Proving Approval: Dividend Regulation and Capital Payout Incentives*

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Abstract

This paper describes the effects of dividend regulation on payout incentives. In the model, risk-shifting, excess cash flow, and signaling incentives affect a firm's decision to issue dividends. The regulator aims to prevent risk shifting through dividend restrictions on undercapitalized firms. However, this action increases the firms' incentives to pay dividends for signaling, potentially inducing capital outflows in some firms that would otherwise use funds for the real sector. Thus, welfare benefits of prudential dividend restrictions at risk-shifting firms are partially offset through less capital and investment at moderately capitalized firms. We discuss environments in which the signaling effect is stronger and suggest policies to mitigate inefficient capital outflows through dividends.

Keywords: *Dividends, Banking, Capital Regulation, Risk-Shifting, Signaling*

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1 Introduction

In the United States, regulators have the authority to restrict the capital policies of banks and have prudential regulatory authority of systemically important financial institutions. [1] Though dividend restrictions have a positive welfare effect through a reduction in risk shifting, we show that these same restrictions will also create an incentive for other firms to issue additional, socially inefficient dividends. This effect arises immediately from the information asymmetry between the regulators and the market: when a firm's dividend payment must be approved by an informed regulator, the market rationally interprets the dividend payment as a signal reflecting *both* the firm fundamentals *and* the regulator's private information. A firm eager to signal its health then has an incentive to issue a dividend only to demonstrate to the market that the regulator approved its dividend plans. Hence, these regulator-induced dividend payments could reduce the loan supply and potentially increase risk. We build a model to study firm dividend behavior in the context of capital regulation and shows that restricting dividends on potentially risky firms, besides reducing risk shifting, also distorts the payout incentives of the entire industry and may have unanticipated welfare implications.

Prudential regulatory authority over nonbank firms is relatively new, though dividend regulation has been in place for decades in the banking industry. While banks act as a useful analogue, the results are applicable whenever capital restrictions and mispriced debt exist, which would likely be the case for systemically important nonbank firms. Even in banking, however, the literature on the incentive structure this regime creates has been largely unexplored.

Compared to other industries, banks are both more likely to pay dividends (see Figure 1) and to change their dividend payments (see Figure 2). Prior to the financial crisis, banks

[1] Once a firm is designated as "systemically important" by the Financial Stability Oversight Council (FSOC) then it is regulated by the Federal Reserve Board. That is, nonbank firms are subject to some of the provisions in in the Federal Deposit Insurance Act (see Pub. L. 111-203, title I, §161, July 21, 2010, 124 Stat. 1420.)

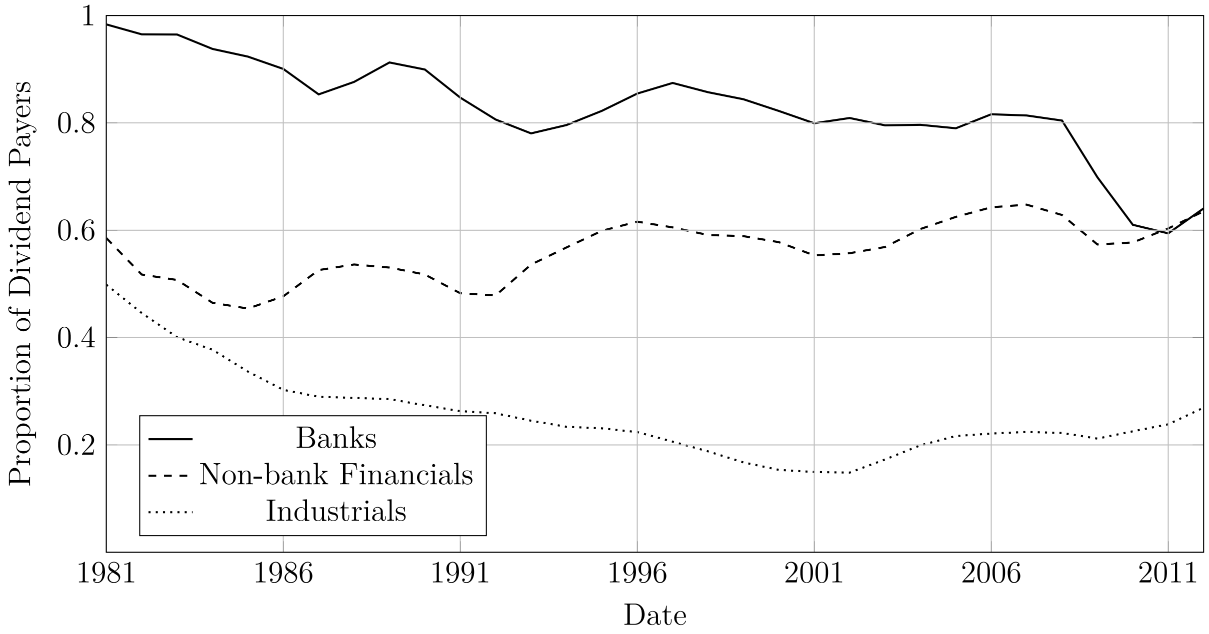

Figure 1: Fraction of firms paying a dividend.

paid dividends roughly four times as often as industrial firms and 33 percent more often than non-bank financial firms. Similarly, banks were three to four times more likely to have increased their dividends over the 15 years leading up to the 2008 financial crisis relative to industrial firms and 33 percent to 50 percent more likely to increase their dividend relative to non-bank financial firms, as shown in Figure 2.

Moreover, in 2007–2008, the largest twenty-one banks shed \$130 billion of equity through dividends off \$1.5 trillion of market capitalization (Acharya, Gujral, Kulkarni, and Shin (2011)). Many of these same banks ultimately relied on the public safety net for their survival not long thereafter. Strikingly, this amount is more than half of the total (Troubled Asset Relief Program) TARP support received by US institutions through December 2008 (\$247 billion). Among non-bank firms associated with the financial crisis, AIG increased its dividend distributions year-on-year every year from 2002 to 2008. It declared its largest dividend per share ever on May 8, 2008, with a payment date of September 19, 2008, the same week as

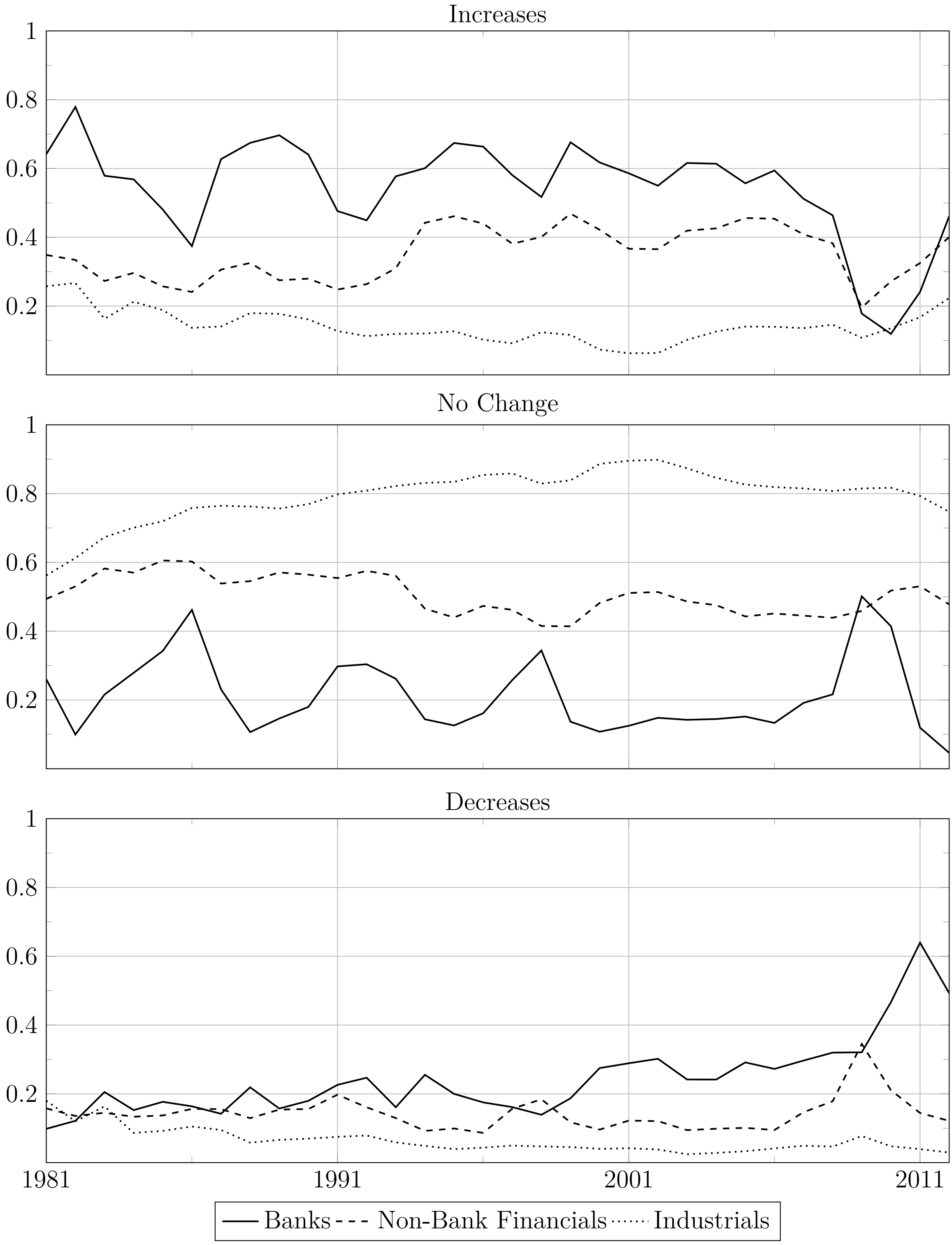

Figure 2: Proportion of firms with a year-on-year increase, decrease, and no change in dividends per share.

the Lehman failure.[2]

In this paper, we incorporate regulatory-specific characteristics into an asymmetric-information model of dividends. Asymmetric information arises as the management possesses private information on the firm's "true" value that the market does not observe. In the model the management acts in the joint interest of short term shareholders, who care about today's stock price (incorporating dividends), and long term shareholders, who care about the future stock price (including dividends).[3] The weight on short-term shareholders provides the management with the incentive to consider the market's reaction to any dividend payments. On the other hand, the weight on long-term shareholders provides the management with the incentive to reinvest excess capital into positive net present value (NPV) projects. Together with the capacity for risk shifting (derived from mispriced debt through explicit or implicit government support), firm equity levels fall into the following three categories:

1. Capital levels are low (undercapitalized), such that the firm is near failure and gains from reinvestment flow to debt holders.

2. Capital levels are moderate (adequately capitalized), such that marginal revenue is high and the firm is far from the default boundary.

3. Capital levels are high (well-capitalized), such that marginal revenue is decreasing or possibly negative through a free cash flow problem.

To our knowledge, this paper is the first to build a theoretical model of the payout incentives of firms, including endogenous firm responses to capital regulation. Despite vast literature on the payout policies of both industrial firms and nonbank-financial firms, little theoretical work examines the unique and consequential circumstances under which banks and systemically important institutions pay dividends. This observation is surprising since

[2]http://www.nasdaq.com/symbol/aig/dividend-history

[3]We borrow this assumption from Miller and Rock (1985).

the theory for non-bank firms does not translate well to banks due to the differences in agency problems faced, capital structures, and the overarching regulatory environment. Furthermore, dividend policy is more relevant for banks compared to both industrial and nonbank-financial firms, as indicated by the fraction of the institutions paying dividends, the frequency with which banks increase dividends, and the total aggregate dollar amount transferred to shareholders through dividend payments.

The rest of the paper is organized as follows. Section 2 reviews the existing literature. Section 3 introduces the framework of the model and obtains the equilibrium dividend policies for various cases with and without a regulator. We provide the testable implications of the model in Section 4. Section 5 discusses the policy implications and concludes the paper.

2 Literature Review

This paper contributes to both the broader literature on payout policies and to the specific and growing literature on payout policies at banks and systemically important financial institutions. Acharya, Gujral, Kulkarni, and Shin (2011) document payout policies of large financial institutions leading up to and during the 2008 financial crisis. The largest institutions decreased their collective common equity from 2000 to 2006 even as their nominal assets grew tremendously. Furthermore, payout policies persisted during the crisis, even for those institutions that ultimately failed or required government assistance. Meanwhile, Hirtle (2014) documents differential behavior of large and small bank holding companies with regard to dividends and repurchases. She finds that \$5 billion–\$25 billion institutions with high repurchases pre-crisis reduced dividends later and by less than institutions with lesser repurchases. However, large bank holding companies with high repurchases pre-crisis reduced their dividends earlier than their low repurchase counterparts, though the sizes of dividend reductions were comparable. Finally, Kanas (2013) finds evidence of risk-shifting from 1992 to 2008, with high-risk banks more likely to dividend.

Closer to this paper, Floyd, Li, and Skinner (2014) compare the payout policies of US banks to those of industrials and non-bank financials over a thirty-year period, including the 2008 financial crisis. Similar to the stylized facts presented above, they document that banks have a higher and more stable *propensity* to pay dividends, even more so than non-bank financials. Further, they echo patterns similar to Acharya, Gujral, Kulkarni, and Shin (2011) with regard to large bank behavior during the crisis.

Despite the growing empirical literature above, few papers examine the unique incentives for payouts in the banking industry. A recent exception is Acharya, Le, and Shin (2013) who study the negative externalities that arise when banks pay dividends. As a result, they argue that the private equilibrium can feature excess dividends and that minimum capital ratios can deter such excess. In contrast, we examine dividend behaviors that arise in the presence of capital regulation and focus on endogenous bank responses.

Although our study focuses on bank payout policy, we benefit from previous theoretical work on corporate dividend policy. Risk-shifting, or the expropriation of wealth by shareholders at the expense of debtholders, dates back at least to the works of Myers (1977) or Jensen and Meckling (1976). Similarly, Galai and Masulis (1976) (among others) demonstrate that stockholders may increase their equity value by increasing the riskiness of their assets to the detriment of debtholders. Meanwhile, free cash flow as an explanation for dividend policy also has roots in Jensen and Meckling (1976) as well as Grossman and Hart (1980) and Easterbrook (1984). The management objective function, where management balances the desires of both short- and long-term shareholders, is from Miller and Rock (1985), one of many papers that view dividends in the context of signaling.

Finally, this paper ties into a larger literature on prompt corrective action (PCA). In particular, we consider the role that regulators play in stemming reductions in capital that result from payout policy. Empirical papers in this literature generally find reduced risk taking and increased capital ratios in response to PCA (e.g., Benston and Kaufman (1997) and Aggarwal and Jaques (2001)), while others report mixed results (e.g., Kanas (2013)). Furthermore, Admati, DeMarzo, Hellwig, and Pfleiderer (2011) advocate payout restrictions to promote a safer financial industry. Our paper contributes to this discussion by highlighting that signaling incentives generated by the presence of PCA result in socially inefficient dividends at banks on the margin of adequate capitalization. As such, payout restrictions are efficient even for institutions far from the default boundary.

3 Institutional Details

While the Comprehensive Capital Analysis and Review (CCAR) is an important regulatory intervention more recently designed for this purpose, the authority to restrict dividend payments has been in place for decades. Regulations such as the CCAR established methods to mitigate the concerns arising from risk shifting. However, the framing of the dividend restriction process, and the extent to which specific information is public, will have important consequences on how the market interprets bank dividend payments. In turn, this will affect bank dividend payment decisions themselves. For example, the Federal Reserve CCAR summary states,

> Typically in the past when the Federal Reserve has objected to a BHC's [Bank Holding Company's] capital plan, it has denied any increase in a BHC's capital distributions from the prior year but has not required a reduction in distributions[...][4]

As such, a market observer would interpret only an *increase* in bank distributions as evidence that the bank met regulatory scrutiny. The market could not readily determine whether a

[4] Comprehensive Capital Analysis and Review 2014: Assessment Framework and Results, March 2014. Board of Governors of the Federal Reserve System.

bank that did not increase its capital distributions did so for business reasons or due to an expected rejection of its capital plan by the regulator. If the market interprets the failure to increase dividend payments as the latter, then the incentive to increase dividends will rise for all banks, including those that would have otherwise used those funds for lending.

4 Model

The basic model includes risk shifting and signaling. Risk shifting in the model, based on both the limited liability protection of equity holders and mispriced debt, acts to incentivize weak firms to "cash-out" through dividend payments. The signaling component arises endogenously in equilibrium. Finally, an assumption of decreasing marginal returns implies that high capital firms have the lowest social marginal cost of dividend payments. Indeed, if marginal returns are negative, owing perhaps to a free cash flow problem, it will be optimal, from a welfare perspective, for some firms to pay dividends.

Note that what we refer to in the model as "equity" is really the residual liquidation value of the firm's assets rather than the investor's expectation of future payments to equityholders. Hence, we use the term "equity" simply to connect to "capital" in the context of the banking industry.

Assume that the debt holders are always paid in full, but that fixed failure costs c associated with failure are borne by the regulator along with any shortfalls.[5] Thus, the stake-holders (given Pareto weights in accordance with their claims) are the debt holders, management (which represents both inside and outside equity holders), and the regulator.

As an illustrative tool, we first examine the model under a *laissez faire* assumption, without a regulator. In this environment, there are three categories of firms. First, for poorly-capitalized firms, all or most returns from reinvestment would flow to debt holders. These

[5]This represents a stylized version of deposit insurance or of bailouts.

firms would then pay a dividend because both short- and long-term shareholders benefit at the expense of debt holders. In this case, dividends are issued for the sole purpose of risk shifting. Second, well-capitalized firms have a strong incentive to pay dividends. If marginal returns are low (or even negative), then the opportunity cost of dividends for long-term shareholders is low, while the short-term shareholders can benefit from signaling. So, these well-capitalized firms will be more incented to issue dividends. Finally, dividends at adequately capitalized firms come at a high opportunity cost to long-term shareholders who would forgo relatively high marginal returns. Being far from the default boundary, debt holders share none of this opportunity cost. Thus, the adequately capitalized firms have a relatively weak incentive for dividend payments. With the well- and undercapitalized institutions (those at either extreme) having the greatest incentive to make dividend payments, the interpretation of the dividend signal by outside investors is attenuated. A dividend payment signals a firm on either of the extremes, while a non-dividend signals a firm in the middle.

We extend the model to incorporate the equilibrium outcome with a regulator. From a regulator's standpoint, the *laissez faire* outcome is problematic: Undercapitalized firms exploit the public safety net by transferring resources to underwater shareholders. To reduce this expropriation of wealth, regulators reasonably respond by restricting dividend payments at undercapitalized institutions. However, by preventing relatively weak firms from paying dividends, regulators inject information on the health and safety of the firm into the market. In short, when the market observes that a firm has not made (or increased) dividend payments, then it concludes that the firm is likely weak. Thus, healthy firms that would have otherwise held additional capital may dividend it away to shareholders, simply to demonstrate that they have been permitted to do so. These firms would have used this capital more productively internally (to make loans), but instead these projects go unfunded and these firms are moved closer to failure (through lower capital levels).

4.1 Firm Characteristics

A key feature of the model is that outside investors do not observe a firm's true equity and asset values.[6] This assumption is reasonable in the context of financial firms given the relative opaqueness of bank their assets.[7] We assume that a continuum of firms enter in period 0 with equity that can take on values $E_0 \sim \Psi$ with support $[\underline{E}, \bar{E}]$. Note that, *ex ante*, firms are identical, with the same distribution on starting equity. Firms all have debt D, which is due at the end of period 1.

Assets pay a gross return given by $R(\cdot) > 0$ with $R' > 0, R'' < 0$. Note that negative marginal returns ($R' < 1$) are allowed, though not required, reflecting the possibility of a free cash flow problem or, alternatively, that a firm's marginal loan does not outperform an investor's opportunity cost. For simplicity, the risk-free rate is zero so that there is no discounting.

4.2 Management

The model timeline is depicted in Figure 3. In period 0, the management observes E_0 and the firm's current assets are $A_0 = R(D + E_0)$. The management chooses whether to pay a dividend $\tilde{d} \in \{0, d\}$. For simplicity, we assume the dividend payment is discrete. The remaining assets are reinvested into the firm so that future assets become $A_1 = R(D+E_0-\tilde{d})$, where R is a revenue function that has decreasing marginal returns. Given limited liability, a firm's equity at the end of period 1 is given by $E_1 = \max\left\{0, R\left(D + E_0 - \tilde{d}\right) - D\right\}$.

We define the change in firm value due to dividend payments by, $R'(D + E) = R(D + E) - R(D + E - d)$. $R' > 0$ implies that keeping the dividends in the firm always generates additional firm value. If, on the other hand, $R' > d$ for all E_0, then paying dividends is

[6]This is similar to Duffie and Lando (2001) in which bond investors do not observe the issuer's assets directly, but instead receive noisy accounting reports. Adding this feature to the model improves the tractability, as it allows us to abstract away from ex-post bank firm uncertainty.

[7]Section 4.6 below allows for a public signal.

always inefficient. We allow for $R' < d$, leaving open the possibility that dividend payments can be optimal. A number of extant theories would be consistent with this assumption. For example, a free cash flow problem, in which managers would expropriate excess cash or invest in negative NPV projects, is consistent with $R' < d$. Clientele effects can also justify this condition. For instance, if shareholders have strong liquidity demands they value a unit of wealth more when held as dividends rather than as equity.[8]

The theory relies on managerial short-term incentives to generate a signaling effect. Following Miller and Rock (1985), we assume management acts in the joint interest of inside shareholders (who must hold onto stock until the end of period 1, e.g., because of vesting) and outside shareholders who will sell their stock after the firm issues dividends. The parameter $\lambda \in (0, 1)$ reflects the weight the management places on the interests of short-term, outside shareholders, with the complementary weight given to insiders.

The firm's objective function is given by:

$$V\left(E_0\right) = \max_{\tilde{d}} \left\{ \tilde{d} + \lambda \mathbb{E}\left[E_1 | \tilde{d}\right] + (1-\lambda) E_1 \right\} \tag{1}$$

where the expectation operator is defined over the distribution of public information, Ψ. This is because although the manager observes E_0, the market can only infer the value of the firm through its dividend policy. Because short-term investors seek to sell their stock before the information asymmetry is resolved, they value the firm at $\tilde{d} + \mathbb{E}\left[E_1 | \tilde{d}\right]$, which depends only on the dividend choice of the firm as the private information is integrated out. Only the final term depends on E_0.

[8] Allen and Michaely (2003) survey the dividends literature, including discussions of free-cash flow and clientele effects. Jensen (1986) and Pettit (1977) are for an examples, among many, of free-cash flow and clientele effects, respectively.

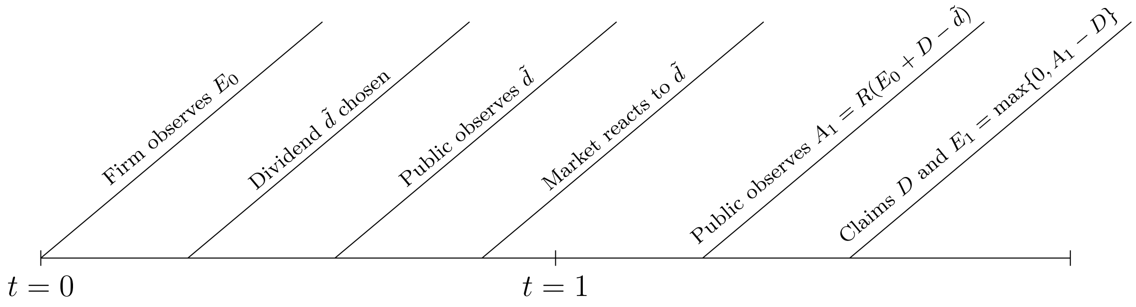

Figure 3: Model timeline.

4.3 First-Best Case

In first-best case the total firm value of all firms is maximized. Note that unlike the firm's objective function, the first-best allocation includes losses borne by the regulator and any failure costs. The first-best problem is written as:

$$\max_{\tilde{d}(\cdot)} \mathbb{E}\left[\tilde{d} + R(D + E_0 - \tilde{d}) - \mathbf{1}(E_1 = 0)c\right], \tag{2}$$

where c represents failure costs and $\mathbf{1}$ is the indicator operator.

The first-best problem is solved piecewise on a firm by firm basis: For each E_0 solve $\max_{\tilde{d}(\cdot)} \tilde{d} + R(D + E_0 - \tilde{d}) - \mathbf{1}(E_1 = 0)c$. The first-best solution is that a firm pay a dividend only when the net present value of the marginal project is greater than 0, net of failure costs. That is,

$$d^*(E_0) = \begin{cases} d, & \text{if } d - R'(D + E_0) - [\mathbf{1}_{E_1(E_0,d)=0} - \mathbf{1}_{E_1(E_0,0)>0}]c > 0 \\ 0, & \text{otherwise} \end{cases} \tag{3}$$

We restrict d, c and $R(\cdot)$, so that dividends are efficient only for those firms with sufficient capital. Dividends are inefficient for low capital firms if the marginal return at $E_0 = d$ (i.e. $R'(D + d)$) is sufficient large, the failure costs c are sufficiently large, or the dividend payment d is sufficiently small. In this way, dividends are only socially efficient as a result of decreasing marginal returns (free cash flow problem), rather than from risk shifting. This leads directly to the following assumption.

Assumption 1. *Paying dividends is never socially efficient at undercapitalized institutions:* $d - R'(D + E_0) - [\mathbf{1}_{E_1=0} - \mathbf{1}_{E_1>0}]c < 0$ *for all* E_0 *such that* $E_1(E_0, d) = 0$.

4.4 ***Laissez Faire*** Case

In the *laissez faire*[9] case, the regulator cannot restrict dividends, but limited liability remains. In addition, assume a pure strategy equilibrium. Since the manager's value function neglects failure costs, a firm with equity E_0 pays a dividend if and only if:

$$\begin{aligned} V(E_0|\tilde{d} = d) - V(E_0|\tilde{d} = 0) = d + \lambda \left(\mathbb{E}^K[E_1|\tilde{d} = d] - \mathbb{E}^K[E_1|\tilde{d} = 0]\right) \\ - (1 - \lambda)\Big(\max\{0, R(D + E_0 - d) - D\} \\ - \max\{0, R(D + E_0) - D\}\Big) \geq 0 \end{aligned}$$

where K is the firm's belief of the set of firms that will pay dividends and E^K is the expectation operator over equity given K. Define

$$\hat{s}(K) = \left(\mathbb{E}^K[E_1|\tilde{d} = d] - \mathbb{E}^K[E_1|\tilde{d} = 0]\right)$$

representing the difference in expected future equity between firms that do and do not pay a dividend.

Then, for any given $\hat{s}$, define the dividend incentive condition:

$$\Phi(E_0, \hat{s}) = d + \lambda\hat{s} - (1 - \lambda)\left(\max\{R(D + E_0) - D, 0\} - \max\{R(D + E_0 - d) - D, 0\}\right)$$

[9] Since there remains a social safety net for debt holders, this is not truly a *laissez faire* environment. We use the term to indicate that there are no regulatory restrictions placed on dividends.

Rewriting given the maximum operator gives

$$\Phi(E_0, \hat{s}) = \begin{cases} d + \lambda\hat{s} - (1-\lambda)R'(D + E_0) & \text{if } R(D + E_0 - d) > 0 \\ d + \lambda\hat{s} - (1-\lambda)\max\{R(D + E_0) - D, 0\} & \text{otherwise,} \end{cases} \tag{4}$$

where a firm pays a dividend if and only if $\Phi > 0$. For any given value of $\hat{s}$ (equilibrium value or not), we can draw Φ as a function of E_0. According to the dividend incentive condition a firm pays a dividend if and only if it lies above the horizontal axis, as shown in the top panel of Figure 4. Note that when E_0 is sufficiently small, the function Φ is flat. In this region, the firm is undercapitalized with or without the dividend. Consequently, in this region the future value of the firm is necessarily 0 and the incentive for dividends does not vary with E_0. As E_0 increases, the risk-shifting incentive for dividends diminishes as the opportunity cost of foregoing returns on reinvested capital is borne by shareholders rather than creditors. However, as E_0 increases further, the marginal returns of reinvested capital decreases due to the assumption $R'' < 0$.

For any dividend incentive function Φ, let $G(\Phi)$ be the dividend signal generated by the incentives. Abusing notation, we will often take the composite form and write $G(\Phi(\cdot, \hat{s})) = G(\cdot, \hat{s})$:

$$\begin{aligned} G(\Phi) = \; & \mathbb{E}[\max\{R(D + E - d) - D, 0\} | \Phi(E, \hat{s}) > 0] \\ & - \mathbb{E}[\max\{R(D + E) - D, 0\} | \Phi(E, \hat{s}) \leq 0]. \end{aligned}$$

The construction of G is shown in the bottom part of Figure 4. For a given $\hat{s}$, the top graph divides the E_0 space into three regions: $[\underline{E}, E_0^1]$, $[E_0^1, E_0^2]$, $[E_0^2, \bar{E}]$. In the first and third intervals (darkly shaded in the bottom graph), $\Phi > 0$, so that firms pay dividends on these intervals. Thus, market expectations of a firm paying dividends are given by integrating future equity (given dividends) over the conditional distribution of dividend

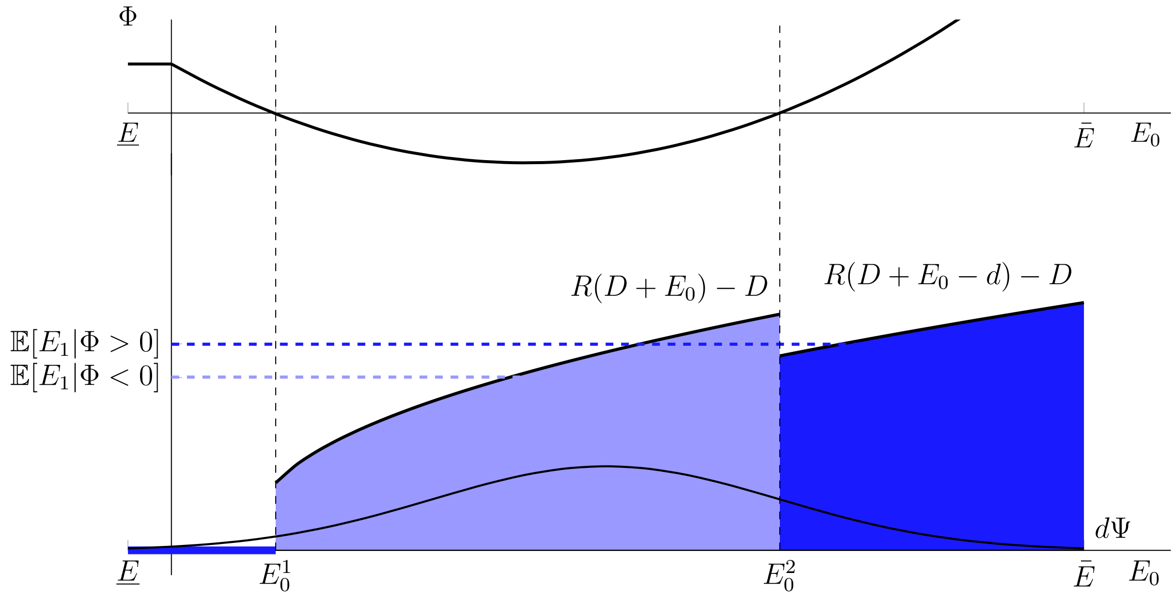

Figure 4: Top Graph: The incentive to dividend Φ for a fixed signal value $\hat{s}$. Bottom Graph: The future value of the firm given dividend decisions and the signal $G(\hat{s}) = \mathbb{E}[E_1|\Phi > 0] - \mathbb{E}[E_1|\Phi <= 0]$. Dark blue areas denote equity levels where firms will choose to pay a dividend, below E_0^1 and above E_0^2. Correspondingly, light blue area denotes where firms do not pay dividends, $E' \in (E_0^1, E_0^2)$.

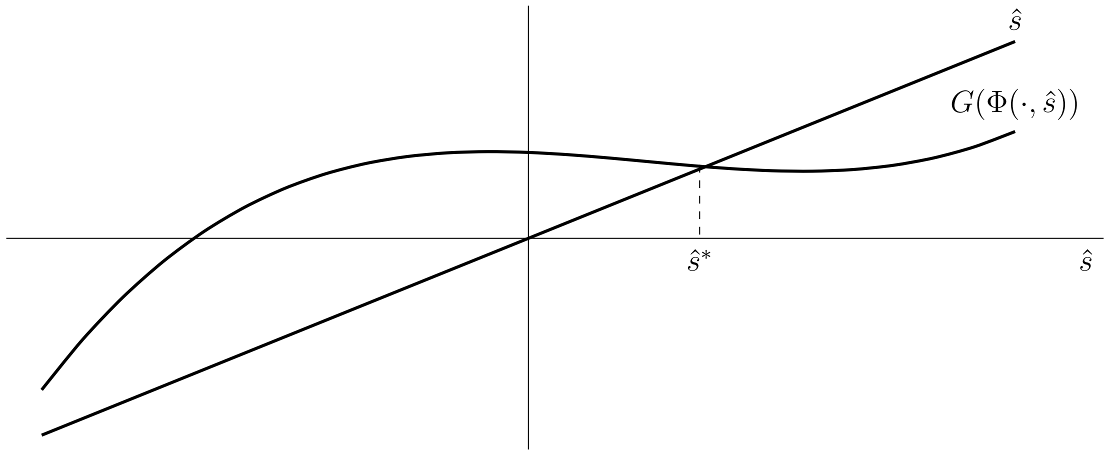

Figure 5: Equilibrium Signal for $G(\cdot, \hat{s})$

payors: $\Psi(E_0|E_0 \in [\underline{E}, E_0^1] \cup [E_0^2, \bar{E}])$. Meanwhile, the second interval (lightly shaded in the bottom graph) is the set of non-dividend firms. Market expectations for non-dividend-paying firms are similarly formed by integrating future equity of these firms (absent dividends) over the conditional distribution of non-dividend payors: $\Psi(E_0|E_0 \in [E_0^1, E_0^2])$. $G(\cdot, \hat{s})$ is then the difference between the market's expected future equity of dividend- and non-dividend-paying firms.

An equilibrium is defined as a fixed point where $G(\cdot, \hat{s}^*) = \hat{s}^*$. Notice that $G(\cdot, \hat{s})$ need not be monotonic in $\hat{s}$. This is because shifting the Φ curve up adds (down subtracts) firms at both the top and the bottom of the equity distribution of non-dividend-paying firms into (from) the dividend-paying population. Then, the effect of a change in $\hat{s}$ on the value of $G(\cdot, \hat{s})$ depends on the weight $d\Psi$ of each of these new additions (subtractions) and that group's expected mean relative to that of the set of dividend- and non-dividend-paying firms. The directional effect of $\hat{s}$ on $G(\cdot, \hat{s})$ consequently depends on the specific parameterization. Nevertheless, many of the conclusions and comparative statics from the model are valid even without a monotonic relationship between $\hat{s}$ and $G(\hat{s})$. Figure 5 is a graphical representation of an equilibrium.

We make some assumptions to guarantee that both dividends and no dividends are observed in equilibrium. This negates the need to consider pooling equilibria that would then require additional assumptions on off-equilibrium beliefs.[10] Let the lower and upper feasible signals be given by

$$\begin{aligned}\underline{\hat{s}} &= \inf_K \mathbb{E}\Big[\max\{R(D+E_0-d)-D,0\}|E_0 \in K\Big] \\ &\quad -\mathbb{E}\Big[\max\{R(D+E_0)-D,0\}|E_0 \notin K\Big], \text{and} \\ \bar{\hat{s}} &= \sup_K \mathbb{E}\Big[\max\{R(D+E_0-d)-D,0\}|E_0 \in K\Big] \\ &\quad -\mathbb{E}\Big[\max\{R(D+E_0)-D,0\}|E_0 \notin K\Big].\end{aligned}$$

Let the production function, dividend size, and parameters be such that for any feasible signal, firms with the minimum and maximum possible values of E_0 find it optimal to pay a dividend. Further, for some intermediate value, $E' \in (\underline{E}, \bar{E})$ the returns from investment are sufficiently high such that for any feasible signal, the firm chooses not to pay a dividend.

Assumption 2. *A firm with the highest or lowest supported equity, $\underline{E}$ or $\bar{E}$, will have an incentive to pay a dividend. Further, there exists a firm with some equity $E' \in (\underline{E}, \bar{E})$ that does not have an incentive to pay a dividend. That is, $\Phi(\underline{E}, \underline{\hat{s}}) > 0$, $\Phi(\underline{E}, \underline{\hat{s}}) > 0$, and $\Phi(E', \bar{\hat{s}}) < 0$*

Under the maintained assumptions, the concavity of the production function, and the convexity of equity, there exist equity levels, E_0^1 and E_0^2, such that firms only pay dividends in that range; $\Phi(E, \hat{s}) \geq 0$ if and only if $E \in [E_0^1, E_0^2]$. That is to say, there will be two levels of equity, between which firms will choose to pay dividends. Below the lower equity level, E_0^1, firms will pay dividends to risk shift. Above the higher equity level, E_0^2, firms will pay dividends to mitigate the free cash flow problem. These two levels of equity can be seen in Figure 4 as the vertical dashed lines. Setting $\Phi = 0$ gives the expressions for these bounds.

[10] Alternatively, we could allow for pooling equilibria in which all firms pay and dividend and use the intuitive criterion Cho and Kreps (1987) to fix out-of-equilibrium beliefs on non-dividends as $\text{argmin}_{E_0}\{d + E_1(E_0, d)\}$. However, this would add complication without changing the underlying mechanisms.

In particular, $E_0^1(\hat{s}) = R^{-1}\left(\frac{d+\lambda\hat{s}}{1-\lambda} + D\right) - D$ and $E_0^2(\hat{s}) = R'^{-1}\left(\frac{d+\lambda\hat{s}}{1-\lambda} + D\right) - D$.

Given this structure for Φ, we can write the following expression for the dividend signal, $G(\cdot, \hat{s})$, in the *laissez faire* case as:

$$G(\cdot, \hat{s}) = \frac{\int_{E_0^2(\hat{s})}^{\bar{E}} (R(D + E_0 - d) - D)\mathrm{d}\Psi(E_0)}{1 - \Psi(E_0^2(\hat{s})) + \Psi(E_0^1(\hat{s}))} - \frac{\int_{E_0^1(\hat{s})}^{E_0^2(\hat{s})} (R(D + E_0) - D)\mathrm{d}\Psi(E_0)}{\Psi(E_0^2(\hat{s})) - \Psi(E_0^1(\hat{s}))} \tag{5}$$

Proposition 1. *There exists an equilibrium and an associated signal $\hat{s}$ such that a firm with capital E_0 does not pay a dividend if and only if $E_0 \in [E_0^1, E_0^2]$.*

Proof. The proof is established by the Brouwer Fixed Point Theorem, which requires that (a) $G(\cdot, \hat{s})$ is continuous in $\hat{s}$ and (b) $G(\cdot, \hat{s}) : [\underline{\hat{s}}, \bar{\hat{s}}] \to [\underline{\hat{s}}, \bar{\hat{s}}]$ maps to the same interval. The first condition is established by continuity and differentiability properties of R and Ψ. The latter follows directly from the definitions of the lower and upper bounds of $\hat{s}$. □

The existence of equilibrium is guaranteed under fairly weak assumptions. However, if agents value the signal too strongly, multiple equilibria can arise. In particular, as more importance is placed on the value to outside equity holders, as $\lambda \to 1$, the behavior of most firms will be governed entirely by the signaling incentive. To ensure a unique equilibrium, assume that λ is small enough to preclude this possibility. That is, we assume that enough value is placed on both inside and outside equity holders to support a unique equilibrium, described in the proposition below. However, this restriction could easily be relaxed if we consider the possibility of multiple equilibria. Furthermore, all subsequent comparative static results would hold if we consider perturbations of the underlying parameters as movements around any particular equilibrium.

Proposition 2. *If the relative importance placed on outside equity holders, λ, is sufficiently small, then there exists a unique equilibrium.*

Proof. This result follows by differentiating $G(\cdot, \hat{s}; \lambda)$ with respect to $\hat{s}$ and showing it is a factor of λ. If λ is sufficiently small, $\frac{\partial G}{\partial \hat{s}} < 1$ and thus $G(\cdot)$ cannot cross the 45-degree line more than once. □

4.5 A Prudential Regulator

One of the key features that makes dividend policy decisions especially interesting–in the context of systemically important financial institutions, and banking in general–is the unique role that regulators play. Either to prevent risk shifting or to maintain a sufficiently low probability of failure, regulators may restrict dividend payments at undercapitalized firms. In many cases, such restrictions are private or implicit, and therefore not directly visible to the market.[11]

Suppose that a regulator is perfectly informed and undertakes a policy of restricting dividends if and only if $R(D + E - d) - D < 0$ (the firm is undercapitalized conditional on paying a dividend). In the model, that would imply that the regulator may forbid dividend payments only when paying a dividend would cause the firm to be unable to meet its liabilities D at the end of period 1. Note that 0 could easily be replaced with any nonzero capital requirement. Given the regulator's behavior, the incentive structure Φ is unchanged. However, firms that breach the capital requirement with dividends are exogenously restricted from dividends. Returning to Figure 5, the partitioning of E_0 into three intervals is unchanged as Φ is unchanged. However, while undercapitalized firms prefer to pay a dividend, they are unable to do so. This implies that these undercapitalized firms move from dividend payors (darkly shaded) to non-dividend payors (lightly shaded). Thus, the signal $G_R(\Phi)$ generated in the presence of a regulator differs from $G(\Phi)$. Figure 6 demonstrates the relative increase

[11]For example, while CCAR results are public, firms set their capital plans with expectations on what will be approved by regulators.

in the signal strength, $G_R(\hat{s})$. In particular,

$$G_R(\cdot, \hat{s}) = \frac{\int_{E_0^2(\hat{s})}^{\bar{E}} (R(D + E_0 - d) - D)\mathrm{d}\Psi(E_0(\hat{s}))}{1 - \Psi(E_0^2(\hat{s}))} - \frac{\int_{E_0^0(\hat{s})}^{E_0^2(\hat{s})} (R(D + E_0) - D)\mathrm{d}\Psi(E_0)}{\Psi(E_0^2(\hat{s}))} \tag{6}$$

where $E_0^0 = R^{-1}(D) - D < E_0^1$ is the minimum equity required to guarantee positive future equity given no dividends. As in the *laissez faire* case, it is straightforward to show that an equilibrium exists when there is a regulator. Furthermore, uniqueness is similarly guaranteed under the appropriate parameter restriction on λ.

The first result is that the introduction of the regulator increases firms' value of the signal and increases the set of firms that would prefer to pay a dividend. Naturally, this does not mean that more firms *do* issue dividends, as the regulator precludes poorly capitalized firms from paying a dividend in any case. However, the nature of this regulatory action does induce some firms to pay a dividend that otherwise would not. In particular, if we let $\hat{s}_R^*$ be the value of the equilibrium signal with the regulator then it must be the case that this is greater than $\hat{s}^*$.

Proposition 3. *A regulator who restricts dividends to firms engaged in risk shifting will increase the market's valuation of dividend-paying firms relative to the* laissez faire *case. In particular, $\hat{s}^* < \hat{s}_R^*$. Furthermore, firms with capital $E_0 \in [E_0^2(\hat{s}_R^*), E_0^2(\hat{s}^*)]$ do not dividend in the laissez faire case but do dividend in the regulator case.*

Proof. The proof follows directly from showing that $G(\cdot, \hat{s}) < G_R(\cdot, \hat{s})$ for all $\hat{s}$. Moving a mass of firms from the dividend-paying group to the non-dividend-paying group increases the expected value of the dividend payers and decreases the expected value of the non-payers. Thus, the regulator's behavior induces a positive shift in G, thereby increasing $\hat{s}^*$. The monotonicity of $E_0^2(\hat{s})$ in $\hat{s}$ guarantees that the change produces a non-empty set of new dividend-paying firms. □

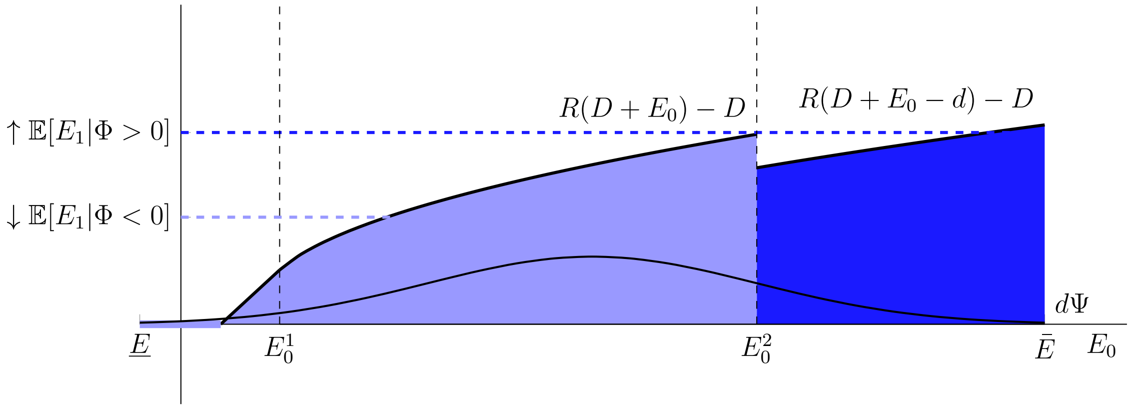

Figure 6: An The future value of the firm given dividend decisions and the signal $G(\hat{s}) = \mathbb{E}[E_1|\Phi > 0] - \mathbb{E}[E_1|\Phi <= 0]$.

4.6 Public Signals

The analysis to this point has relied on external investors (the public) having only a prior distribution of all possible realization of E_0 and a regulator who had perfect knowledge of the firm's equity position. In reality, the nesting of information would be more complex. In particular, external investors receive public signals (e.g., from public filings) of the firm's quality. Moreover, a regulator can observe both the public data as well as an additional private signal of firm quality (e.g., from regulatory examinations) that provides a more precise but still imperfect signal of the state of the firm. Meanwhile, the firm managers are likely to have the best information about the state of the firm.

Let $E_0 \sim \Psi[\underline{E}, \bar{E}]$ be the unconditional distribution of a firm's starting equity. Assume that Ψ is differentiable and $d\Psi(E_0) > 0$ for all E_0 in the support $[\underline{E}, \bar{E}]$. Suppose further that a public signal $\tilde{e}_P(e_0)$ generates a posterior distribution $E_0 \sim \Psi_P = \Psi(\cdot|\tilde{e}_P)$. Assume that signals obey first order stochastic dominance so that higher $\tilde{e}_P$ are more likely to come from higher values of E_0. Mathematically, for $\tilde{e}'_P < \tilde{e}''_P$ and for all E_0, it is the case that $\Psi(E_0|\tilde{e}'_P) \geq \Psi(E_0|\tilde{e}''_P)$. Notice that all of the results from the previous section hold under Ψ_P, as they did not depend on the particular distributional assumptions. That is, the existence of an equilibrium and its uniqueness necessarily hold so long as the posterior distribution Ψ_P

satisfies the properties required of Ψ.

4.6.1 Comparative Statics

This section examines comparative statics for the equilibrium with the prudential regulator. In particular, it examines how changes in the distribution of capital levels affect the strength of the dividend signaling mechanism. The following proposition states that an increase in the underlying uncertainty increases the equilibrium value of signaling and an increase in the proportion of firms that pay dividends. In particular, if the support of E_0 is expanded, $\hat{s}^*$ necessarily increases.

Proposition 4. *An increase in uncertainty increases the incentive of firms to pay dividends. Suppose that the support of E_0 is widened to $[\underline{E} - \eta, \bar{E} + \eta] \sim \Psi'$ for some $\eta > 0$ such that the mean of Ψ' is equal to that of Ψ. Assume further that $\Psi'(\cdot | E_0 \in [\underline{E}, \bar{E}]) = \Psi$. Then the regulated equilibrium features an increased dividend incentive.*

The comparative statics in the case of mean shifts of the distribution of Ψ are ambiguous because the effect of an increase in mean equity, E_0, has a non-monotonic effect on the increase in period 1 equity, E_1. For the region in which $E_1 = 0$ (i.e., the firm is undercapitalized), an increase in starting capital has no effect on future shareholder value. However, the concavity of the production function dictates that the effect of an increase in E_0 has the largest effect in the region just above E_0^1 where the firm is just above undercapitalized and decreasing thereafter.

Nevertheless, comparative statics can be drawn for distributions that give rise to equilibria where sufficiently few or sufficiently many firms pay a dividend. Suppose that there is a mean shift Δ of the distribution Ψ. In the case where the mass of firms is already issuing a dividend, a positive mean shift ($\Delta > 0$) in E_0 further skews the distribution. As such, the signaling value of dividends is dampened, $\partial \hat{s}^* / \partial \Delta < 0$. In the case where the mass of firms already do not issue a dividend, the logic is reversed. Ψ becomes more skewed and the signal less informative when $\Delta < 0$. Consequently, $\partial \hat{s}^*/\partial\Delta > 0$ when sufficiently many firms do not issue a dividend.

For the arguments above, we require one additional assumption: The density of firms on the boundary between dividends and non-dividends must be sufficiently small. This is guaranteed assuming that the density $d\Psi(E_0)$ is sufficiently small for all points in $\underline{E}, \bar{E}$.

Assumption 3. *For all possible values of $\hat{s} \in [\underline{E} - \bar{E}, \bar{E} - \underline{E}]$ and for all $E_0 \in [\underline{E}, \bar{E}]$,*

$$\frac{1}{d\Psi(E_0)} > \frac{\partial E_0^2}{\partial \hat{s}} d\Psi(E_0^2) \left[\frac{\left(\int_{E_0^2}^{\bar{E}} E_1(E_0, d) d\Psi(E_0) - E_1(E_0^2, d)(1 - \Psi(E_0^2)) \right)}{(1 - \Psi(E_0^2))^2} \right.$$
$$\left. + \frac{\left(\int_{E_0^0(\hat{s})}^{E_0^2} E_1(E_0, 0) d\Psi(E_0) - E_1(E_0^2, 0)\Psi(E_0^2) \right)}{[\Psi(E_0^2)]^2} \right]$$
$$+ \frac{\partial E_0^0}{\partial \hat{s}} \frac{E_1(E_0^1, 0)\Psi(E_0^2) d\Psi(E_0^2)}{[\Psi(E_0^2)]^2}$$

Results on mean shifts follow given Assumption 3.

Proposition 5. *When sufficiently many (few) firms pay a dividend, a positive mean shift in equity decreases (increases) the value of the dividend signal. Let $\nu(\Psi)$ be the mass of firms that do not issue dividends in an equilibrium for a given distribution of public signals Ψ. (i) There exists a $\underline{\nu}$ such that for any Ψ' such that $\nu(\Psi') < \underline{\nu}$ and associated equilibrium signal $\hat{s}(\Psi')$, it is the case that $\partial \hat{s}(\Psi')/\partial\Delta < 0$ where Δ is a mean shift in Ψ'. (ii) Similarly, there exists a $\bar{\nu}$ such that for any Ψ' such that $\nu(\Psi') > \bar{\nu}$ and associated equilibrium signal $\hat{s}(\Psi')$, it is the case that $\partial \hat{s}(\Psi')/\partial\Delta > 0$.*

4.7 Welfare Analysis

This section discusses the welfare implications of a dividend-restricting regulator relative to the *laissez faire* equilibrium. In addition, it addresses implementation of the efficient outcome by adjusting the set of firms over which dividends may be restricted. We show that the welfare implications of dividend restrictions on only undercapitalized institutions are generally ambiguous. Ultimately, welfare consequences are driven by the skewness in favor of overcapitalization. Only in the case of a distribution heavily skewed toward overcapitalized firms could dividend restrictions on undercapitalized firms decrease welfare through the signaling effect. We also show that by broadening the set of firms for which the regulator restricts dividends, the first-best allocation can be implemented with dividend restrictions.

A policy of restricting dividend on undercapitalized institutions is welfare improving if the regulated welfare is greater than welfare in the *laissez faire* case, denoted as W_{Reg} and W_{LF}, respectively. The welfare implications of dividend restrictions of undercapitalized banks firms can then be written as $\Delta W = W_{Reg} - W_{LF}$. Similarly, denote other equilibrium objects with subscripts analogously (e.g. $E^1_{0,LF}$). In addition, note that in the case of dividend restrictions, $R^{-1}(D) - D$ represents the initial level of equity below which a firm fails and above which it does not. The expression for welfare in these two cases can be written as:

$$\begin{aligned} W_{LF} = & \int_{\underline{E}}^{E^1_{0,LF}} [d + R(D + E_0 - d) - c] d\Psi + \int_{E^1_{0,LF}}^{E^2_{0,LF}} R(D + E_0) d\Psi \\ & + \int_{E^2_{0,LF}}^{\bar{E}} [d + R(D + E_0 - d)] d\Psi, \text{ and} \end{aligned} \tag{7}$$

$$\begin{aligned} W_{Reg} = & \int_{\underline{E}}^{R^{-1}(D)-D} [R(D + E_0) - c] d\Psi + \int_{R^{-1}(D)-D}^{E^2_{0,Reg}} R(D + E_0) d\Psi \\ & + \int_{E^2_{0,Reg}}^{\bar{E}} [d + R(D + E_0 - d)] d\Psi. \end{aligned} \tag{8}$$

To evaluate ΔW, a few notes are helpful. First, given the results of Section 4.5, $s^*_{LF} < s^*_{Reg}$.[12] This implies that $E^1_{0,LF} < E^1_{0,Reg}$ and $E^2_{0,LF} > E^2_{0,Reg}$. In addition, there is substantial overlap of firm behavior between the *laissez faire* and regulated regimes. In particular, firms with $E_0 > E^2_{0,LF}$ will pay dividends in both cases. Meanwhile, firms with $E_0 \in [E^1_{0,LF}, E^2_{0,R}]$ do not pay dividends in both cases. Thus, ΔW can be written with only the remaining parts of the distribution of E_0 in mind. Namely,

$$\Delta W = \underbrace{\int_{\underline{E}}^{E^1_{0,LF}} [R'(D+E_0) - d]\, d\Psi}_{\text{Increased Investment}} + \underbrace{\int_{R^{-1}(D)-D}^{E^1_{0,LF}} c\, d\Psi}_{\text{Reduced Failure}} - \underbrace{\int_{E^2_{0,Reg}}^{E^2_{0,LF}} [R'(D+E_0) - d]\, d\Psi}_{\text{Decreased Investment}} \tag{9}$$

Dividend restriction policies for undercapitalized firms affect welfare through three channels. The first channel is increased investment in all low capital firms that without the policy would pay a dividend. Note that, due to decreasing marginal returns, low equity firms have the highest marginal return, R'. Through this channel, dividend restrictions would have a positive effect on social welfare. The second channel is a decrease in failures among undercapitalized institutions that would otherwise survive with the extra equity from not paying a dividend. Even with dividend restrictions, some firms, namely those with capital $R^{-1}(D) - D$, will fail. The dividend restriction policy only avoids failure costs in a subset of undercapitalized firms, those with capital in $[R^{-1}(D) - D, E^1_{0,LF}]$. Like the first channel, decreasing failures would have a positive impact on overall social welfare. The third channel, however, has a negative effect. More highly capitalized institutions will invest less as a result of paying a dividend for signaling purposes. This affects firms with capital in $[E^2_{0,R}, E^2_{0,LF}]$ and offsets some of the benefit achieved from the first two channels.

In general, ΔW cannot be signed. However, the decomposition of the expression in Equation (9) highlights conditions under which the ΔW can be signed. The dividend is

[12] Recall that in general there may be multiple equilibria. However, for any *laissez faire* equilibrium signal s^*_{LF} there exists an equilibrium with a regulator where $s^*_{Reg} > s^*_{LF}$. This follows from the fact that $G(\cdot)$ is defined on the compact set $[s^*_{LF}, \bar{\hat{s}}]$, so that the Brouwer Fixed Point Theorem applies.

welfare improving unless a sufficient mass of highly capitalized banks firms exists. This follows from an examination of terms in the integrands. First, R' is lower at higher capital institutions (and bounded below by 0) so that the integrand in the first term is larger than the third. In addition, the integrand in the second term is a welfare benefit from reduced failure costs. Together, the integrands push in favor of welfare improvements from dividend restrictions. However, for specific distributions that are heavily skewed in favor of overcapitalized firms, it is theoretically possible that the signaling effects of the third term dominate and $\Delta W < 0$.

4.7.1 Implementation of first-best

With perfect information, the regulator can implement the first-best outcome through strict capital regulation. In particular, Equation 3 requires that firms dividend if and only if they have sufficient capital so that they face negative marginal social returns. Given Assumption 1, this will be the case only when the firm also faces negative marginal private returns. In particular, it is efficient for a bank firm to dividend if and only if the dividend payment is greater than the marginal revenue from investing the funds internally, $d - R'(D + E_0) > 0$. Given the concavity of R, there is a unique equity level, E^*, such that $d - R'(D + E^*) = 0$ above (below) which it is (not) efficient for a firm to pay a dividend.

Proposition 6. *A perfectly informed regulator may implement the efficient allocation by allowing dividend payments if and only if $E_0 \geq E^*$.*

The idea of the proof is as follows: Without any signaling incentives, well-capitalized firms would pay dividends in line with the efficient allocation, paying if and only if $E_0 > E^*$. By restricting the pool of possible dividend-paying firms only to the best capitalized ones, such a policy would force a positive dividend signal. This would push up the incentive to pay dividends for all firms, including those below E^*. However, such firms are precluded from paying dividends under the policy, leaving only those with $E_0 > E^*$ able to pay dividends.

As these firms already had an incentive without a signaling incentive, they will continue to pay dividends with the policy.

While such a policy would induce the efficient allocation, it would be an expansion beyond what regulatory authority permits. In particular, it would restrict even those healthy firms that are not shifting risk to the public sector. Even if regulatory authority for such a restriction existed, it would require that the regulator have enough knowledge to confidently calibrate E^*. This is a strong assumption and suggests that the model should incorporate the regulators' imperfect knowledge about the firm. The following subsection introduces such an information asymmetry between banks firms and regulators. The analysis provides a richer set of tradeoffs for the regulator when calibrating policies of dividend restrictions. A strict dividend policy produces false positives (unnecessarily restricted from paying dividends), while a looser dividend policy produces false negatives (improperly allowed to dividend).

4.8 An Imperfectly Informed Regulator

The analysis thus far has assumed that the regulator perfectly observed the true equity of a firm. In reality, like the market, a regulator likely also observes the firm's true equity with some noise. However, one would expect the regulator's signal to be at least as fine or finer than that of the public, given the regulator's access to non-public information. This Section extends the above results to an environment in which the regulator is imperfectly informed on the quality of the firm.

If the regulator does not have perfect information, we must first specify a new dividend restriction policy. In the case of perfect information, the regulator could eliminate risk-shifting entirely by prohibiting dividend payments for firms at which paying a dividend would make it undercapitalized ,$R(D + E_0 - d) < D$. However, when the regulator cannot perfectly observe E_0, it cannot perfectly eliminate risk-shifting. Through this Section, assume that the regulator receives a signal $\tilde{e}_{Reg} \sim S(\cdot|E_0, \tilde{e}_P)$ in addition to the public signal. Further, assume that this signal is informative in the sense of first order stochastic dominance. That is $S(\cdot|E_0'', \tilde{e}_P) \leq S(\cdot|E_0', \tilde{e}_P)$ whenever $E'' > E'$. As a counterpart to the full information case, assume that the regulator prohibits dividend payments whenever the expected value of the equity is sufficiently small. This could be an expected value of 0 equity given the regulator's information $(\tilde{e}_{Reg}, \tilde{e}_P)$, or it could be set at a higher threshold (as with minimum regulatory capital levels). Denote this threshold $\bar{e}$. Formally, we assume that the regulator has a policy of prohibiting dividend payments if and only if $\mathbb{E}^R[E_0|\tilde{e}_{Reg}, \tilde{e}_P] < \bar{e}$ where $\mathbb{E}^R[\cdot|\tilde{e}_{Reg}, \tilde{e}_P]$ is the expectation of the regulator of the underlying equity given the public and private information. Given this policy, first order stochastic dominance implies that firms with higher levels of E_0 are less likely to face a dividend restriction.

It is helpful to view the case of an imperfectly informed regulator in comparison to the *laissez faire* and regulation cases above, along with the under-, adequately, and well-capitalized distinctions previously discussed. For a given $\hat{s}$ (not necessarily the equilibrium value), note that the incentives to pay a dividend are identical to the imperfectly informed regulator case $\Phi(\cdot, \hat{s})$. Given these incentives, define $G_{IR}(\cdot, \hat{s})$ as the signal generated from the imperfectly informed regulator. Formally,

$$\begin{aligned} G_{IR}(\cdot, \hat{s}) = & \frac{\int_{E_0 \in K} \int_{e^H} E_1(E_0, d) dS(\tilde{e}|E_0) d\Psi(E_0|\tilde{e})}{\int_{E_0 \in K} \int_{e^H} dS(\tilde{e}|E_0) d\Psi(E_0|\tilde{e})} \\ & - \frac{\int_{E_0 \notin K} \int E_1(E_0, 0) dS(\tilde{e}|E_0) d\Psi(E_0|\tilde{e})}{\int_{E_0 \notin K} \int dS(\tilde{e}|E_0) d\Psi(E_0|\tilde{e}) + \int_{E_0 \in K} \int_{e^L} dS(\tilde{e}|E_0) d\Psi(E_0|\tilde{e})} \\ & - \frac{\int_{E_0 \in K} \int_{e^L} E_1(E_0, 0) dS(\tilde{e}|E_0) d\Psi(E_0|\tilde{e})}{\int_{E_0 \notin K} \int dS(\tilde{e}|E_0) d\Psi(E_0|\tilde{e}) + \int_{E_0 \in K} \int_{e^L} dS(\tilde{e}|E_0) d\Psi(E_0|\tilde{e})} \end{aligned} \tag{10}$$

where $\tilde{e} = (\tilde{e}_{Reg}, \tilde{e}_P)$ is the set of all public and private signals, $E_1(E_0, \hat{d}) = \max\{R(D + E_0 - \hat{d}) - D, 0\}$, e^H is the set of $\tilde{e}|\mathbb{E}^R[E_0|\tilde{e}] > \bar{e}$ and e^L is its complement, and the thresholds E_0^0

and E_0^2 are functions of $\hat{s}$ as defined in Section 4.5. Further, $K = [\underline{E}, E_0^1] \cup [E_0^2, \bar{E}]$ is the set of firms that choose to pay a dividend so long as they are permitted to do so.

Figure 7 is a graphical depiction of the construction of G_{IR}. The set of firms paying a dividend (represented in the first term of (10)) are those darkly shaded areas in the figure. These firms both want to pay a dividend and are allowed to do so by the regulator. Firms in this group fall into two regions, either below E_0^1 or above E_0^2. To pay a dividend, the regulator must also receive a signal of sufficiently strong health (high equity). Firms below E_0^1 are more likely to generate signals of poorer capital, while those above E_0^2 are more likely to carry signals of stronger capital. This gives rise to the rightward shift in the distribution of firms, depicted by the dotted line in the figure. Firms with low capital that are allowed to pay are misdiagnosed as healthy by the regulator (false negatives), while those with high capital are appropriately unrestricted (true negatives).

Meanwhile, the firms that do not pay a dividend (the negative term of (10)) also fall into one of two groups below $d\Psi$ in Figure 7. The first group contains those with capital $E_0 \in [E_0^1, E_0^2]$ that would not want to pay a dividend, whether restricted or not. This is the unshaded area under $d\Psi$ in the figure. In (10), this is the first term after the subtraction. The second group of firms that do not pay a dividend are those that would like to, but are restricted by the regulator. This includes poorly capitalized firms that the regulator appropriately diagnoses as unhealthy (true positives), represented by the lightly shaded area in the figure. These firms pay a dividend in the *laissez faire* case, but not in the regulated case. The second group also includes well-capitalized firms that the regulator incorrectly flags as unhealthy (false positives), represented by the moderately shaded area in the figure. These well-capitalized firms pay dividends both in the *laissez faire* case and in the regulated case, since they are healthy, but not in the imperfectly informed regulator case. Together, the restricted firms that would like to pay a dividend (the light and moderately shaded portion of the figure), but for which the dividend restriction is binding, are represented in the final

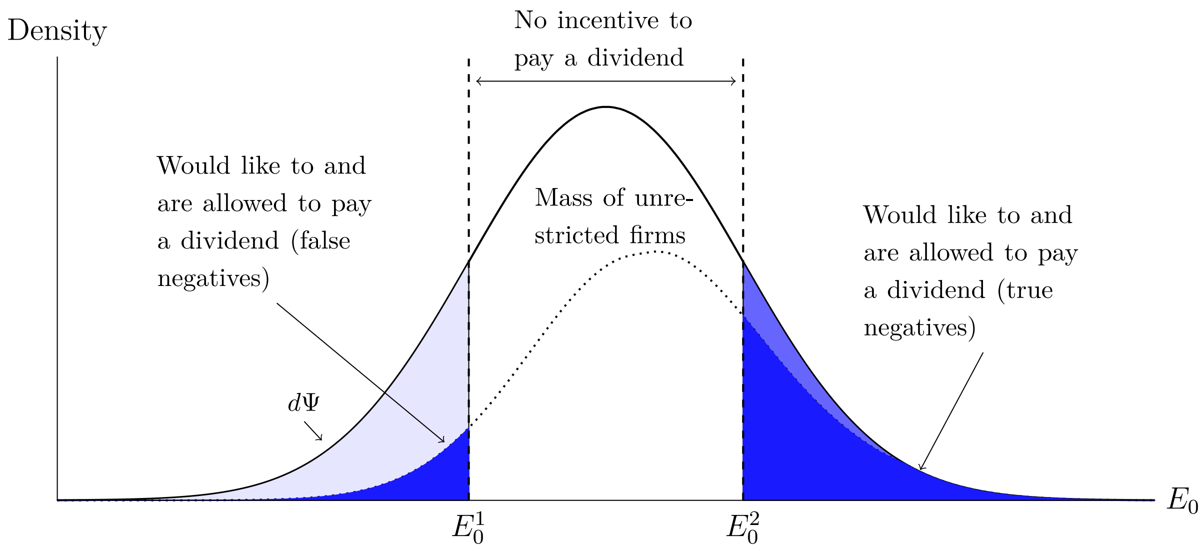

Figure 7: Distribution of firms paying dividends under an imperfectly informed regulator for a given signal $\hat{s}$.

term in (10).

The consequences of an imperfectly informed regulator can then be understood by contrasting $G_{IR}(\hat{s})$ to $G(\hat{s})$ and $G_R(\hat{s})$. For low equity firms, the imperfectly informed regulator lies between the *laissez faire* and the regulated case. In the former, these firms pay a dividend, while in the latter, these same firms do not. Imperfect information implies that these firms will pay a dividend only when the regulator incorrectly identifies them as sufficiently capitalized.

For firms with adequate capital, the imperfect information case is identical to both the *laissez faire* and regulated cases. For a given $\hat{s}$, firms in the adequately capitalized region do not want to pay a dividend in either case and the restriction is non-binding. Thus, a regulator who erroneously believes that such a firm's capital is low will nonetheless have no effect on a firm that would not issue a dividend in the *laissez faire* case.

On the other hand, well-capitalized firms' behavior in the imperfect information case does not lie between the *laissez faire* and regulated case. In both cases, the well-capitalized firms pay a dividend. However, if a regulator incorrectly identifies a well-capitalized firm as having equity below $\bar{e}$, then it will be restricted from issuing a dividend.

Adding imperfect information to the regulator's action choices changes the equilibrium in the following way.

Proposition 7. *In an environment with an imperfectly informed regulator, at least one of the following two conditions must hold.*

1. *The equilibrium incentive to pay dividends is higher than in the laissez faire case, but lower than in the case of a perfectly informed regulator. That is,* $\hat{s}^*_{IR} \leq \hat{s}^*_R$*, where* $G_R(\cdot, \hat{s}^*_R) = \hat{s}^*_R$ *and* $G_{IR}(\cdot, \hat{s}^*_{IR}) = \hat{s}^*_{IR}$.

2. *The imperfectly informed regulator has a stricter dividend policy than a perfectly informed regulator, in the sense that proportion of firms paying a dividend is lower. That is,*

$$\int_{E_0} \int_{\{\tilde{e}|\mathbb{E}[E_1|\tilde{e}]\geq \bar{e}\}} dS(\cdot) d\Psi(\cdot|E_0 \in K(\hat{s}^*_{IR})) \leq \int_{E_0} d\Psi(\cdot|E_0 \geq E_0^2(\hat{s}^*_R)) \tag{11}$$

where $K(\hat{s}^*_{IR}) = [\underline{E}, E_0^1(\hat{s}^*_{IR}))] \cup [E_0^2(\hat{s}^*_{IR})), \bar{E}]$.

Proposition 7 dictates that, relative to the case of a perfectly informed regulator, firms operating with an imperfectly informed regulator will have a decreased incentive to pay dividends, a decreased ability to pay dividends, or both. The outcome is a function of both the quality of the regulator's signal ($S(\cdot|E_0)$) and the strictness of the regulator's dividend restriction policy, ($\bar{e}$). The former guarantees that some well-capitalized firms will be restricted from paying a dividend and some poorly-capitalized firms will be allowed to pay a dividend. The latter determines the extent to which the regulator is willing to make this tradeoff. In addition, note that implementing an increasingly strict regulatory policy (a higher $\bar{e}$) does not have a direct implication on the equilibrium incentive to pay a dividend, as both conditions in Proposition 7 may hold in equilibrium.

With an imperfectly informed regulator, the welfare tradeoffs are now more stark. As in Section 4.7, restricting dividends at firms perceived to be undercapitalized increases welfare by reducing the receivership costs induced from risk shifting and increasing investment where returns are highest. However, from Proposition 7, this will also raise the incentive to pay a dividend. This increased incentive will cause additional under-capitalized firms to want to pay a dividend and, under imperfect information, some may be allowed to do so. In addition, some firms restricted from paying dividends may have been doing so efficiently, and restricting dividends for this group is a net welfare loss. As in Section 4.7 the overall welfare effect will depend on the exact parameterization of the model.

5 Policy Implications

In this simple model, the power of dividend payments as a signaling device is intensified by the presence of a regulator that prevents risk shifting. Notice that, in the models with regulators, risk shifting is utterly eliminated. However, some adequately capitalized firms are induced to *reduce* their capital levels via dividend payments. While overall dividend restrictions make sense for prudential regulation purposes, these ancillary effects should not be ignored. To mitigate the incentives for excessive dividends for signaling purposes, a number of alternatives may be considered. For example, the results suggest that industry-wide changes to the banking sector, such as increased volatility, have perverse effects on dividend incentives. Such a time is precisely when a depletion of capital for dividends at the expense of maintaining lending to the real sector may be most detrimental. Consequently, a policy of blanket dividend restrictions or limits during such macroeconomic events based on pre-defined market measures would further prevent inefficient dividends for signaling purposes that may arise during such periods.

Furthermore, pre-defined benchmarks may help mitigate inefficient signaling through dividends. While current policy restricts dividend payouts to an extent,[13] this restriction may leave a significant informational asymmetry between regulators and public markets, especially if book equity is a lagging indicator of firm health. Additional publicly observable benchmarks, such as quarterly or annual net income, could serve as natural barriers for payouts. For example, more than two-thirds of banks earning negative income in 2008 paid a dividend (contrasted to 50 percent of financial and less than 10 percent of industrials). A blanket dividend restriction on banks or systemically important financial institutions earning negative income would quash the firm's incentive to pay a dividend during this time period when a firm has a particularly strong incentive to signal that its negative income is an aberration. Simultaneously, such a restriction would preserve capital that may be needed if negative income persists. Thus, using a combination of earnings, capital, and perhaps other publicly observable variables, pure signaling rationales for dividends could be abated.

6 Appendix

Proposition 4

Proof. The proof relies on the asymmetry of the effect of more or less capital today on the firm's future value. At the top end, this translates to additional capital. At the bottom end, given the limited liability protection, the corresponding decrease in the firm's future value from the decreased current capital is bounded below by zero.

$$G_R(\cdot, \hat{s}) = \frac{\int_{E_0^2(\hat{s})}^{\bar{E}+\eta} (R(D+E_0-d)-D)\mathrm{d}\Psi'(E_0(\hat{s}))}{1-\int_{E_0^2}^{\bar{E}+\eta} \mathrm{d}\Psi'(E_0)} - \frac{\int_{E_0^0(\hat{s})}^{E_0^2(\hat{s})} (R(D+E_0)-D)\mathrm{d}\Psi'(E_0)}{\int_{\underline{E}-\eta}^{E_0^2} \mathrm{d}\Psi'(E_0)}$$

[13] See 12 CFR 208.5.

Differentiating with respect to η yields:

$$\frac{\partial G_R}{\partial \eta} = \frac{(R(D+\bar{E}+\eta-d)-D)\mathrm{d}\Psi'(\bar{E}+\eta)(1-\Psi'(E_0^2))}{(1-\Psi'(E_0^2))^2}$$
$$+\frac{\mathrm{d}\Psi'(\bar{E}+\eta)\int_{E_0^2(\hat{s})}^{\bar{E}+\eta}(R(D+E_0-d)-D)\mathrm{d}\Psi'(E_0(\hat{s}))}{(1-\Psi'(E_0^2))^2}$$
$$+\frac{\mathrm{d}\Psi'(\bar{E}-\eta)\int_{E_0^0(\hat{s})}^{E_0^2(\hat{s})}(R(D+E_0)-D)\mathrm{d}\Psi'(E_0)}{(\Psi'(E_0^2))^2}$$

As $\eta \to 0$, $\frac{\partial G_R}{\partial \eta} > 0$, concluding the proof. □

Proposition 5

Proof. Define the following function:

$$\hat{G}_R(\Delta) = \frac{\int_{E_0^2(\hat{s}(\Delta))}^{\bar{E}+\Delta} E_1(E_0,d)d\Psi'(E_0)}{\int_{E_0^2(\hat{s}(\Delta))}^{\bar{E}+\Delta} d\Psi'(E_0)} - \frac{\int_{E_0^0(\hat{s}(\Delta))}^{E_0^2(\hat{s}(\Delta))} E_1(E_0,0)d\Psi'(E_0)}{\int_{\underline{E}+\Delta}^{E_0^2(\hat{s}(\Delta))} d\Psi'(E_0)}$$

where $E_1(E_0, \hat{d}) = \max\{0, R(D+E_0-\hat{d})-D\}$ is the future equity function and Δ represents a mean shift in the distribution of E_0 giving rise to new equilibrium values including $\hat{s}(\Delta)$. The definition of equilibrium requires that $G_R(\Delta) = s^*(\Delta)$. Therefore, for any $\hat{s}^*(\Delta)$ it is the case that, $\partial \hat{G}(0)/\partial\Delta = \partial\hat{s}^*/\partial\Delta$. Writing out the derivative yields:

$$\frac{\partial \hat{G}_R(0)}{\partial \Delta} = A + B\frac{\partial \hat{s}^*}{\partial \Delta} = \frac{\partial \hat{s}^*}{\partial \Delta}$$
$$\Rightarrow A = (1-B)\frac{\partial \hat{s}^*}{\partial \Delta}$$

where

$$A = \frac{d\Psi(\bar{E})\left((1-\Psi(E_0^2))E_1(\bar{E},d) - \int_{E_0^2}^{\bar{E}} E_1(E_0,d)d\Psi(E_0)\right)}{(1-\Psi(E_0^2))^2}$$
$$- \frac{d\Psi(\underline{E})\int_{E_0^0(\hat{s}(\Delta))}^{E_0^2} E_1(E_0,0)d\Psi(E_0)}{[\Psi(E_0^2)]^2}$$
$$B = \frac{\partial E_0^2}{\partial \hat{s}^*}\left[\frac{d\Psi(E_0^2)\left(\int_{E_0^2}^{\bar{E}} E_1(E_0,d)d\Psi(E_0) - E_1(E_0^2,d)(1-\Psi(E_0^2))\right)}{(1-\Psi(E_0^2))^2}\right.$$
$$\left.+\frac{d\Psi(E_0^2)\left(\int_{E_0^0(\hat{s}(\Delta))}^{E_0^2} E_1(E_0,0)d\Psi(E_0) - E_1(E_0^2,0)\Psi(E_0^2)\right)}{[\Psi(E_0^2)]^2}\right]$$
$$+\frac{\partial E_0^0}{\partial \hat{s}^*}\frac{E_1(E_0^0,0)\Psi(E_0^2)d\Psi(E_0^2)}{[\Psi(E_0^2)]^2}$$

Assumption 3 guarantees that $B < 1$. Consequently, $\frac{\partial \hat{s}^*}{\partial \Delta}$ has the same sign as A.

Further, note that the increasing property of R signs the numerator of the first term in the expression in A, while the second term is negative:

$$(1-\Psi(E_0^2))E_1(\bar{E},d) - \int_{E_0^2}^{\bar{E}} E_1(E_0,d)d\Psi(E_0) > 0$$

(i) Consider some distribution Ψ' and some $\underline{\nu}$ such that $\Psi(E_0^2(\hat{s}^*)) = \underline{\nu}$. As $\underline{\nu} \to 0$ and the mass of banks firms pay a dividend, the second term of A dominates and so, $A < 0$.

Consequently, $\frac{\partial \hat{s}^*}{\partial \Delta} < 0$.

(ii) Consider some distribution Ψ' and some $\underline{\nu}$ such that $\Psi(E_0^2(\hat{s}^*)) = \underline{\nu}$. As $\underline{\nu} \to 1$ and the mass of banks firms do not pay a dividend, the first term of A dominates and so, $A > 0$. Consequently, $\frac{\partial \hat{s}^*}{\partial \Delta} > 0$.

□

Proposition 7

Proof. For any $\hat{s}$, define A', B', C', D', and F' as the set of firms in the set of true negatives, false negatives, true positives, false positives, and firms that do not want to pay dividends in accordance with Figure 7 jointly defined by a pair $(E_0, \tilde{e})$. Let Υ be joint probability distribution over $(E_0, \tilde{e})$ induced by S, Ψ and define Υ_X be defined as the conditional distribution $\Upsilon(\cdot|(E_0, \tilde{e}) \in X')$.

Let the masses of these groups be defined as:

$$A = \int_{E_0^2}^{\bar{E}} \int_{\{\tilde{e}|\mathbb{E}(E_1) \geq \bar{e}\}} dS(\tilde{e}|E_0) d\Psi \tag{12}$$

$$B = \int_{\underline{E}}^{\bar{E}_0^2} \int_{\{\tilde{e}|\mathbb{E}(E_1) \geq \bar{e}\}} dS(\tilde{e}|E_0) d\Psi \tag{13}$$

$$C = \int_{E_0^2}^{\bar{E}} \int_{\{\tilde{e}|\mathbb{E}(E_1) < \bar{e}\}} dS(\tilde{e}|E_0) d\Psi \tag{14}$$

$$D = \int_{E_0^2}^{\bar{E}} \int_{\{\tilde{e}|\mathbb{E}(E_1) < \bar{e}\}} dS(\tilde{e}|E_0) d\Psi \tag{15}$$

$$F = \int_{E_0^1}^{E_0^2} d\Psi \tag{16}$$

Define $\mathbb{E}_{\tilde{d}}[X] \equiv \int_{X'} E_1(E_0, \tilde{d}) d\Upsilon_X$ be the conditional expectation of E_1 over set X' given dividend policy $\tilde{d}$. Notice that given the set of E_0 of integration and first order stochastic dominance of the signal implies that:

$$E_{\tilde{d}}[A] \geq E_{\tilde{d}}[D] \geq E_{\tilde{d}}[F] \geq E_{\tilde{d}}[B] \geq E_{\tilde{d}}[C] \tag{17}$$

Given this, rewrite G_{IR} and G_R as:

$$G_R = \frac{A\mathbb{E}_1[A] + D\mathbb{E}_1[D]}{A + D} - \frac{B\mathbb{E}_0[B] + C\mathbb{E}_0[C] + F\mathbb{E}_0[F]}{B + C + F} \tag{18}$$

$$G_{IR} = \frac{A\mathbb{E}_1[A] + B\mathbb{E}_1[B]}{A + B} - \frac{C\mathbb{E}_0[C] + D\mathbb{E}_0[D] + F\mathbb{E}_0[F]}{C + D + F} \tag{19}$$

Therefore, we can write:

$$\begin{aligned}
G_R - G_{IR} &= \frac{A\mathbb{E}_1[A](B - D)}{(A + B)(A + D)} + \frac{C\mathbb{E}_1[C](B - D)}{(B + C + F)(C + D + F)} + \frac{F\mathbb{E}_1[F](B - D)}{(B + C + F)(C + D + F)} \\
&+ \frac{D\mathbb{E}_1[D]}{A + D} - \frac{B\mathbb{E}_1[B]}{A + B} + \frac{D\mathbb{E}_1[D]}{C + D + F} - \frac{B\mathbb{E}_1[B]}{B + C + F} \\
&= \frac{A(B - D)(\mathbb{E}_1[A]) - A(B\mathbb{E}_1[B]) - D\mathbb{E}_1[D] + BD(\mathbb{E}_1[D] - \mathbb{E}_1[B])}{(A + B)(A + D)} && (20) \\
&+ \frac{BD(\mathbb{E}_0[D] - \mathbb{E}_0[B]) + CD(\mathbb{E}_0[D] - \mathbb{E}_0[C]) + DF(\mathbb{E}_0[D] - \mathbb{E}_0[F])}{(B + C + F)(C + D + F)} && (21) \\
&+ \frac{BC(\mathbb{E}_0[C] - \mathbb{E}_0[B]) + BF(\mathbb{E}_0[F] - \mathbb{E}_0[B])}{(B + C + F)(C + D + F)} && (22)
\end{aligned}$$

Notice that Terms 21 and Terms 22 are both greater than 0 by the inequalities of 17. Meanwhile, the numerator of Term 20 is strictly greater than

$$A(B - D)(\mathbb{E}_1[A] - \mathbb{E}_1[D]) + BD(\mathbb{E}_1[D] - \mathbb{E}_1[B]).$$

Therefore, $G_R - G_{IR} \geq 0$ whenever $B \geq D$. Furthermore, if $D > B$ then the mass of firms that pay a dividend is strictly greater under imperfect information than perfect information as these masses represent the false negatives and true negatives under an imperfectly informed regulator. □

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