Bank Capital and Dividend Externalities

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Dividend payouts affect the relative value of claims within a firm. When firms have contingent claims on each other, as in the banking sector, dividend payouts can shift the relative value of stakeholders' claims across firms. Through this channel, one bank's capital policy affects the equity value and risk of default of other banks. In a model where such externalities are strong, bank capital takes on the attribute of a public good, where the private equilibrium features excessive dividends and inefficient recapitalization relative to the efficient policy that maximizes banking sector equity. We compare the implications of the model with observed bank behaviour during the crisis of 2007-09. (*JEL* G01,G21,G24,G28,G32,G35,G38)

As the financial system's capital was being depleted in the 2007-2009 financial crisis, some banks curtailed their dividends but others, especially securities firms, continued to pay dividends well into the depth of the crisis. Indeed, as we will see below, some firms - including those that entered financial distress - actually *increased* their dividends into the crisis.

Our paper provides a framework that can accommodate such divergence in the reactions of financial intermediaries in their capital decisions. Using this framework, we ask how divergent interests of the

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We are grateful to David Hirshleifer and Philip Strahan (the editors) and two anonymous referees for comments and suggestions that substantially improved our paper. We thank Frederic Boissay, Egemen Eren, Tirupam Goel, Anton Korinek, Ulf Lewrick, Nikola Tarashev and participants at the 2014 Western Finance Association Meetings and the 2014 Financial Intermediation Research Society Meetings for helpful discussions. Sebastian Deininger, Aaditya Iyer and Kate Waldock provided excellent research assistance. The views expressed here are those of the authors and not necessarily those of the Bank for International Settlements.

doi:10.1093/rfs/XXX000

banks' stakeholders are likely to play out during times of heightened financial distress.

Dividend payouts shift the relative value of claims between a firm's stakeholders, but in the banking sector, interlocking balance sheets across banks introduces another dimension to the distributional implications of dividend policy. Dividend payouts can shift the relative value of stakeholders' claims *across* firms as well as within each firm. Through this channel, one bank's capital policy affects the equity value and risk of default of other banks through the classic risk-shifting incentives described in Jensen and Meckling (1976). In a model where such externalities are strong, the private equilibrium has excessive dividends and inefficient recapitalization relative to the efficient policy that maximizes banking sector equity value. In this way, banking sector capital takes on the attributes of a public good even among bank shareholders. This aspect of bank capital as a public good is in addition to the broader macro arguments concerning undercapitalized banks being a drag on economic activity, thereby perpetuating weak banks and slow growth (Shin (2016a)).

We highlight the role played by banks' franchise values as the determinant of equilibrium behavior. Lower franchise values exacerbate the incentive problem and lead to worse outcomes. To the extent that banks' market-to-book multiples provide a proxy for franchise values, our arguments take on added significance in the current environment of depressed market-to-book ratios in the banking sector.

In the simplified setting of our model with a fixed terminal date, the optimal policy that maximizes the value of the bank (total equity plus debt value) is to pay no dividends. This is because paying dividends will decrease the total value of the bank by increasing the probability that its franchise value will be lost. However, we show that in practice when the dividend policy of a bank is set to maximize only its equity holders' value, the dividend policy reflects a tradeoff between (i) paying out to equity holders the available cash today rather than transferring it to creditors in default states in the future; and (ii) saving the equity's option on the franchise value since dividend payout raises the likelihood of default and thus foregoing this value. When debt is risky (i.e, when bank leverage is sufficiently high), the optimal dividend policy depends on the bank's franchise value. If the franchise value exceeds a critical threshold, the effect in (ii) dominates and it becomes optimal for the bank not to pay any dividends. However, if the franchise value is below the critical threshold such that risk-shifting benefits in (i) become dominant, then the bank would pay out all available cash as dividends.

Equilibrium in the dividend game reflects the spillovers across banks, and the benchmark model with common knowledge of payoffs gives rise to multiple equilibria. We refine these equilibria using global game methods, and derive the unique switching equilibrium. In this equilibrium, each bank's payout policy depends on its franchise value. There is a critical threshold for the franchise value such that a bank pays no dividends above the threshold and pays maximum dividends below the threshold.[1]

The equilibrium is inefficient relative to the capital policy that maximizes the equity value of the banking sector. This inefficiency is in addition to the classic debt overhang problem described by Myers (1977). In our model, banks do not have an incentive to curb excessive dividends, as the benefits accrue only to their creditors who in turn are their interconnected counterparties. The innovative features of our two-bank model are that (i) interconnectedness can give rise to strategic complementarities in dividend decisions; and (ii) the socially optimal outcome can be obtained through coordination among shareholders of interconnected banks. Our model applies generally to all firms in financial distress, but is most relevant in the context of bank holding companies, especially broker-dealer firms, as they have high levels of leverage and interconnectedness.

The main innovation in our paper is in modeling this interaction of two agency problems - an agency friction between interconnected banks superimposed over an agency friction between the banks and their outside creditors. While risk-shifting in the one-bank model can be efficiently priced or contracted away (using covenants, e.g.) by individual bank creditors, restricting dividends is desirable in the case of interconnected banks over and above the shareholder-creditor conflict. In particular, cutting dividends can make even equity claims of both banks more valuable, but this is an externality that they do not internalize. While outside creditors are also hurt by this agency friction between interconnected banks, they can limit such risk-shifting by only using exclusive contracts (e.g., covenants that are tied not just to the behavior of banks they lend to, but also of other banks).[2]

We extend our model to incorporate negative dividends, which we interpret as equity issuance. We show that the result on excessive dividends in our benchmark model generalizes to under-capitalization of banks in this extension. By issuing equity, a bank increases the value of claims of its creditors, among whom are shareholders of its interconnected banks. Banks pay the cost of equity issuance but do not

[1] The solution method does not rely on the iterative dominance argument of Morris and Shin (1998, 2003), but focuses on showing uniqueness of equilibrium, as first examined by Goldstein and Pauzner (2005).

[2] Note, however, that the presence of explicit or implicit government guarantees can imply that even in the one-bank case, creditors may not have incentives to limit shareholder dividends. In effect, the shareholder-creditor conflict in the presence of government guarantee transforms into a conflict between the taxpayer and the bank as a whole.

internalize this positive externality. One key question is why banks do not find ex ante mechanisms to mitigate such ex post agency problems, e.g, by including dividend cutoff or earnings retention covenants in bank debt contracts. We review the classic arguments in the context of our model and discuss the possible impediments to addressing the inefficiencies through the classic contracting approach.

Our paper is structured as follows. Section 1 summarizes the related literature. Section 2 reviews the pattern of financial firms' dividend payouts during the 2007-2009 financial crisis. Sections 3 and 4 present the theoretical analysis on banks' dividend policies. Section 5 extends the benchmark model to take into account equity issuance decisions. Section 6 discusses the ex ante contracting problem, reviews the events of 2007-09 in the light of our model. Section 7 concludes.

1. Related Literature

Our paper is related to at least three strands of literature. The first strand is the large literature on corporate dividend policies. Allen and Michaely (2003), Frankfurter and Wood (2006), Baker (2009), and DeAngelo, DeAngelo and Skinner (2009) provide excellent summaries of this literature. Existing theories propose two main reasons why firms pay dividends: (1) to resolve agency conflicts between managers and shareholders; and (2) to signal firms' quality in the presence of asymmetric information. (2) offers an alternative explanation for why banks might have been reluctant to cut dividends well into the financial crisis - to signal their quality during a time of uncertainty. However, the fact that some banks *increased* their dividend payments appears more consistent with a risk-shifting explanation, as proposed in our paper.

The second strand of related literature studies suboptimal dividend and capital policies as a result of shareholder-debtholder conflict of interests.[3] Black (1976) and Smith and Warner (1979) were the first in this literature that focuses on dividends. Black (1976) points out an extreme example of this conflict, saying "there is no easier way for a company to escape the burden of a debt than to pay out all of its assets in the form of a dividend, and leave the creditors holding an empty shell". Similar to our one-bank model, Fan and Sundaresan (2000) and DeMarzo and Fishman (2007) analyze the trade-off between paying out dividends and foregoing of the firm's continuation value. In Fan and Sundaresan (2007), when cash-flow based covenants are in place,

[3] This strand of literature belongs to the broader literature on risk-shifting (see, for example, Jensen and Meckling (1976), and Galai and Masulis (1976)): the same debtholder-shareholder tension that can affect payout and capital policies as in our paper can also lead to substitution from safer to riskier assets. However, due to lack of detailed asset-level data, asset substitution is difficult to detect as a manifestation of risk-shifting.

not all cash is paid out as dividends, as doing so might violate these covenants, resulting in a loss of the firm's continuation value. De Marzo and Fishman (2007) study this payoff in the context of optimal security design, where the firm's agent makes the dividend decision based on the presence of an outstanding risky debt and a line of credit. As the agent's continuation value is decreasing in the probability of defaulting on debt obligations, he has no incentive to divert cash to shareholders before their debt is serviced.

Shareholders' aversion to raising capital in our model can be related to the debt overhang problem in Myers (1977). As in Myers (1977), shareholders dislike raising equity as doing so would benefit creditors at their own expense. Admati et al. (2015) show that conflict of interest between the borrower and the creditor can lead to inefficient recapitalization, e.g. shareholders' reluctance to reduce leverage via issuing equity. Our paper contributes to this second strand of literature by studying the debt-equity agency problem in the form of conflicts of interest across banks. Our new insight is that coordination among bank equity holders can help preserve system-wide capital and stability.

Finally, our paper is related to studies examining suboptimal equilibria arising from externalities in a financial network setting. Bhattacharya and Gale (1987) argue that banks' ability to borrow from each other creates a moral hazard problem where banks free ride on liquidity and under-invest in liquid assets. Unlike their model where the inefficiency arises because other banks are likely to honor a bank's borrowing requests, in our model it results from a bank's failure to honor its debt obligation. As a result, our model delivers the opposite result. In Bhattacharya and Gale (1987), the greater the credibility of payments on interbank claims, the stronger the incentive to free ride and the stronger the moral hazard of insurance provided by these claims. Our model, on the other hand, suggests that the more credible interbank claims, the lower the incentive to shift risks.

Other related papers in this last strand of literature include Zawadowski (2013), Acemoglu, Ozdaglar, and Tahbaz-Salehi (2015), and Admati et al. (2013). In Zawadowski (2013), individual banks do not have incentives to purchase insurance on counterparty default due to costs of equity and the low probability of counterparty default. This underinsurance problem is exacerbated by the fact that banks ignore the externalities their own failures impose on their counterparties, the counterparties of their counterparties, and so on. Acemoglu, Ozdaglar, and Tahbaz-Salehi (2013) argue that the financial network that arises in equilibrium is inefficient due to the fact that banks only internalize the externalities of their risk taking actions on their immediate counterparties but not on the rest of the network. While these papers focus on the decision to purchase counterparty default insurance

(Zawadowski, 2013) and endogenous network formation (Acemoglu, Ozdaglar, and Tahbaz-Salehi, 2015), we focus on the dividend and equity issuance decisions, forms of risk-shifting that have not been analyzed in the financial network literature.

The closest paper to ours is Admati et al. (2013), which points out (but does not formally model) that banks do not internalize the negative externalities their distress impose on the financial system (and consequently tax payers' money) and thus choose socially excessive leverage. We explicitly model bank interconnectedness and show that such externalities can also be costly from the point of view of the banks' shareholders. Unlike in their model where issuing equity is never desirable by shareholders, it is so under our model when the incentive to preserve the franchise value is strong, i.e, when the franchise value is sufficiently large. In turn, dividend payouts and under-capitalization arise when bank franchise values are sufficiently eroded.

2. Dividend Payments During 2007-2009

To set the stage for our model, we review the dividend patterns during the 2007-2009 financial crisis for a group of 10 large US banks and securities firms.[4] (Figure **1a**) shows the cumulative credit losses of the ten firms beginning in 2007Q3, where losses in each quarter are indicated by the respective segment in the bar chart. The losses are raw dollar numbers, not normalized by size. (Figure **1b**) shows the cumulative dividends of the 10 firms over the two-year period from 2007Q1 to 2008Q4.

The first striking feature is that dividend payments by these firms continued well into the depth of the crisis in 2008. The bars associated with large commercial bank holding companies such as Bank of America, Citigroup and JP Morgan Chase show evenly spaced segments corresponding to the respective quarter, indicating that these banks maintained a smooth dividend payment schedule in spite of the crisis. For some other firms, such as Merrill Lynch, dividend payments increased in the latter half of 2008. Shin (2016a, 2016b) shows similar patterns in the dividend payments of banks in the euro area during and after the euro area crisis of 2011-12.

Particularly worthy of note is the sharp divergence of dividend payments during 2008. Among firms that either failed, or were otherwise resolved or acquired during the crisis, Lehman Brothers and Merrill

[4] Bank of America, Citigroup, JP Morgan Chase, Wells Fargo, Wachovia, Washington Mutual, Goldman Sachs, Morgan Stanley, Merrill Lynch and Lehman Brothers. We do not include Bear Stearns in our sample, as it has a relatively short run of data due to its takeover by JP Morgan in March 2008.

Lynch increased their dividend payments in 2008[5], while Wachovia and Washington Mutual decreased their dividends drastically in the third quarter of 2008. The dividend payouts of these four institutions can be better seen in (Figure **1c**), which normalizes dividend payouts relative to 2007Q1. Another way to present a bank's dividend behavior is to normalize its dividend payment by the book value of its equity. (Figure **1d**) plots this ratio for the ten banks in our sample. All ratios are normalized such that the ratio in Quarter 1, 2007 is set equal to 1.

The divergent dividend behavior of the four outliers is further highlighted in Figure **2** where cumulative credit losses for each bank are plotted alongside its quarterly dividend payments. Again, what is striking is the contrast between the two broker-dealers (Lehman Brothers and Merrill Lynch) and the two commercial banks (Washington Mutual and Wachovia).

Even as dividend payments were eroding capital, recapitalization through equity issuance was limited. Figure **3** shows the total amount of capital raised by the ten banks over 2007Q3 to 2008Q4. Two observations are worthy of note. First, for most banks, most of the capital raised was in the form of preferred stocks and debt instead of common equity. Second, while all commercial banks had positive net issuance of common stocks[6], three out of the four investment banks (Lehman Brothers, Goldman Sachs and Morgan Stanley) had negative net common stock issuance, indicating that total repurchases of common stocks exceeded total issuance over the said period. An exception is Merrill Lynch, whose common stock issuance was large relative to the total amount of capital raised.

Figures **4** and **5** examine the impact of capital policies on leverage. Figure **4** plots book leverage ratios for the ten banks in our sample from 2007Q1 to 2008Q4. The plot shows that relative to commercial banks and bank holding companies, investment banks entered the financial crisis with higher leverage. As the crisis progressed, banks' leverage rose steadily until later quarters when book leverage ratios for some banks started to decrease. Book leverage ratios are based on accounting numbers which do not reflect market price fluctuations. In Figure **5** we present banks' quasi-market leverage ratios which reflect the bank's market capitalization.[7] When leverage is calculated using market

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[5] For instance, the quarterly dividends for Lehman Brothers were 106 mil(2007Q1), 105 mil (2007Q2), 103 mil (2007Q3), 104 mil (2007Q4), 130 mil (2008Q1), and 204 mil (2008Q2).

[6] Net common stock issuance is defined as the dollar amount of common stock issued minus the dollar amount of common stock repurchased.

[7] Quasi-market leverage is defined as quasi-market value of assets over market value of common equity. Quasi-market value of assets is defined as book value of assets minus book value of common equity plus market value of common equity, where market value of common equity is number of common shares outstanding times price per share.

capitalization, the increase in leverage is more dramatic still, reflecting the decline in their share prices.[8]

Why did banks continue to pay dividends during the crisis, even when losses were accumulating? And what accounts for the divergence in the pattern of dividend payments between the banks? Motivated by these questions, we turn to a theoretical investigation to shed light on these questions. We highlight the importance of franchise values. To the extent that securities firms' franchise values are more sensitive to financial distress, dividends will be higher in equilibrium. We examine the implication for risk-shifting for interconnected banks, and show that such firms have greater incentive to pay dividends.

3. Single Bank Model

We first lay out a model of dividend policy for a single bank. Then, we introduce a second bank that is financially linked to the first bank and study the externalities in their dividend policies. The model relies partly on the structure in Acharya, Davydenko and Strebulaev (2012).

There are two dates - date 0 and date 1. Consider a bank at date 0 with cash assets of $c>0$ and non-cash assets y (such as loans and securities) that are due at date 1 and take realizations in the interval $\left[\underline{y},\bar{y}\right]$ with density $h(y)$, where $0<\underline{y}<\bar{y}$.

The bank finances the assets with liabilities ℓ that are due at $t=1$. Assume that $\ell\in\left(c+\underline{y},c+\bar{y}\right)$, so that the probability of bank default is non-zero but strictly below 1. There is no possibility of renegotiating this debt in the case of default and the bank cannot issue capital at $t=0$ or $t=1$ against its future value. In other words, the debt contract is hard and the payment of ℓ must be met at $t=1$ using the bank's cash savings and realized value of assets. The *book option value of equity* of the bank (BE) at date 0 is defined as:

$$\mathrm{BE}=E(\max\{0,y-\hat{y}\}) \tag{1}$$

where $\hat{y}$ is the threshold value of asset realization when the bank just meets its liabilities ℓ. In other words, $\hat{y}$ satisfies $c+\hat{y}=\ell$. The book option value of equity is the fair value of the call option on the bank's portfolio.

An alternative notion of equity for the bank is its *market capitalization*, or market equity, which reflects the price of its shares. Market equity and the book option value of equity will diverge since market equity reflects the discounted value of future cash flows, as well as the snapshot of the bank's portfolio. We assume that if the bank survives

[8] Note that both measures of leverage may understate the true leverage over this time period due to accounting practices that received scrutiny subsequently. One salient example is Lehman Brothers' use of Repo 105 that removed \$50 billion in liabilities from its balance sheet in 2008Q2.

after date 1, the expected value of its future profit is given by $V > 0$. The franchise value V depends on the market-implied discount rates for future cash flows, as well as expected future cash flows themselves.

Incorporating the franchise value, the market equity of the bank is given by

$$\mathrm{ME} = E(\max\{0, y - \hat{y}\}) + \Pr(y \geq \hat{y}) \cdot V \tag{2}$$

where $\Pr(y \geq \hat{y})$ is the probability of bank solvency.

Our focus will be on the bank's dividend policy at date 0. The bank can pay a dividend d, up to its starting cash balance of c. As a benchmark, consider the first best dividend - the one that maximizes the total value of the bank (the value of debt plus the value of equity). Denote by $\hat{y}(d)$ the default threshold of the bank's non-cash assets when the bank has paid dividend of d. In other words, $\hat{y}$ is the solvency threshold of y:

$$\hat{y}(d) \equiv \ell + d - c \tag{3}$$

The bank is solvent at date 1 if and only if $y \geq \hat{y}$. The bank's *total value* is the sum of dividends paid at date 0, expected assets, plus the expected franchise value:

$$\begin{aligned} & d + E(y + c - d) + \Pr(y \geq \hat{y}(d)) \cdot V \\ = \ & E(y + c) + \Pr(y \geq \hat{y}(d)) \cdot V \end{aligned} \tag{4}$$

The dividend d only affects (4) through the probability of solvency of the bank. Since the default threshold $\hat{y}$ is increasing in d, the second term in (4) is strictly decreasing in the dividend. Thus, as long as the bank has positive franchise value V, the value-maximizing dividend policy is to pay none. The intuition for the first best policy is straightforward. In the absence of the bank's franchise value, a dividend only affects the distribution of payoffs between equity holders and creditors and does not matter for the bank's total value. However, when the bank has a positive franchise value, paying dividends reduces the bank's expected franchise value.

Now consider the "second best" dividend policy, that maximizes the shareholder's payoff. The shareholder's payoff is given by the sum of the dividend d and the ex-dividend market value of equity. In other words, the shareholder's payoff considered as a function of d is given by

$$\begin{aligned} U(d) &= d + E(y - \hat{y} + V | y \geq \hat{y}) * Pr(y \geq \hat{y}) \\ &= d + E(y - \hat{y} | y \geq \hat{y}) * Pr(y \geq \hat{y}) + \Pr(y \geq \hat{y}) \cdot V \end{aligned} \tag{5}$$

We proceed to analyze the second best dividend policy, and contrast it with the first best. For algebraic tractability, we impose a parametric form on the density $h(.)$, and assume that y is uniformly distributed over the interval $\left[\underline{y},\bar{y}\right]$. Hence, $h(y)=1/(\bar{y}-\underline{y})$. Then, (5) can be written as

$$\begin{aligned} U(d) &= d+\frac{(\bar{y}-\hat{y})^2}{2\left(\bar{y}-\underline{y}\right)}+\frac{\bar{y}-\hat{y}}{\bar{y}-\underline{y}}\cdot V \\ &= d+\frac{(\bar{y}+c-\ell-d)^2}{2\left(\bar{y}-\underline{y}\right)}+\frac{(\bar{y}+c-\ell-d)}{\bar{y}-\underline{y}}\cdot V \end{aligned} \tag{6}$$

Shareholders choose d to maximize (6). The choice reflects the tradeoff between having one dollar of cash in hand today (the first term) versus the ex dividend market equity of the bank (sum of second and third terms). The derivative $U'(d)$ thus gives the sensitivity of the *cum-dividend* share price of the bank with respect to the dividend d. Although $U(d)$ is a quadratic function of d, we see from (6) that $U(d)$ is a convex function of d since the squared d^2 term enters with a positive sign. Hence, the first-order condition will not give us the optimum. Instead, given the convexity of the objective function, the optimal dividend policy will be a bang-bang solution, where either no dividends are paid or all cash is paid out in dividends. We summarize this feature in terms of the following Lemma.

Lemma 1. The dividend policy of the bank that maximizes shareholder payoff is either maximum dividends $d=c$ or no dividends $d=0$.

Note that this bang-bang solution does not arise from the assumption of uniform cash flow distribution. Rather, it relies on the assumption that equity holders have an embedded option, and that the choice of dividends is analogous to choosing the strike price of this option. Because the option value is convex in its strike price, so long as the choice of dividends at date $t=0$ does not affect this distribution in a continuous manner, a corner solution is obtained.

This result implies there are cases under which second best dividends are excessive relative to the first best. From now on we will focus on and refer to the second best dividend policy as the "optimal" dividend policy. To distinguish the second-best policy from the first best, we refer to the first-best dividend policy as the "socially optimal" dividend policy.

3.1 Franchise Value and Optimal Dividend

The fact that the bank either pays maximum or minimum dividends simplifies our analysis greatly, and we can focus on how the bank's franchise value V affects the bank's dividend policy. Denote by $U(d,V)$ the shareholder's payoff function (the cum-dividend price of shares) when dividends d are paid and when the franchise value conditional on survival is V. From the bang-bang nature of the solution, we need only compare $U(0,V)$ and $U(c,V)$ in finding the optimal d. Define the payoff difference $W(V)$ as

$$W(V) \equiv U(0,V) - U(c,V) \tag{7}$$

$W(V)$ is the payoff advantage of paying zero dividends relative to paying maximum dividends, expressed as a function of the franchise value V. Then, the optimal dividend policy as a function of the franchise value V is given by

$$d(V) = \begin{cases} 0 & \text{if } W(V) \geq 0 \\ c & \text{if } W(V) < 0 \end{cases} \tag{8}$$

From our expression for U in (6), we have

$$\begin{aligned} W(V) &= U(0,V) - U(c,V) \\ &= \frac{c^2 - 2c\left(\ell - \underline{y}\right)}{2\left(\bar{y} - \underline{y}\right)} + \frac{c}{\bar{y} - \underline{y}} \cdot V \end{aligned} \tag{9}$$

which is an increasing linear function of V with slope $c/(\bar{y} - \underline{y})$. Thus, there is a threshold V^* of the franchise value such that the bank pays maximum dividends when $V < V^*$, but pays no dividends when $V \geq V^*$. The intuition is that when the franchise value is high, the value to the shareholders of remaining solvent is high, and the solvency probability can be raised by retaining cash rather than paying out cash as dividends. This result is in line with models of Keeley (1999), Fan and Sundaresan (2000), and DeMarzo and Fishman (2007), where a high continuation value deters the transfer of value to shareholders.[9]

The threshold value V^* solves $W(V^*) = 0$. From (9), we have

$$V^* = \ell - \frac{c}{2} - \underline{y} \tag{10}$$

We summarize our result as follows.

Proposition 1. For $V^* = \ell - \frac{c}{2} - \underline{y}$, the optimal dividend policy is given by

$$d(V) = \begin{cases} 0 & \text{if } V \geq V^* \\ c & \text{if } V < V^* \end{cases} \tag{11}$$

[9] DeMarzo and Fishman (2007) and Fan and Sundaresan (2000) analyze the role of franchise values in the debtholder - shareholer agency problem as in our model, while Keeley (1990) focuses on bank risk taking under mispriced deposit insurance.

Risk-shifting via dividends is more pronounced in banks with high liabilities ℓ. For two banks with the same book option value of equity, it is therefore the more highly leveraged bank that is more likely to engage in risk-shifting. In addition, risk-shifting is more likely to happen in bad times than good ($\frac{\partial V*}{\partial c}<0$ and $\frac{\partial V*}{\partial \underline{y}}<0$).

In the next section, we show that in an interconnected system where banks are contingent debtors of one another, paying dividends creates negative externalities on bank franchise values that are not internalized by the dividend paying bank. This results in a suboptimal decentralized equilibrium in which banks pay out excessive dividends.

4. Two Bank Model

We now turn to the main model of our paper, where there are interconnected banks. We consider two banks linked in a simple way through an over-the-counter swap that depending on the state of the world, will make one bank a creditor of the other.

We denote the two banks as A and B. The set-up for each bank is identical to the one above for an isolated bank but we denote the parameters for each bank by means of the subscripts $\{a,b\}$ for banks A and B. Thus each bank i is characterized by $(c_i,d_i,\ell_i,y_i,V_i,h_i)$, where $i\in\{a,b\}$. For notational economy, we consider the symmetric case where the support for $t=1$ realizations of non-cash assets is the same for both banks, and given by $\left[\underline{y},\bar{y}\right]$.

The two banks have a hard financial contract linking them, that generates a claim and corresponding obligation at $t=1$. Whether a bank has a claim on, or link to, another bank depends on a state of the world whose realization is independent of the realization of the non-cash assets of the two banks. Furthermore, we assume that the non-cash asset realizations of the two banks are independent.

In state A, bank A owes bank B an amount $s_a>0$; in state B, bank B owes bank A an amount $s_b>0$. States A and B have probabilities p and $(1-p)$, respectively. There is no other linkage between the banks. We analyze state A and state B in terms of possible outcomes for the two banks and then compute market equity values at $t=0$.

In state A, bank A's total debt is ℓ_a+s_a. Thus, it can avoid default only if $y_a+c_a-d_a>\ell_a+s_a$. Therefore, its default threshold is given by:

$$\hat{y}_a\equiv\ell_a+s_a+d_a-c_a \tag{12}$$

The default point for bank B in state B is determined analogously. As before, we assume that default points for both banks lie within the support of their non-cash asset realization, i.e., $\underline{y}<\ell_i+s_i-c_i<\ell_i+s_i<\bar{y}$.

The new element in the two-bank case is that the default point of bank A in state B depends on the possibility of default by bank B on its financial contract with bank A. To see this, consider state B from the standpoint of bank A.

If $y_b > \hat{y}_b$, then B makes the full payment of s_b to A, whose cash flow is now $y_a + s_b$. Hence, A's default threshold in this case is given by:

$$\hat{y}_a^{ND} \equiv \ell_a + d_a - c_a - s_b \tag{13}$$

where the superscript "ND" indicates the default point for bank A when bank B does not default on its obligations.

However, if $y_b < \hat{y}_b$, then B defaults. We assume that in this case, A's financial claim ranks *pari passu* with the other outstanding debt of bank B. Thus, A recovers the pro-rata share of its claim from B's remaining assets amounting to

$$s_b^D \equiv \frac{s_b}{\ell_b + s_b} \cdot (y_b + c_b - d_b)$$

Then, A's default point is now higher than in the case of no default by B, given by:

$$\hat{y}_a^D \equiv \ell_a + d_a - c_a - s_b^D \tag{14}$$

where the superscript "D" indicates that the default point of bank A when bank B defaults on its contract.

The distinction between $\hat{y}_a^{ND}$ and $\hat{y}_a^D$ makes it clear that in some states of the world when B owes A but B's cash flow realization is poor, A's default likelihood goes up. As such, A's default likelihood is increasing not just in its own dividends but also in dividends of B since the more B has paid out in dividends, the less it has available to pay A as its creditor. This dependence in payoffs generates a spillover effect of dividend policy that ties together the interests of the banks. We examine this interaction of dividends and default likelihoods of the two banks and study its implications for their optimal dividend policies.

Consider the payoff of bank A's shareholders at $t = 0$. This payoff is the cum-dividend share price of bank A, which is given by the sum of four terms:

$$\begin{aligned} U_a(d_a, d_b, V_a) &= d_a + p\int_{\hat{y}_a(d_a)}^{\bar{y}} [y_a - \hat{y}_a(d_a) + V_a] h_a(y_a) dy_a \\ &+ (1-p)\int_{\hat{y}_b(d_b)}^{\bar{y}} \left[\int_{\hat{y}_a^{ND}(d_a)}^{\bar{y}} \left[y_a - \hat{y}_a^{ND}(d_a) + V_a\right] h_a(y_a) dy_a\right] h_b(y_b) dy_b \\ &+ (1-p)\int_{\underline{y}}^{\hat{y}_b(d_b)} \left[\int_{\hat{y}_a^D(d_a, d_b)}^{\bar{y}} \left[y_a - \hat{y}_a^D(d_a, d_b) + V_a\right] h_a(y_a) dy_a\right] h_b(y_b) dy_b \end{aligned}$$

Each of the four terms has a simple interpretation:

- The first term, d_a, is the dividend paid out at $t=0$ to A's equityholders.
- The second term captures the payoff in state A when A's cash flow is sufficiently high to pay all of its creditors including B.
- The third term captures the outcome in state B when B does not default on A and A's cash flow is high enough to avoid default.
- Finally, the fourth term captures the outcome in state B when B defaults on A and yet A's cash flow is high enough to avoid default.

Note that the payoff function for A's shareholders is written explicitly as a function of d_a and d_b, thereby stressing the dependence of the default thresholds on the two dividend policies. The fourth term is the key to understanding the interaction between the two dividend policies.

In Internet Appendix A, we show that $\frac{\partial^2 U_a(d_a,d_b)}{\partial d_a^2}>0$ so that the shareholder's payoff is convex in the dividend, just as in the single bank case. Then, as with the single bank case, the optimal solution is a bang-bang solution of either no dividends or maximum dividends.

The negative externality of each bank's dividend payout on the other bank can be characterized in terms of the partial derivative $\partial U_a/\partial d_b$:

$$\frac{\partial U_a}{\partial d_b}=-(1-p)\int_{\underline{y}}^{\hat{y}_b}\left[V_a h_a(\hat{y}_a^D)+\frac{s_b}{(\ell_b+s_b)}Pr[y_a>\hat{y}_a^D]\right]h_b(y_b)dy_b \quad (15)$$

which is always negative and where we have used the fact that $\frac{\partial \hat{y}_a^D}{\partial d_b}=\frac{s_b}{\ell_b+s_b}$. Note that this result is not reliant on the assumption of cash flows having a uniform distribution. The intuition is clear. An increase in dividend payout of bank B reduces the cash it has available for servicing its debt, including that due to bank A in state B. This increases the default risk of bank A, causing it to lose its franchise value more often and bank A's equity holders also to lose their cash flow more often to creditors. We summarize this finding in terms of the following Lemma.

Lemma 2 (Negative externality of dividend payout). All else equal, an increase in dividend payout of bank B lowers the equity value of bank A. Formally, $\partial U_a/\partial d_b<0$ and $\partial U_b/\partial d_a<0$.

In order to characterize the equilibrium dividend policies of the two banks, consider the payoff advantage to bank A of paying zero dividend over paying the maximum dividend of c_a as follows:

$$W_a(d_b,V)=U_a(0,d_b,V)-U_a(c_a,d_b,V) \quad (16)$$

Since y is uniformly distributed over $\left[\underline{y},\bar{y}\right]$, we can write $W_a(d_b,V)$ as:

$$W_a(d_b,V)=Z+\frac{c_a}{\bar{y}-\underline{y}}\cdot V_a \quad (17)$$

where

$$Z = -c_a + \frac{c_a}{\bar{y}-\underline{y}} \left\{ \begin{array}{c} \frac{c_a}{2} + \bar{y} - \ell_a - s_a p \\ + s_b(1-p)\left(1 + \frac{\hat{y}_b - \underline{y}}{\bar{y}-\underline{y}}\left[\frac{\underline{y}+c_b-d_b+\ell_b+s_b}{2(\ell_b+s_b)} - 1\right]\right) \end{array} \right\} \quad (18)$$

We note the close similarity in the functional form for $W_a(d_b,V)$ as compared to the single-bank case. Comparing (17) with (9), we note that in both cases, the payoff advantage to bank A of paying zero dividends is an increasing linear function of V_a, with slope $c_a/(\bar{y}-\underline{y})$. Then, just as in the single-bank case, the optimal dividend policy of bank A takes the form of a bang-bang solution where bank A either pays zero dividends or pays out all its cash as dividends, depending on its franchise value V_a. Denote by $V_a^*(d_b)$ the value of V_a that solves:

$$W_a(d_b,V) = 0 \quad (19)$$

Then, the optimal dividend of bank A is given by

$$d_a(V_a) = \begin{cases} 0 & \text{if } V_a \geq V_a^*(d_b) \\ c_a & \text{if } V_a < V_a^*(d_b) \end{cases} \quad (20)$$

The form of the optimal dividend policy is similar to the single-bank case, but the new element is that the switching point $V_a^*(d_b)$ depends on the dividend policy of bank B. Given the bang-bang nature of the optimal dividends, we can restrict the action space of the banks to the pair of actions "pay no dividends" and "pay maximum dividends", and the strategic interaction can be formalized as a 2×2 game parameterized by the franchise values of the banks. The payoffs for bank A (choosing rows) can then be written as:

		Bank B pay dividend	Bank B not pay dividend
Bank A	pay dividend	$U_a(c_a,c_b,V_a)$	$U_a(c_a,0,V_a)$
	not pay dividend	$U_a(0,c_b,V_a)$	$U_a(0,0,V_a)$

(21)

There is an analogous payoff matrix for bank B. We first characterize the Nash equilibria associated with this 2×2 game, which we call uncoordinated dividend policies. We then show that these policies are excessive relative to the coordinated ones.

4.1 Nash Equilibria

Recall our notation $V_a^*(d_b)$ for the threshold value of V_a that determines bank A's optimal dividend policy. We noted that bank A's optimal threshold depends on bank B's dividend d_b. However, given the bang-bang solution for both banks' dividend policies, we need only consider the extreme values for d_b, namely $d_b = 0$ and $d_b = c_b$. The following preliminary result is important for our argument:

Lemma 3. $V_a^*(0) < V_a^*(c_b)$ and $V_b^*(0) < V_b^*(c_a)$

In other words, the optimal threshold point for bank A's dividend policy is lower when bank B is paying no dividends. Bank A refrains from paying dividends for a greater range of franchise values when bank B also refrains from paying dividends. In this sense, the two banks' decisions to refrain from paying dividends are mutually reinforcing. The proof of this lemma is given in Internet Appendix B. A direct corollary of the lemma is that we have multiple Nash equilibria when the franchise values (V_a, V_b) of the two banks fall in an intermediate range.

Proposition 2. Nash equilibrium dividend policies are given as follows.

1. When $V_a > V_a^*(0)$ and $V_b > V_b^*(0)$, the action pair $(d_a, d_b) = (0,0)$ is a Nash equilibrium.
2. When $V_a > V_a^*(c_b)$ and $V_b < V_b^*(0)$, the action pair $(d_a, d_b) = (0, c_b)$ is a Nash equilibrium.
3. When $V_a < V_a^*(0)$ and $V_b > V_b^*(c_a)$, the action pair $(d_a, d_b) = (c_a, 0)$ is a Nash equilibrium.
4. When $V_a < V_a^*(c_b)$ and $V_b < V_b^*(c_a)$, the action pair $(d_a, d_b) = (c_a, c_b)$ is a Nash equilibrium.

Clauses 1 and 4 give rise to the cases of interest. The cases covered in 1 and 4 have a non-empty intersection, and so imply that we have multiple equilibria in the dividend policies of the banks. Whenever (V_a, V_b) are such that

$$V_a^*(0) < V_a < V_a^*(c_b) \quad \text{and} \quad V_b^*(0) < V_b < V_b^*(c_a) \tag{22}$$

then both $(d_a, d_b) = (0,0)$ and $(d_a, d_b) = (c_a, c_b)$ are Nash equilibria. The reason for the multiplicity arises from the payoff spillovers of the dividend policies of the two banks. The more dividends are paid out by one bank, the greater is the incentive of the other bank to pay out dividends. We present a global game refinement of this multiplicity in Internet Appendix D.

Figure **6** characterizes the region of multiple equilibria as the box in the middle. We call these equilibrium outcomes of *"uncoordinated dividend policies"* to indicate that they are chosen as individual best responses to the other bank's choice.

4.2 Excessive Dividends under Uncoordinated Policies

Given the negative externality to paying dividends, uncoordinated dividend policies can be excessive even *relative to the policies* that maximize the joint market equity values of the two banks. We noted earlier that when the interests of the creditor are taken into account, the dividends that maximize bank shareholders' value are excessive relative to those that maximize the overall bank value. To show the excessive nature of dividends even for joint market equity value maximization, consider a dividend policy (d_a,d_b) that maximizes the joint equity value of the two banks, $U_a(d_a,d_b)+U_b(d_a,d_b)$.

We call these policies the *coordinated* ones. Then, we obtain that

Proposition 3 (Excessive Dividends). Uncoordinated dividend policies can be excessive compared to the coordinated one.

A proof and an illustration of this Proposition is provided in Internet Appendix C.

5. Model with Equity Issuance

In this section, we extend our benchmark model to allow for negative dividends, which we interpret as equity issuance. The domain for d_i now becomes $(-\infty < d_i <= c_i)$. We also assume that whenever the bank issues equity $(d_i \leq 0)$, it incurs a cost equal to $-1/2K_i d_i^2$. We show that the dividend excessiveness result from the benchmark model implies suboptimal capitalization by interconnected banks. In this setting, as the single-bank case yields the same insights on risk-shifting as those obtained from the multiple-bank case, we only present multiple-bank results. With this additional ingredient, bank A's equity value becomes:

$$\begin{aligned}
U_a(d_a,d_b,V_a) &= d_a - \frac{1}{2}K_a d_a^2 I_{d_a \leq 0} + p\int_{\hat{y}_a(d_a)}^{\bar{y}} [y_a - \hat{y}_a(d_a) + V_a] h_a(y_a) dy_a \\
&+ (1-p)\int_{\hat{y}_b(d_b)}^{\bar{y}} \left[\int_{\hat{y}_a^{ND}(d_a)}^{\bar{y}} \left[y_a - \hat{y}_a^{ND}(d_a) + V_a\right] h_a(y_a) dy_a\right] h_b(y_b) dy_b \\
&+ (1-p)\int_{\underline{y}}^{\hat{y}_b(d_b)} \left[\int_{\hat{y}_a^{D}(d_a,d_b)}^{\bar{y}} \left[y_a - \hat{y}_a^{D}(d_a,d_b) + V_a\right] h_a(y_a) dy_a\right] h_b(y_b) dy_b
\end{aligned}$$

Where $I_{d_a \leq 0}$ is an indicator function, taking the value of 0 if $d_a > 0$ and 1 if $d_a \leq 0$. We first show conditions under which it is optimal for the bank to pay dividends or issue equity, and solve for the optimal equity issuance in the latter case. We then discuss conditions under which banks' optimal equity issuance policies are strategic complements or substitutes. Next, we show that equity issuance by one bank creates a positive externality on the other bank. Finally, we show that the Nash equilibrium equity issuance outcome features undercapitalization relative to the first best outcome that maximizes the combined shareholder value of both banks.

5.1 Equity Issuance Decision

The optimal dividend/equity issuance decision is summarized in Proposition 4 below:

Proposition 4. There exists a threshold continuation value V_a^*:

- above which it is optimal for bank A to issue equity, in which case the optimal amount of equity to be issued is:

$$d_a^* = \frac{1}{K_a\left(\bar{y}-\underline{y}\right)-1}\left\{ \begin{array}{c} ps_a + l_a - c_a - V_a - \underline{y} \\ + \frac{(1-p)s_b}{2\left(\bar{y}-\underline{y}\right)(l_b+s_b)}\left[(l_b+s_b)^2 + \left(c_b - d_b + \underline{y}\right)^2 + 2(d_b - c_b - \bar{y})(l_b+s_b)\right] \end{array} \right\}$$

- below which it is optimal for the bank to pay out maximum dividends: $d_a^* = c_a$.

Furthermore, the threshold continuation value V_a^* only depends on the cost of equity issuance when this cost and the riskiness of the $t=1$ non-cash asset value are sufficiently low. In particular, there exists a threshold value of $K_a(\bar{y}-\underline{y})$,

- above which $V_a^*(1) = X_a - \frac{c_a}{2}$,
- under which
$V_a^*(2) = X_a - c_a + c_a\left(K_a\left(\bar{y}-\underline{y}\right)-1\right)\left[\left(K_a\left(\bar{y}-\underline{y}\right)-1\right) - \sqrt{\left(\left(K_a\left(\bar{y}-\underline{y}\right)-1\right)^2 - 1\right.}\right]$

where $X_a - c_a < V_a^*(2) < V_a^*(1)$ and:

$$X_a = ps_a + l_a - \underline{y} + \frac{(1-p)s_b}{2\left(\bar{y}-\underline{y}\right)(l_b+s_b)}\left[(l_b+s_b)^2 + \left(c_b - d_b + \underline{y}\right)^2 + 2(d_b - c_b - \bar{y})(l_b+s_b)\right].$$

We present the proof in Internet Appendix E. The proposition suggests that, similar to the benchmark case, risk-shifting via dividend payments occurs at low continuation values. The difference with the benchmark analysis is that at high continuation values, it is optimal for the bank to issue equity. The optimal amount of equity issuance is the result of trading off equity issuance costs K_a against the benefit of preserving the bank's continuation value.

5.2 Complementarity/ Substitutability in Equity Issuance Decisions

We now analyze how the optimal equity issuance decision of one bank is affected by that of its interconnected bank.

As $\frac{\partial^2 U_a(d_a,d_b)}{\partial d_a^2} < 0$ (see Internet Appendix A), we obtain that the sign of the equity issuance policy of A in response to that of B, $\frac{d(d_a^*)}{d(d_b)}$, is the same as the sign of $\frac{\partial^2 U_a(d_a,d_b)}{\partial d_a \partial d_b}$. [10] The cross-partial term can be derived to be as follows:

$$\frac{\partial^2 U_a(d_a,d_b)}{\partial d_a \partial d_b} = (1-p)\frac{s_b}{l_b+s_b}\int_{\underline{y}}^{\hat{y}_b}\left[h_a\left(\hat{y}_a^D\right) - V_a h_a^{'}\left(\hat{y}_a^D\right)\right] h_b(y_b) dy_b \quad (23)$$

where we have used the fact that $\frac{\partial \hat{y}_a^D}{\partial d_b} = \frac{s_b}{(l_b+s_b)}$, and the assumption that both y_a and y_b are uniformly distributed over $[\underline{y},\bar{y}]$.

This condition suggests that two distinct effects drive the interaction in banks' equity issuance decisions: (i) Lower equity issuance of B increases A's benefits from risk-shifting due to an increase in B's default risk and thereby an increase in A's overall default risk. (ii) Lower equity issuance of B increases the amount of cash flows A has to generate to avoid default. This in turn affects A's probability of keeping its franchise value, thereby affecting its expected benefits of equity issuance derived from franchise value protection.

How banks' equity issuance interacts is unambiguous under effect (i): low equity issuance of B makes it more attractive for A to risk-shift and issue less equity (Strategic complementarity). The effect of B's equity issuance decision on that of A under (ii) depends on how likely A is able to generate higher cash flows in B's default states. Specifically, if cash flows are uniformly distributed, the probability that A generates enough cash flows to avoid default in B's default states does not depend on the default threshold. As a result, B's equity issuance decision does not affect A's expected benefits of protecting its franchise value and effect (ii) disappears.

When cash flows are not uniformly distributed, we obtain two cases. On the one hand, if $\int_{\underline{y}}^{\hat{y}_b}\left[h_a^{'}\left(\hat{y}_a^D\right)\right] h_b(y_b) dy_b < 0$, A is less likely to generate enough cash flows to meet the higher default threshold ($\hat{y}_a^D$) resulting from B's lower equity issuance. As a result, the expected benefits from saving the franchise value is lower and A finds it optimal to decrease equity issuance when B's equity issuance is low (Strategic complementarity).

On the other hand if $\int_{\underline{y}}^{\hat{y}_b}\left[h_a^{'}\left(\hat{y}_a^D\right)\right] h_b(y_b) dy_b > 0$, A is more likely to generate sufficient cash flows that meet the higher default threshold. In this case, the expected benefits from saving the franchise value is

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[10] The first order condition (FOC) is $\frac{\partial U_a(d_a,d_b)}{\partial d_a} = 0$. Differentiating FOC by d_b at, say, the Nash response of A, $d_a^*(d_b)$, gives $\frac{\partial^2 U_a}{\partial d_a^2}\frac{d(d_a^*)}{d(d_b)} + \frac{\partial^2 U_a}{\partial d_a \partial d_b} = 0$. So $\frac{d(d_a^*)}{d(d_b)} = -\left(\frac{\partial^2 U_a}{\partial d_a^2}\right)^{-1}\frac{\partial^2 U_a}{\partial d_a \partial d_b}$. As $\frac{\partial^2 U_a}{\partial d_a^2} < 0$, we have that $sign\left(\frac{d(d_a^*)}{d(d_b)}\right) = sign\left(\frac{\partial^2 U_a}{\partial d_a \partial d_b}\right)$. This analysis follows Tirole (1988).

higher and A finds it optimal to increase equity issuance when B's equity issuance is low (Strategic substitutability).[11]

Overall, the above analysis suggests the following:

- when $\int_{\underline{y}}^{\hat{y}_b}\left[h_a^{'}\left(\hat{y}_a^D\right)\right]h_b(y_b)dy_b \leq 0$, banks' equity issuance decisions are strategic complements.[12]
- when $\int_{\underline{y}}^{\hat{y}_b}\left[h_a^{'}\left(\hat{y}_a^D\right)\right]h_b(y_b)dy_b > 0$, banks' equity issuance are strategic complements under effect (i) and strategic substitutes under effect (ii).[13] Which effect dominates depends on A's franchise value.
    1. If A's franchise value is sufficiently low such that $V_a < \frac{\int_{\underline{y}}^{\hat{y}_b}\left[h_a\left(\hat{y}_a^D\right)\right]h_b(y_b)dy_b}{\int_{\underline{y}}^{\hat{y}_b}\left[h_a^{\prime}(\hat{y}_a^D)\right]h_b(y_b)dy_b}$, then A's desire to protect its franchise value is low and hence effect (i) dominates: banks' equity issuance decisions are strategic complements.
    2. If A's franchise value is sufficiently high such that $V_a > \frac{\int_{\underline{y}}^{\hat{y}_b}\left[h_a\left(\hat{y}_a^D\right)\right]h_b(y_b)dy_b}{\int_{\underline{y}}^{\hat{y}_b}\left[h_a^{\prime}(\hat{y}_a^D)\right]h_b(y_b)dy_b}$, then A's desire to protect its franchise value is high and hence effect (ii) dominates: banks' equity issuance decisions are strategic substitutes.

5.3 Positive Externalities of Banks' Equity Issuance

The effect of bank B's equity issuance on bank A's equity value is:

$$\frac{\partial U_a}{\partial d_b} = -(1-p)\int_{\underline{y}}^{\hat{y}_b}\left[V_a h_a(\hat{y}_a^D) + \frac{s_b}{(\ell_b + s_b)}Pr[y_a > \hat{y}_a^D]\right]h_b(y_b)dy_b < 0,$$

That is, equity issuance by bank B creates positive externalities on bank A's shareholder value.

5.4 Undercapitalization under Uncoordinated Policies

We can now show that:

Proposition 5. When banks' franchise values are high such that it is optimal for them to issue equity, uncoordinated equity issuance decisions result in undercapitalization relative to coordinated ones. That is,

$$d_a^{FB} < d_a^*,\ d_b^{FB} < d_b^*,$$

[11] This analysis can be generalized to understand how the probability of issuing equity of one bank depends on the amount of equity issuance of its counterparty.

[12] This condition holds, for example, when $\hat{y}_a^D$ is to the right of the mean of a well-behaved bell-shaped distribution, indicating A has high default risk in B's default states.

[13] This condition holds, for example, when $\hat{y}_a^D$ is to the left of the mean of a well-behaved bell-shaped distribution, indicating A has low default risk in B's default states.

where d_a^* and d_b^* are Nash outcomes and d_a^{FB} and d_b^{FB} are first best outcomes.

The proof of this proposition is given in Internet Appendix F. Intuitively, banks fully bear the costs of equity issuance but do not internalize the positive externalities their issuance policy has on interconnected banks. As a result, their equity issuance is suboptimally low from the perspective of combined banks' shareholders.

6. Lessons

In this section, we first discuss how our model complements existing literature in explaining the observed excessive dividends and under-capitalization of banks during the recent financial crisis (Sections 6.1 and 6.2) and in providing a new contagion channel (Section 6.3). We then discuss why ex ante contracting (or the lack of which) may fail to remedy such suboptimal policies (Section 6.4). Lastly, we discuss lessons for public policy (Section 6.5).

6.1 Bank Dividend Payouts During 2007-2009

Our model is a deliberately stark and simplifed one, and drawing lessons should be done with caution. Nevertheless, some key insights emerge fromt the analysis. One is the possibility of sharp divergence in dividend payouts. In practice, the divergence occurred during the 2008 crisis, as documented in section 2. The elements that account for our model predictions are high leverage and high incidence of balance sheet interconnections through contingent claims. These elements were in place for the banks and securities firms described in section 2. In this sense, the outcomes are consistent with our model's prediction that dividend payments are more likely with higher leverage. In contrast, commercial banks which had lower leverage than securities firms and with more tangible claims either smoothed out or decreased their dividends throughout the crisis.

We note the importance of franchise values. While all banks' franchise values were arguably depressed during the crisis, the greater vulnerability of securities firms to the disruptions of relationships likely made them more sensitive than commercial banks to financial distress. Our model predicts larger dividends for such firms. While commercial banks' clients, whose relationship with the bank are commonly formed through illiquid loan contracts, are not very likely to "run" during bad times, securities firms' customers may have found it easier to exit relationships.[14]

[14] In fact, the crisis of 2007-2009 revealed that a major class of securities firms' clients - hedge funds relying on prime brokerage services- are prepared to shift their cash and

Importantly, the negative externalities described in our two bank model could be a further element in the divergent behaviour in dividend payments between investment banks and commercial banks. Excessive dividends can result from strategic complementarity of (uncoordinated) dividend policies between interconnected banks. Compared to commercial banks, investment banks and broker-dealers are more highly interconnected to each other and to the rest of the financial system via proprietary trading and other securities market activities. A summary measure of the interconectedness is in the value of OTC derivatives contracts.[15] Exposure of dealers to OTC derivatives contracts in December 2008 amounted to $33,889 billion (BIS (2009)), with interest rates derivatives and credit default swaps (CDS) being the two most significant components ($18,420 bil and $5.652 bil, respectively). Breakdowns of counterparty types show the significant interconnectedness of investment banks with other investment banks and financial institutions. Out of the $18,420 bil ($5,652 bil) exposure to interest rates derivatives contracts (CDS contracts), $6,629 bil ($3,177 bil) were between two dealers, $10,731 bil ($2,377 bil) were between a dealer and another financial institution, and only $1,061 bil ($98 bil) were between a dealer and a non-financial customer.[16]

6.2 Bank Equity Issuance

In spite of the disruptions to the financial system during the 2008 crisis, recapitalization was limited (See Section 2 and the evidence in Acharya et al. (2012).) Dudley (2009) notes the resistance to equity issuance by

securities to safer institutions when signs of distress occur (see Duffie, 2010). The collapse of Bear Stearns and Lehman Brothers prompted large flows of hedge fund client assets out of Morgan Stanley and Goldman Sachs (those with historically the largest share of the prime brokerage business), and into commercial banks that were perceived, at the time, as the most creditworthy, such as Credit Suisse, JP Morgan, and Deutsche Bank. According to Global Custodian magazine, 44 percent of hedge funds reduced balances with Goldman and 70 percent backed out from Morgan Stanley. Since prime brokerage is a high profit margin activity, that involves the bank lending cash and securities to hedge funds and providing custody and other businesses, the loss of relationships with hedge fund clients may have caused a significant decline in franchise values of many securities firms and potentially an increase in franchise values of several creditworthy commercial banks.

15 Duffie (2010) states: "At least one of the two counterparties of most OTC derivatives is a dealer. It would be uncommon, for example, for a hedge fund to trade directly with, say, an insurance company. Instead, the hedge fund and the insurance company would normally trade with dealers. Dealers themselves frequently trade with other dealers. Further, when offsetting a prior OTC derivatives position, it is common for market participants to avoid negotiating the cancellation of the original derivatives contract. Instead, a new derivatives contract that offsets the bulk of the risk of the original position is frequently arranged with the same or another dealer. As a result, dealers accumulate large OTC derivatives exposures, often with other dealers".

16 Table 1 in Internet Appendix G documents the derivatives exposures of 9 out of 10 banks in our sample as of quarter 1 of 2008. The table reveals significantly higher derivatives exposures of investment banks relative to those of commercial banks.

these institutions, whose executives told regulators “repeatedly over the past 18 months” that “now is not a good time to raise capital”.

As argued in Admati et al (2013) and Calomiris and Herring (2013), debt overhang may be one reason for banks’ reluctance to raise equity in such times. An implication of our model is that inefficiencies are more pronounced for banks that are more interconnected due to externalities that cannot be internalized. Haldane (2009) notes that more systemically important banks tend to have lower capital buffers, and suggest that implicit guarantees may be one reason for the lower capital. Our risk-shifting mechanism sheds further light.

6.3 Financial Contagion

Our model complements the literature on direct channels of contagion (see Allen and Gale (2000) and Zawadowski (2013)) and suggests that risk-shifting from shareholders to creditors may be an additional contagion channel in an interconnected financial network. A distressed bank has incentives to pay out dividends, thereby increasing the probability of its default, leading to erosion in asset values of its counterparty which is an otherwise healthy bank. Duarte and Kolasinski (2014) empirically examine possible channels of contagion across broker-dealers and dealer banks during the 2007-2009 financial crisis. They conclude that the direct channel (franchise value erosion via counterparty risk exposure) accounted for almost all of the contagion. The indirect channel (system wide illiquidity shock caused by the failure of a large institution) accounted for a mere 5% of all contagion prior to government intervention in the fall of 2008, and disappeared post-intervention.

6.4 Ex ante Contracting

A natural question arises as to why creditors and shareholders of banks do not find ex ante contractual mechanisms to limit the inefficiencies in dividend or equity issuance decisions. In the classic context, creditors can write covenants limiting dividends in the bank’s stressed states. In practice, such covenants can be suboptimally few and ineffective. One reason may be that banks do not fully internalize the externalities of their policies. Another possibility is creditors’ lack of monitoring incentives and difficulties in writing complete ex ante contracts.

Becht, Bolton, and Roell (2011) have argued that bank creditors do not have strong incentives to write such covenants in the presence of government’s explicit and implicit guarantees on bank debt. In addition, when banks are interconnected, optimal contracting on dividend faces practical difficulites due to the limits on efficient contracting. The policies of one bank depends on those of its counterparties, and in turn on the policies of the counterparties of its counterparties.

Efficient contracts would invoke conditions across firms. In practice, contracts and covenants tend to be non-exclusive: one party in a contractual relationship cannot constrain its counterparties' policies that are dependent on third parties, leading to inefficient outcomes.[17]

Moreover, dividend restricting covenants may also be ineffective because creditors and shareholders may underestimate the probability of distress. Finally, covenants mandating equity issuance faces problem of negative information conveyed by this decision, in the manner of Myers and Majluf (1984). Covenants limiting leverage can in principle encourage equity issuance. However, such covenants are not effective in practice as the true economic leverage of banks, masked by accounting maneuvers and banks' complexity, is often hard to gauge. Even if it were possible to effectively contract on equity issuance, these ex ante contracts would be ineffective for the exclusivity reasons discussed above.

6.5 Implications for Public Policy

Our model sheds further light on the imposition of dividend restrictions for weak banks. In the United States, such provisions have been a feature of the Prompt Corrective Action (PCA) procedure of 1991, which includes mandatory limits to dividends and compensation to senior managers of banks that are under-capitalized.[18] The capital conservation buffer in Basel III has a similar rationale.

Our model provides theoretical backing to rules that restrict capital erosion in crisis periods when banks usually find their franchise values depressed and are pushed into the risk-shifting/ dividend paying regions of the model. The model suggests that dividend restrictions may even be desirable from the perspective of combined banks' shareholders in a setting with interconnected banks, let alone when considering the broader public interest in a healthy banking system that can support the real economy. In this regard, our paper is similar in spirit to Admati et al. (2013) which advocates restrictions on banks' equity payout. Admati et al. (2013) argue that higher capital means that equity holders and bank managers have more "skin in the game" and thereby are less inclined to take excessive risk. Analyzing the payout decision from a different angle, Acharya, Mehran and Thakor (forthcoming) reach the same conclusion as ours that part of bank capital should only be available to equity holders when banks perform well. Acharya, Mehran and Thakor (forthcoming) argue that banks tend to fund themselves with excessive leverage in anticipation of correlated failures and government bail-out of

[17] See Bisin and Gottardi (1999), Bisin and Guaitoli (2004), Bisin et al. (2011), Dubey, Geanaoplos, and Shubik (2005), Acharya and Bisin (2014) for the literature on non-exclusive contracts.

[18] Compensation to senior managers of banks can be thought of as dividends paid to internal capital, and hence is applicable to our model here.

bank creditors. Consequently, optimal regulation features a contingent rule, in which part of bank capital is unavailable to creditors upon failure and available to shareholders only in the good states.

While the conclusions in Admati et al. (2013) and Acharya, Mehran and Thakor (forthcoming) are based on the argument of moral hazard from government bailouts, the novel element in our analysis is the focus on bank interconnectedness and externalities. In our model, the failure to coordinate among shareholders of interconnected banks may prevent the efficient private contracting.

Our model also has implications for bank resolution and the possible benefits of clearing house arrangements of derivative contracts.[19] Under these arrangements, banks internalize the costs of their default on each other by putting upfront margins and capital. Ex post, during times of stress, this capital can be used for co-insurance. Dividend policy can be understood in light of this general principle. Originally, clearinghouses of commercial banks were formed mainly to deal with information-based contagion. Clearinghouses for derivatives, on the other hand, are intended to deal with counterparty risk and interconnectedness issues (Duffie and Zhu, 2011). The key insight is that one bank's equity is in part a debt claim on other banks. Hence, insights from agency problems between equity and debt of each bank carry over to conflicts of interest across inter-connected banks.

7. Conclusion

We have examined a model where a combination of risk-shifting incentives and diverse bank franchise values can lead to divergent dividend behavior across banks. When banks are contingent creditors of each other, dividend payouts by one bank exerts negative externalities on the other banks' equity. Because individual banks do not internalize these negative externalities, their uncoordinated dividend policies can be excessive, relative to a benchmark that considers shareholders' collective interests. In this sense, banking sector capital takes on the attributes of a public good, even in the limited context when only shareholders' interests are taken on board. Given the banking sector's broader role in supporting the real economy, the public good attributes may be much more salient in practice.

[19] Singh (2010) reports that Goldman Sachs, Citi, JP Morgan, Bank of America, and Morgan Stanley were jointly carrying almost $500 billion in residual OTC derivatives payables as of December 2009. Singh (2010) mentions two main reasons for this under-collateralization. First, these large financial institutions were viewed as privileged and safe clients. Second, "dealers have agreed, based on the bilateral nature of the contracts, not to mandate adequate collateral for dealer to dealer positions. In fact, dealers typically post no initial margin to each other for these contracts".

We have highlighted the importance of franchise values for the outcome. The lower are bank franchise values, the more acute are the externalities, and the worse is the economic outcome. Given the current depressed levels of bank market-to-book ratios, our arguments acquire added significance.

Our model generates two main testable hypotheses. First, during financial crises, banks that have higher leverage or lower franchise values are more likely to engage in risk-shifting via dividend payments. Second, banks that are more interconnected have dividend policies and capital decisions that are more likely to exhibit strategic complementarities. Although the first hypothesis has been discussed under existing literature, the second hypothesis is, we believe, novel.

Our findings suggest some scope among financial intermediaries to internalize the externalities. In particular, greater retention of earnings as equity will exert positive spillover effects on other banks. Higher equity of one bank has attributes of a public good, which exerts positive spillovers on the franchise values of other banks, resulting in higher value of the financial sector as a whole.

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Figure 1a
Cumulative Credit Losses, 2007Q3 - 2008Q4

This figure plots the cumulative credit losses for the ten banks included in our study, over the period from Quarter 3, 2007 to Quarter 4, 2008. All numbers are in billions of US dollars. *Data source:* Bloomberg.

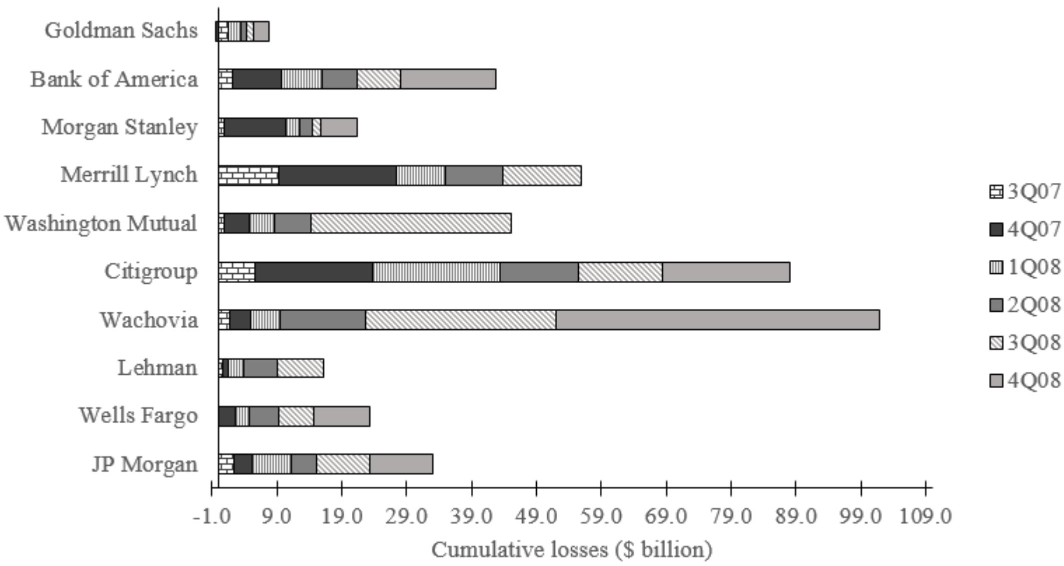

Figure 1b
Cumulative Dividends, 2007Q1 - 2008Q4

This figure plots the cumulative dividends paid by the ten banks included in our sample, over the period from Quarter 1, 2007 to Quarter 4, 2008. All numbers are in billions of US dollars. *Data source:* Compustat.

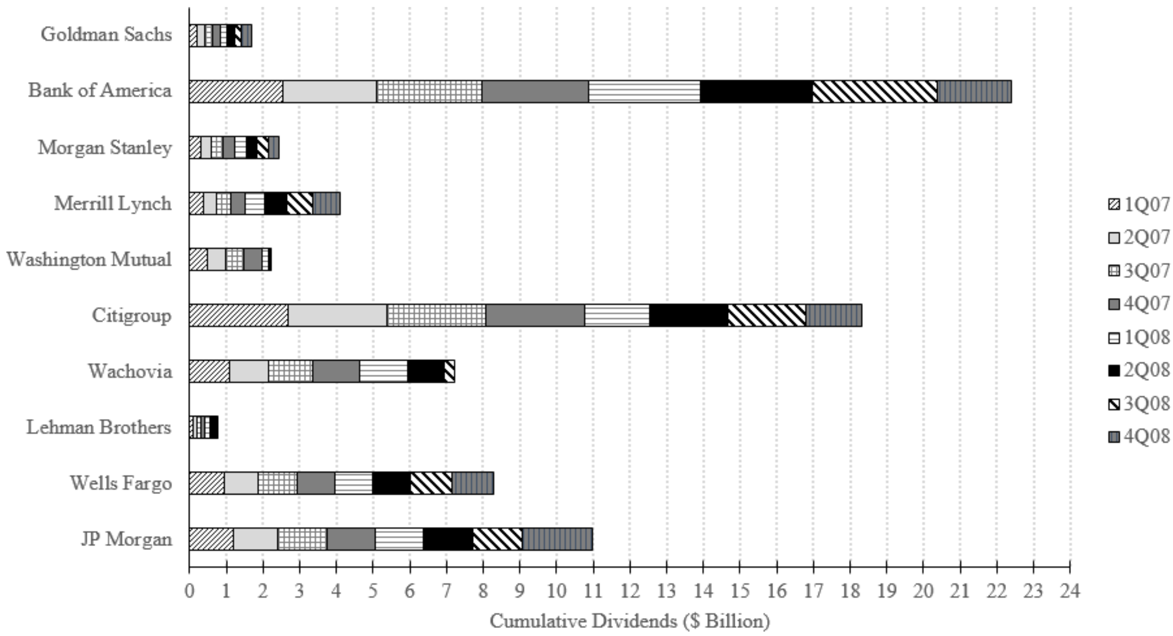

Figure 1c
Dividend Payments (2007Q1 = 1)

This figure plots dividend payments of the ten banks included in our sample, where all amounts are normalized so that the dividend payment in Quarter 1, 2007 is set to be equal to 1. *Data source:* Compustat.

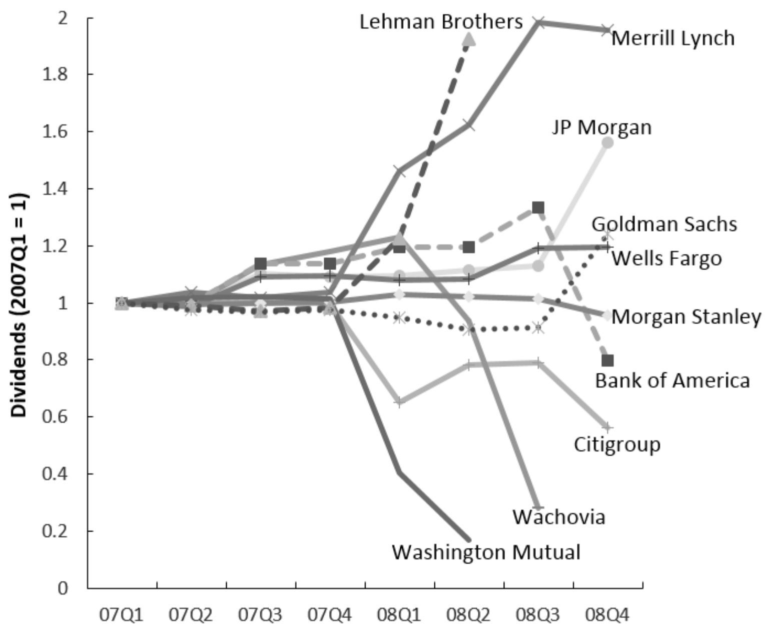

Figure 1d
Dividends as a Percentage of Book Equity (2007Q1 = 1)
This figure plots the ratio of dividends over book value of equity for the ten banks included in our sample. All ratios are normalized such that the ratio in Quarter 1, 2007 is set equal to 1. *Data source:* Compustat.

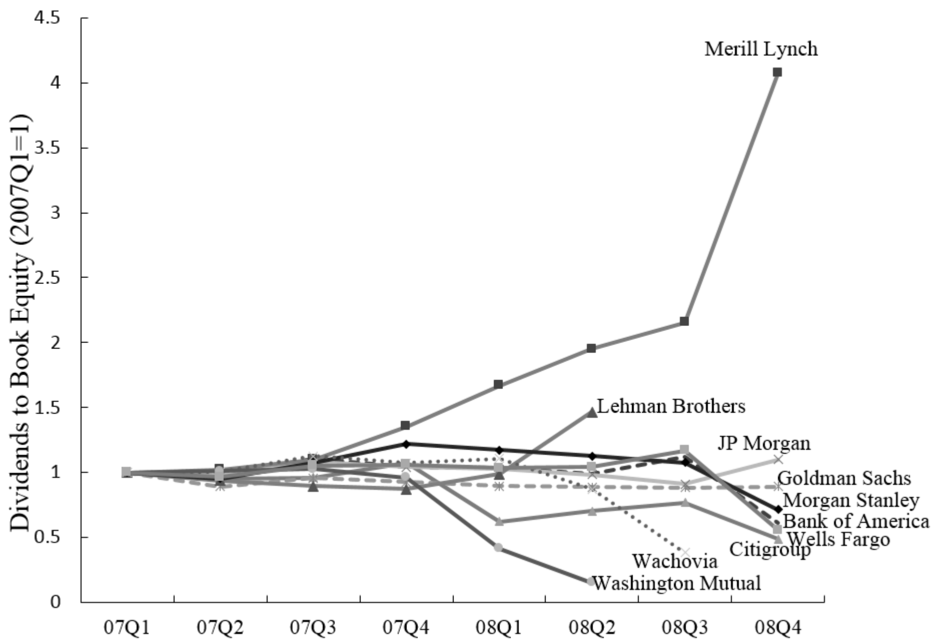

Figure 2
Dividend Payments and Cumulative Credit Losses
These figures plot cumulative credit losses (the gray lines) alongside quarterly dividends (the black lines) for Lehman Brothers, Merrill Lynch, Washington Mutual, and Wachovia. All numbers are in billions of US dollars. *Data source:* Compustat and Bloomberg.

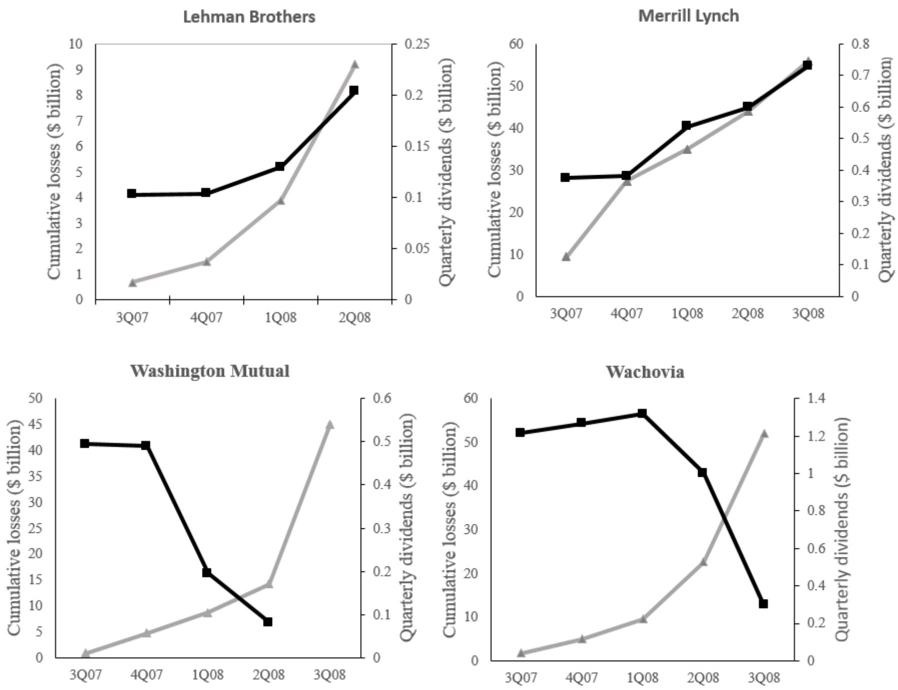

Figure 3
Banks' Capital Issuance by Type
This figure plots the amount of capital raised by the ten banks included in our sample from Quarter 3 of 2007 to Quarter 4 of 2008. Net common stock issuance is common stock issued minus common stock repurchased. Net preferred stock issuance is preferred stock issued minus preferred stock redemptions. Net long term debt issuance is long term debt issued minus long term debt repayments. All numbers are in billions of US dollars. *Data source:* Cash flow statements from banks' 10-Q and 10-K reports.

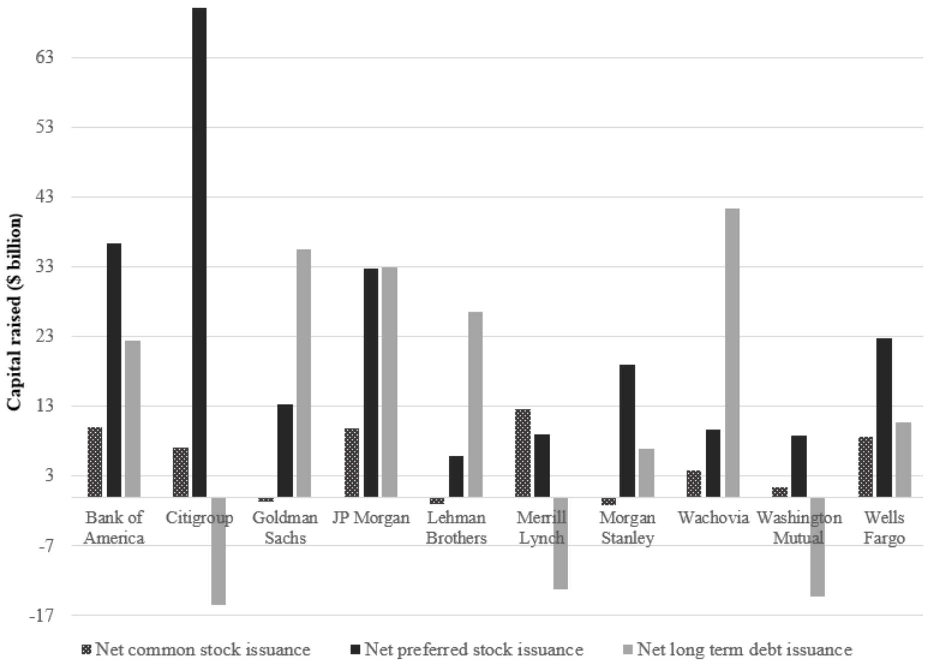

Figure 4
Book Leverage
This figure plots the book leverage ratios of the ten banks included in our sample from Quarter 1 of 2007 to Quarter 4 of 2008. Book leverage is defined as total book value of assets (ATQ) divided by total book value of common equity (CEQQ). *Data source:* Compustat.

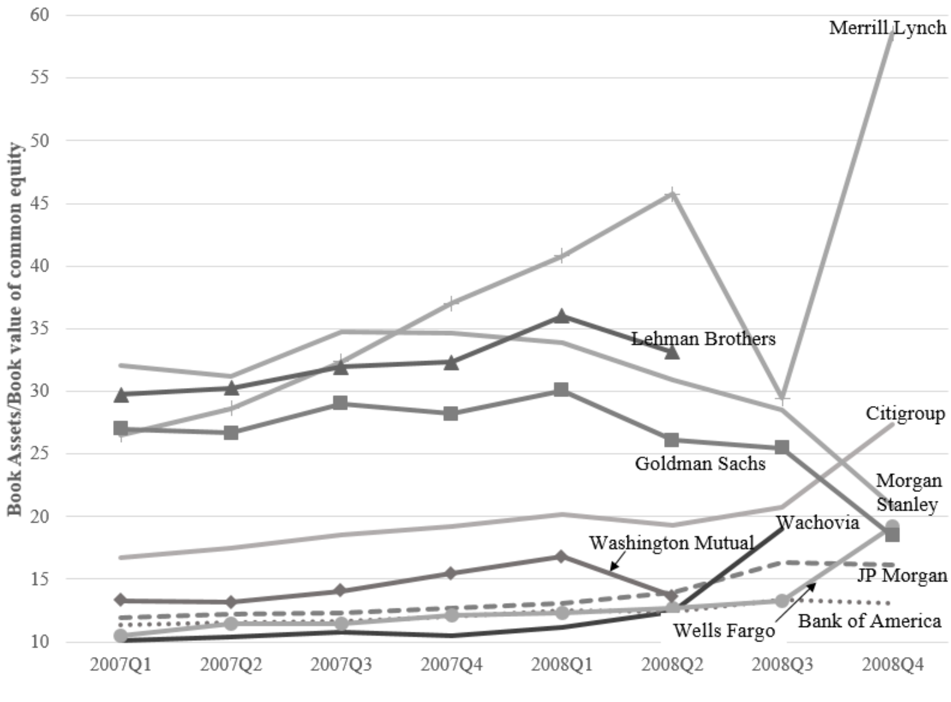

Figure 5
Quasi-Market Leverage
This figure plots the quasi-market leverage ratios of the ten banks included in our sample from Quarter 1 of 2007 to Quarter 4 of 2008. Quasi-market leverage is defined as quasi-market value of assets over market value of common equity. Quasi-market value of assets is defined as book value of assets (ATQ) minus book value of common equity (CEQQ) plus market value of common equity, where market value of common equity is number of common shares outstanding (CSHOQ) times price per share (PRCCQ). *Data source:* Compustat and CRSP.

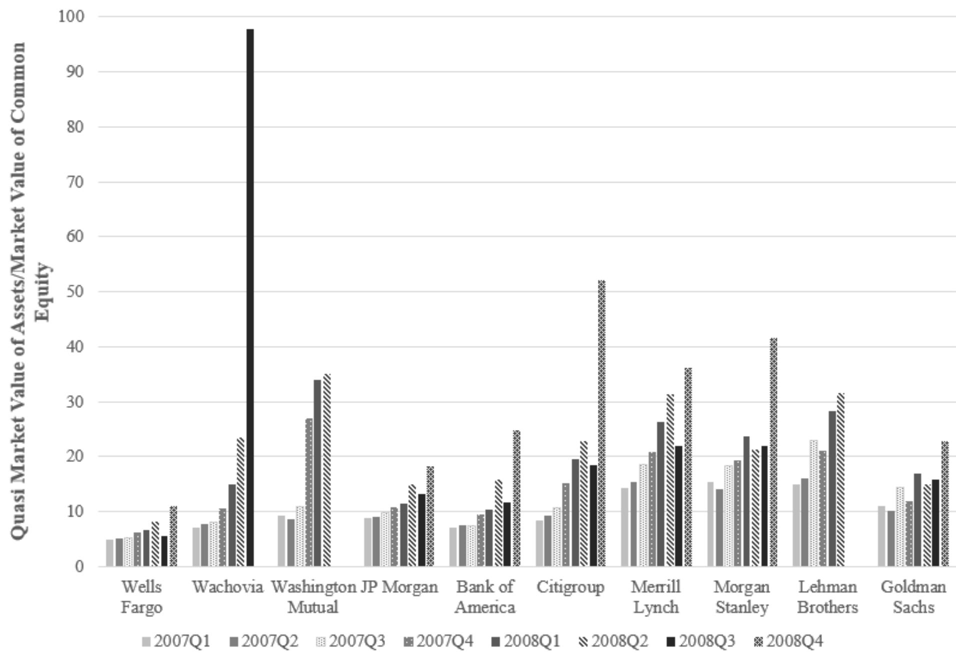

Figure 6
Strategic Complementarity of Dividend Policies
V_a and V_b are the franchise values of banks A and B, respectively. V_i^* is the threshold franchise value of bank i ($i \in \{a,b\}$), below which it pays maximum dividends. d_i and c_i are, respectively, the dividend payment and $t=1$ cash flow of bank i. For each cell, the first and second values are the Nash dividend policy of bank A and bank B, respectively.