)(1-\alpha) \\ \Omega &= \alpha/\lambda + 0.95*rnd2(1-\alpha/\lambda) \end{aligned}\right\} \qquad (10)$$

where *rnd1* and *rnd2* are iid distributed random draws from an even distribution between 0 and 1. The distribution of Z covers values that satisfy the criteria $(1-Z)>\alpha$ and $\theta > \frac{1-Z}{1-Z+\alpha Z}$. The distribution of omega covers most of the values that satisfy the condition $1>\Omega>\alpha/\lambda$. (See section 2)

Eight different combinations of observable parameter variables were tested. Each combination was simulated 200 times with different values of Z and Ω determined by (9). The deposit rate was determined mechanically as $\delta = \alpha/3$. With this rule the bank never promises more interest payments on deposits than what revenues generated by a corresponding amount of investments would yield under favourable circumstances. The algorithm tested every possible combination of integer values for balance sheet variables (I,L,E,D) separately. The bank should have some equity and the lowest amount of equity tested in these simulations was +1. A special subroutine searched an optimal value of dividends in both the good state and the bad state for each possible combination of balance sheet variables.

The algorithm minimises

$$E(\psi) = H(1 - Z) + \theta\alpha L \qquad (11)$$

Where H is the amount of investments liquidated at stage four. The amount of liquidations is determined either by the need of currency or by the amount of assets, whichever condition is binding. If a run takes place

$$H = Min\{I, (\eta E + (1 + \delta)D - \alpha' I - L)/Z\}. \qquad (12)$$

If no run takes place

$$H = Min\{I, (\eta E + \delta D + N\Omega\lambda - \alpha' I - L)/Z\}. \qquad (13)$$

where α' is either α or 0, depending on the state of bank investments.

Results are summarised in table 1. The following regularities can found in the results.

- In every case the optimal amount of equity is one, which was exogenously set as the absolute minimum. There is no exception in the whole set of 200*8 = 1600 simulation rounds.
- In each case the average bad state dividend is lower than the average good state dividend, implying that the dividend is indicative of the state of the bank.
- The average return of depositors who hold their investments till maturity (non-withdrawer) is higher than the return of those who withdraw at stage four because of the liquidity shock (withdrawers).

TABLE 1

Simulation set nr	1	2	3	4	5	6	7	8
Observable variables	α=0.4; λ =0.5	α=0.2; λ =0.5	α=0.1; λ =0.5	α=0.2; λ =0.3	α=0.1; λ =0.3	α=0.15; λ =0.2	α=0.1; λ =0.2	α=0.05; λ =0.2
Average dividend in bad state	0.14	0.35	0.16	0.15	0.16	0.17	0.17	0.17
Average dividend in good state	0.47	0.56	0.64	0.57	0.69	0.65	0.70	0.74
Average equity E	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Average investments I	144	149	146	173	171	183	182	180
Average non-withdrawer's return	0.24	0.12	0.06	0.12	0.06	0.09	0.06	0.03
Average withdrawer's return	0.12	0.06	0.03	0.06	0.03	0.04	0.03	0.01

N=200

$\delta = 0.3*\alpha$; $\theta=0.995$

Average withdrawers's return = return of a depositor who withdraws at stage four in any case

Average non-withdrawer's return = return of a depositor who does not withdraw before stage five unless there is a run of a personal liquidity shock

5 The model and previous empirical literature

Lintner (1956) noticed that many companies maintain a stable dividend rate. They react sluggishly to new higher levels of profit and minimise the risk of having to drastically cut dividends. This classical finding has been corroborated by subsequent authors, including Brav et al (2005). Garrett and Priestley (2000) found that unexpected increases in permanent earnings affect the current dividend whereas negative shocks have no observable impact, consistently with the hypothesis of strong aversion to dividend cuts. Avoiding dividend cuts may have to do with signalling; at least this smoothing has been much more commonplace in the U.S. than in Hong Kong, where the institutional environment probably reduces the need for signalling (Chemmanur et al 2010). Aivazian et al. (2006) found that bond issuing rated companies are significantly more likely to smooth their dividends than non-rated firms, probably because bond issuers need to avoid sending negative signals, such as dividend cuts.

Some empirical studies concentrate on banks' dividend policies. The findings of Casey and Dickens (2000) corroborated the hypothesis that large U.S. banks prefer paying stable dividends. Newman et al (2002) presented findings on the dividend policies of U.S. bank holding companies; the dividend stability

hypothesis found particularly strong support in the data. Theis et al (2010) found that U.S. banks tried to maintain stable dividends even during the recent financial crisis; in fact, no other correlate of dividends had as much explanatory power. However, there seem to be no detailed comparative studies on differences between banks' and non-banks' dividend policies.

Maintaining stable dividends during difficult times would be almost useless as a signalling device if no attention were paid to dividends. The stock market reacts positively to dividend increases of bank holding companies (Filbeck and Mullineaux 1999). If a bank announces dividend cuts, this often induces negative abnormal returns in non-announcing banks, presumably because banks' assets are correlated and investors interpret dividend cuts as signals on debtors' financial problems (Bessler and Nohel 2000).

The model relies on the assumption that depositors pay attention to dividends, which seems to be the case. The Islamic banking system may be a particularly interesting "natural laboratory" concerning these effects. The compensation paid to depositors is not a fixed rate of interest but depends directly on the performance of the bank. The amount of money market instruments in the Islamic financial system is limited, and it is difficult to find substitutive sources of funding in case depositors withdraw. Hence, one would expect that Islamic banks would be particularly reluctant to send negative signals to depositors by paying lower than expected dividends. This is precisely the case; deposit supply seems to react positively to dividends, and dividends remain remarkably stable (Hassan et al 2003).

There is some empirical literature on factors that might trigger a deposit run. The evidence suggests that both fundaments and contagion play a role, consistently with the assumptions made in section two. During the critical phases of the Argentine crisis in the second half of 2001, banks with weak fundaments were more likely to suffer from loss of deposits (McCandless et al 2003). Depositor groups have reacted to each others' withdrawals (Starr and Yilmaz 2007) and the decision to withdraw has been observed to spread from individual to individual in the social network (Iyer and Puri 2008). Both withdrawals from failing banks and contagious runs can be identified in data from the Great Depression of the U.S. in the 1930s (Saunders and Wilson 1996). A run can be triggered by signals that might even be interpreted as reassuring: retail depositors paradoxically started to queue at branch offices of Northern Rock when the Bank of England had announced its intention to support the bank (see e.g. Shin 2009).

6 Discussion

Industry practitioners tend to argue that equity capital is expensive for banks. This claim contradicts the Modigliani-Miller irrelevance theorem. This paper presents a potential explanation to this paradox. The explanation is based on banks' vulnerability to deposit runs, which is a problem specific to credit institutions. It is argued that the viability of opaque banks with short maturity debt and illiquid assets depends on signalling. If the bank reveals its weak position by cutting dividends, suspicious counterparties no longer trust it and withdraw funding. These nervous creditors may include both money market counterparties and retail depositors. Spencian signalling by paying dividends is possible because distributing non-existent profits is costly or even impossible. Sending reassuring dividend signals during difficult times by paying, say, one euro per share is obviously less costly if equity capital is minimal relative to exposures.

The approach is somewhat different from the mainstream literature on dividend signalling. Normally it is assumed that signalling is costly relative to share repurchases because of tax reasons. In this model taxation plays no role. The bank might signal its good state even with share repurchases instead of dividend payments, provided these repurchases are publicly observable.

In real life a high dividend may even be an alarming signal; if the bank distributes more to shareholders than what it used to, this might be interpreted as a sign of "cashing out", especially if this happens during a recession. Hence, the most reassuring signal might be dividend stability rather than dividend maximisation.

The model has at least one obvious policy implication. If the public observes clear symptoms of a recession, it is reasonable to restrict banks' dividend payments. If such a regulation is enforced and applies to all banks, dividend cuts tell nothing about the profitability of any particular institution, and bank solvencies could be enhanced with retained earnings without bank-specific adverse signalling effects.

The opaqueness of the bank is a central assumption. If investors are able to observe the true leverage of the bank, minimising the amount of capital in order to be able to maintain an impressive dividend yield irrespective of profitability would be an inefficient strategy. Counterparties would pay attention to the absolute amount of dividends relative to the volume of operations rather than to the dividend per share, and choosing a weaker capitalisation would not make it easier to send reassuring signals. Thus, the model yields the following empirical prediction. Complex banking organisations, where the true leverage cannot be accurately estimated by outsiders, are more likely to consider equity capital

expensive. A bank with simple operations, a transparent balance sheet and no off-balance sheet risks cannot mimic high profitability by choosing an extreme leverage and paying a high and steady return on a tiny equity capital. Interestingly, minimising the capital base seems to have become more commonplace when banking has become more complicated. The true leverage of modern large and complex banking organisations can hardly be deduced from public information. Off-balance sheet vehicles such as SIVs and conduits, proved a major source of risk in the financial crisis in 2008-2009, but obviously even supervisors with their privileged access to information were unable to understand how much risk was taken through them; at least it is difficult to mention any pre-crisis policy initiatives to regulate these vehicles. In the past, before derivatives and off-balance sheet vehicles became commonplace, banks were much less leveraged than what they are now (See e.g. Åhman 1943 p 70, Thies and Gerlowski 1993, Saunders and Wilson 1999.) High capitalisation ratios found in bank balance sheets from past decades probably give a reasonably accurate idea about the true leverage of banks in our grandparents' time. Obviously early and mid 20th century banks did not consider equity highly expensive. There may be several explanations for this change in the way of thinking, and different explanations are not necessarily mutually exclusive.

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APPENDIX 1; PROOF OF PROPOSITON 2

If the bank hoards enough currency to pay the dividend η_g in any state, $E(\psi)$ is the multiple of the required amount of currency in the bad state ($\delta D+\eta_g E+N\lambda\Omega$), the opportunity cost of one unit of currency in the good state (α) and the probability of receiving the normal return (θ). Liquidation costs cannot materialise and the value of Z is irrelevant.

If the bank hoards enough currency to be able to pay dividends without liquidations in the good state only, the total cost is the sum of two components.

- The expected value of the opportunity cost of holding currency is $\alpha\theta\{\delta D+\eta_g E-\alpha I+N\lambda\Omega\}$.
- In the bad state it must liquidate assets to get the sum $I\alpha$ not received from investments. The expected value of the cost of asset liquidation, in case the dividend can be paid by liquidating, is $(1-\theta)\alpha I(1-Z)/Z$. If there are not sufficient assets to cover the payment needs, the cost is the maximal liquidation loss $I(1-Z)$, which must be less.

In expected value terms the total cost of being prepared to pay dividends without liquidations in the good state only is lesser than the cost of having enough currency to make payments in any state at least if

$$\theta\alpha(\delta D+\eta_g E-\alpha I+N\lambda\Omega) +(1-\theta)\alpha I(1-Z)/Z < \theta(dD+\eta_g E+N\lambda\Omega)\,\alpha \qquad \text{(i)}$$

$$\Leftrightarrow \theta > (1-Z) / [1-Z+\alpha Z] \qquad \text{(ii)}$$

By assumption, this condition holds. There cannot be cases where the optimal value of L lies between $\delta D+\eta_g E-\alpha I+N\lambda\Omega$ and $\delta D+\eta_g E+N\lambda\Omega$. With such values of L the derivative of ψ with respect to L would be $\alpha\theta -(1-\theta)\,(1-Z)/Z \Rightarrow \frac{\partial^2\psi}{\partial L^2} = 0$.

The expression (ii) is a sufficient but not a necessary condition because the bank may run out of assets, which limits the cost in the bad state, making hoarding of currency for the bad state less useful.
QED

APPENDIX 2: PROOF OF PROPOSITION 3

Because $E=N-D$ and $I = N-L$, the necessary amount of currency is $L= \delta D+\eta_g(N-D) -\alpha (N-L) +N\lambda\Omega$

$$\Rightarrow L = [\eta_g N+\delta D+N\lambda\Omega-D\eta_g-\alpha N]/(1-\alpha) \qquad \text{(i)}$$

The expected value of the cost of hoarding this amount of currency is the multiple of θ, α and expression (i).

The amount of investment revenue that does not materialise in the bad state is $I\alpha$. The cost of liquidating enough investments to get this missing sum is $I\alpha(1-Z)/Z$, and the probability of this occurring is $(1-\theta)$. Because $I = N-L$, and because L is determined by expression (i), the expected value of this cost component is

$$\text{Min}\ [\ (1-\theta)\alpha[(1-Z)/Z]\ [N-(\eta_g N+N\lambda\Omega+\delta D-D\eta_g-\alpha N)/(1-\alpha)]\ ,\ (1-Z)I\ \ ] \qquad \text{(ii)}$$

The cost (1-Z)I is incurred if the bank is unable to make all the payments even if it liquidates all the investments.

In the good state the cost consists of the opportunity cost of not making investments, which equals $L\alpha$. The probability of this occurring is θ. Because the amount of currency is determined by (i), the expected value of this cost is

$$\theta\alpha[\eta_g N+\delta D-D\eta_g-\alpha N+N\lambda\Omega]/(1-\alpha) \qquad \text{(iii)}$$

If the sum of (ii) and (iii) is differentiated with respect to D, one gets either

$$-\theta\alpha(\eta_g-\delta)/(1-\alpha) < 0 \qquad \text{(iv)}$$

(if the bank is unable to pay the dividend in the bad state and nothing but the good state matters at the margin), or

$$\frac{(\eta_g-\delta)(1-\theta-Z)\alpha}{(1-\alpha)Z} \qquad \text{(v)}$$

The expression (v) is negative iff $1-\theta-Z<0$. The lowest value of θ in banks not able to make all payments without liquidations in the bad state is $(1-Z)/(1-Z+\alpha Z)$. With this minimal value of θ

$$1-\theta-Z = 1-Z-(1-Z)/(1-Z+\alpha Z) < 0 \Leftrightarrow 1-1/[1-Z(1-\alpha)] < 0 \qquad \text{(vi)}$$

Because $0< Z(1-\alpha)<1$, (vi) holds with certainty. And because the derivative of (v) with respect to θ is negative, (v) cannot become positive with higher values of θ. Therefore costs decrease when the deposit base expands at the cost of equity capital.

QED

APPENDIX 3 PROOF OF PROPOSITION 4

Terminology and notation; Marginal benefit from dividends = the derivative of
-P • (loss caused by the run)
with respect to η, where P is the probability of the run.
η_a =dividend in the good state (investments yield α)
η_b = dividend in the bad state (no return on investments)
And * denotes optimal dividend.

Sub-proposition 1: Optimal $\eta_a = [L+\alpha I-\Omega\lambda-\delta D]/E$
PROOF: Iff $\eta_a < [L+\alpha I-\Omega\lambda-\delta D]/E$, the good state marginal cost of paying more dividends is zero at stage three because there is no alternative use for excess currency. The marginal benefit is always positive. Therefore the optimal dividend in the good state satisfies $\eta_{a*} \geq [L+\alpha I-\Omega\lambda-\delta D]/E$

It is not possible to find cases where η_a^* is wholly or partly paid by liquidating assets because it is never profitable to make investments that need to be liquidated anyway.
QED

Subproposition 2: If $\eta_b = \eta_a = [(L+\alpha I-\Omega\lambda N-\delta D)/E]-$, the marginal cost of paying dividends in the bad state is E(1-Z)/Z.[3]
PROOF:
The sub-proposition 1 implies that this bad state dividend cannot be financed without liquidations. => The marginal cost of increasing the dividend in the bad state equals E(1-Z)/Z.
QED

Subproposition 3 With η_{a*} the marginal benefit of dividends in the good state < E(1-Z)/Z.
PROOF
If the marginal benefit of the dividend in the good state were higher than E(1-Z)/Z, it would be rational to increase the dividend even by liquidating because the benefit would exceed the cost.

The marginal cost of increasing the dividend η_a by hoarding more currency is αE in the good state. This is less than E(1-Z)/Z because by assumption $(1-Z)>\alpha$ and $(1-Z)/Z > (1-Z)$. Therefore, whenever the marginal benefit exceeds E(1-Z)/Z, it would have been optimal to hoard more currency.

[3] Notation: X– = infinitesimally smaller than X

The possibility of the bad state does not change the conclusion. Having more currency cannot increase the cost, and does not make currency hoarding less attractive. Therefore a rational bank hoards currency until optimal $\eta_{a*} < E(1-Z)/Z$.
QED

Subproposition 4 The good state marginal benefit of increasing the dividend is higher or as high as in the bad state if $\eta_b = \eta_a$.
PROOF
In both cases the impact on the probability of the run is the same. In the bad state there are less assets because some of them have already been liquidated anyway in order to pay the dividend. Therefore there are less assets that might be lost in a run, decreasing the cost.
QED

Subpropositions 1 and 2 imply that the marginal cost of increasing η_b is $E(1-Z)/Z$ if $\eta_b = \eta_a$*-. Subpropositions 3 and 4 imply that when $\eta_b = [(L+\alpha I-\Omega\lambda N-\delta D)/E]-$, the marginal benefit from increasing the dividend is less than $E(1-Z)/Z$. Therefore the marginal cost is higher than the marginal benefit, and it is rational to reduce the dividend. Therefore $\eta_a* > \eta_b*$.
QED.

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