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THE INFORMATION CONTENT OF DIVIDENDS: SAFER PROFITS, NOT HIGHER PROFITS

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ABSTRACT

Contrary to the central predictions of signaling models, changes in profits do not empirically follow changes in dividends, and firms with the least need to signal pay the bulk of dividends. We show both theoretically and empirically that dividends signal safer, rather than higher, future profits. Using the Campbell (1991) decomposition, we are able to estimate expected cash flows from data on stock returns. Consistent with our model's predictions, cash-flow volatility changes in the opposite direction from that of dividend changes, and larger changes in volatility come with larger announcement returns. We find similar results for share repurchases. Crucially, the data support the prediction---unique to our model---that the cost of the signal is foregone investment opportunities. We conclude that payout policy conveys information about future cash-flow volatility.

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I Introduction

Dividends represent one of the major financial decisions corporations make. Understanding both how capital markets evaluate dividends, and why firms pay dividends is central to theories of asset pricing, portfolio allocation, capital structure, capital budgeting, cost of capital, and to public economics, in particular regarding the effects of tax policy. Yet, despite extensive research, financial economists still do not fully understand why capital markets value dividends or how a given firm's payout policies are determined.[1] Even firms with very similar observable characteristics, such as age, earnings, and level of cash, display stark differences in terms of their dividend policies.

One credible and intuitive idea, dating back at least to Miller and Modigliani (1961), holds that dividend changes convey information about firms' future prospects. Miller and Rock (1985), Bhattacharya (1979), and others later formalize this idea, suggesting dividends signal future profits. According to this idea, therefore, dividend changes should be followed by earnings or cash-flow changes in the same direction. However, numerous empirical studies have failed to find evidence supporting this mechanism.[2] At a more fundamental level, to establish that signaling motives are a pervasively important influence on firms' payout decisions, one needs to show that firms with the greatest need to signal make the largest payouts, whereas firms with little need to signal pay few or no dividends (e.g., see DeAngelo et al. (2009)). Along these lines, extant models predict that younger and riskier firms should be more likely to signal with dividend payouts than mature firms, because they have more incentives to do so.[3] Yet empirical evidence suggests exactly the opposite: mature and less risky firms pay the bulk of dividends (e.g, Kahle and Stulz (2017)). In their review paper, DeAngelo et al. (2009) discuss the two pieces of evidence above and write, "We conclude that managerial signaling motives [...] have at best minor influence on payout policy" (p. 95).

[1]The empirical evidence shows that stock prices systematically increase at the announcement of dividend initiations or increases, and systematically decrease at the announcement of dividend omissions or decreases; see, e.g., Allen and Michaely (2003), DeAngelo et al. (2009), and references therein.

[2]See, among others, Watts (1973), DeAngelo, DeAngelo, and Skinner (1996), Benartzi, Michaely, and Thaler (1997) and Grullon, Michaely, and Swaminathan (2002).

[3]See, among others, Bhattacharya (1979, 1980), John and Williams (1985), Miller and Rock (1985), Kumar (1988), Bernheim (1991), and Guttman et al. (2010).

In this paper, we argue that signaling theory quite naturally explains firms' payout policies, subject to one crucial qualification: the firm's attribute that payout policy signals is the second moment of expected cash flows, not the first. Specifically, prior literature has examined whether dividend changes signal changes in the level of future cash flows. We show both theoretically and empirically that although dividend changes do signal, they signal future cash-flow volatility and not the level of future cash flows. If firms announce a dividend policy before current cash flows are realized, the lower their expected future cash-flow volatility, the better able they are to commit to a higher dividend. Signaling is costly because, with imperfect access to capital markets, paying dividends comes with foregone investment opportunities, and higher-risk firms discover that imitating safer firms is too costly.

Our main prediction is that cash-flow volatility should decrease following a dividend increase, and should increase following a dividend decrease. Furthermore, larger dividend payments should carry more information; specifically, both larger decreases in cash-flow volatility and larger cumulative abnormal returns should be observed around the announcement of larger dividend increases.

Our model yields an additional and more nuanced cross-sectional prediction that speaks directly to the economic channel underlying our results. In our model, as in Miller and Rock (1985), the cost of the signal is foregone investment opportunities. Consequently, following a dividend change, we expect a larger change in future cash-flow volatility for firms with *smaller* current earnings. The reason is that when the current earnings decrease, the foregone future investment opportunities at a given dividend level increase. As a result, the same dollar of dividend should carry a larger information content for a lower earnings level. In other words, in our framework, the firms in which signaling has the greatest impact are those with the lowest level of *current* profits, because the cost of the signal is foregone investment opportunities.

As a byproduct, our model also helps us understand the survey evidence showing that managers increase dividends when they believe the chance of future cuts is lower, for example, Lintner (1956) and Brav et al. (2005). If dividend increases signal safer profits going forward, then firms can afford to keep future dividend payments stable after a dividend increase. Furthermore, if stopping dividend payouts is not costless, the risk of incurring this cost is lower when earnings are more stable.

To test the model empirically, we need to estimate the volatility of cash flows, which presents two challenges. First, realized cash flows are non-stationary, implying that computing the standard deviation of realized earnings or cash flows will generate a biased estimate of cash-flow volatility. Second, we need a precise estimate of the volatility of cash flows, as opposed to, say, the volatility of assets or returns. To address these challenges, we borrow the method from asset pricing initially proposed by Campbell (1991) and Campbell and Shiller (1988a,b) to study aggregate market return predictability.[4] These studies argue that unexpectedly high returns follow positive news about higher future cash flows or news about lower future discount rates. Vuolteenaho (2002) extends this framework and applies it at the individual firm level. We follow Vuolteenaho (2002) to construct measures of cash-flow and discount-rate news and examine whether they vary around dividend events.[5]

To implement this method, we begin by identifying four "dividend events" at the firm level: dividend increases and decreases (the intensive margin), and dividend initiations and omissions (the extensive margin). For each of these events, we estimate two firm-level vector auto-regressions (VARs): one for the 60 months before the event and another for the 60 months after. These VARs identify cash-flow and discount-rate news separately; we subsequently test whether cash-flow and discount-rate news following the dividend event differ from those before the event.

We find the variance of cash-flow news is significantly lower after dividend increases and initiations, and the variance of cash-flow news is significantly higher after dividend decreases and omissions. Consistent with our theory, larger changes in dividends are associated with larger changes in cash-flow volatility in the expected direction, and announcements of larger changes in dividends are associated with larger cumulative abnormal returns in the same direction.

[4]Bernanke and Kuttner (2005) and Weber (2015) use the method to study the response of stock returns to monetary policy shocks.

[5]Other popular measures of volatility in asset pricing, such as stock-return volatility or the implied volatility from option prices, measure the volatility of returns, so the extent to which they capture the volatility of cash flows or discount rates is unclear (e.g., see Chay and Suh (2009)).

Importantly, the same dollar of dividend paid is followed by a larger reduction in cash-flow volatility for firms with smaller current earnings. This result is consistent with our theory, in which signaling has the greatest impact on firms with the lower *level* of current profits, because the cost of the signal is foregone investment opportunities. This result is, however, inconsistent with an agency theory of dividends in which dividends themselves constitute "good news" because they come with lower private benefits of control.

What about the first moment of expected cash flows? Using our method, we revisit the earlier evidence on changes in the first moment of earnings following changes in dividends, and we confirm the earlier findings: corporate earnings generally do not change in the same direction as dividend changes, which is inconsistent with the traditional dividend-signaling models. Furthermore, discount-rate news does not change following dividend changes. Hence, any change in firm-level riskiness following dividend events relates exclusively to cash-flow volatility. This result reinforces the advantages of our approach relative to traditional measures of risk including beta (e.g., Grullon et al. (2002); Hoberg and Prabhala (2009)). For example, our method can delineate the precise theoretical channel at play, whereas traditional measures fail to do so. Our results indicate the evidence in Grullon et al. (2002) of a decrease in systematic risk, that is beta, following dividend increases is exclusively driven by changes in the volatility of cash-flow news and not by changes in discount-rates news.

Finally, we examine share repurchases. Together with dividends, share repurchases constitute the firm's overall payout policy. Prior empirical literature has documented several differences between dividend and share-repurchase policies, most notably, the existence of substitution between them (e.g., Grullon and Michaely (2002)). In our framework, however, share repurchases are just another way to return cash to shareholders. As a result, we expect a pattern of changes in cash-flow volatility following share-repurchases announcements similar to that following announcements of dividend increases and initiations. Consistent with our hypothesis, we find a strong decline in cash-flow volatility following share-repurchase announcements and no changes in either the first moment of cash-flow news or discount-rate news. Also consistent with our hypothesis, we find larger share-repurchase programs associated with both larger reductions in cash-flow volatility and larger announcement returns. We conclude that announcements of changes to firms' payout policies, whether through dividends or share repurchases, convey information about future changes in firms' cash-flow volatility.

Our empirical approach presents four advantages relative to prior literature. First, by using a stock-return decomposition, we directly measure variables that investors care about and that capital markets price. By contrast, approaches based exclusively on accounting information may measure variables that are not value-relevant and may thus be prone to criticism. Second, by using stock returns rather than realized earnings or cash flows, we are employing a framework that is not subject to the non-stationarity bias that arises when estimating cash flows from accounting information.[6] Third, our approach also delivers a measure of the first moment of expected future cash flows, thereby allowing us to revisit prior empirical literature on the first moment of cash flows with a method whose parameters are market-based estimates. Fourth, the method also directly delivers a measure of expected discount rates, thereby allowing us to test whether dividend changes convey information about changes in the firm's discount rate.

Our results carry two implications. First, unlike prior literature, we are able to support the hypothesis that dividends signal firms' future prospects: crucially, the signal is about expected cash-flow volatility, that is, the second and not the first moment of future cash flows. Signaling models of dividends were popular in the 1980s, but they fell out of favor (e.g., DeAngelo et al. (2009)) because the data did not support the models' central predictions that (a) the first moment of earnings should change in the same direction of dividend changes, and (b) younger and riskier firms should be more likely to signal with dividends than mature firms. Our paper shows payout policy does convey information about cash-flow volatility in a manner consistent with signaling theory and inconsistent with a variety of alternative explanations. Second, whereas prior literature has documented dividends and share repurchases have different features, we document a key shared attribute: both signal future changes in expected cash-flow volatility. One criticism of dividend-signaling theories (e.g., Allen and Michaely (2003)) argues many

[6]A vast literature in accounting indicates earnings changes have both permanent and transitory components, which implies a non-stationary distribution (e.g., see Brooks and Buckmaster (1976), Collins and Kothari (1989), Easton and Zmijewski (1989) and Kormendi and Lipe (1987).

signaling models have been unable to account for the different features of dividend and share repurchases. We demonstrate, with respect to future changes in cash-flow volatility, dividends and share repurchases convey similar information to the market.

The method we employ to measure the moments of the distribution of expected cash flows and discount rates, combined with our findings regarding firms' conveying information about the second moment of future cash flows, suggests opportunities for future research exploring the motives of other corporate financial decisions using our approach. Our method may also be able to shed light on questions beyond finance. For example, a recent strand of economics literature has stressed ways in which aggregate uncertainty can affect firm investment dynamics (e.g., Bloom (2009), Bloom et al. (2007)). Researchers may now expand this line of reasoning to investigate the precise relevant source of firm-level uncertainty driving firms' investment policies.

II The Theoretical Framework

In this section, we develop our testable hypotheses. We begin by showing in Section II*A.* that a simple framework with symmetric information and a precautionary savings motive is sufficient to generate our main prediction that dividend payments should correlate negatively with subsequent changes in cash-flow volatility. This baseline framework, however, cannot account for the announcement return evidence we present. Therefore, in Section II*B.* we add asymmetric information about future cash-flow volatility. We solve the resulting signaling model in Section II*C.* and we develop our testable hypotheses in Section II*D.*

A. Basic Setting

Consider a manager running a firm on behalf of risk-neutral investors, which operates for three dates ($t = 0, 1, 2$) and two periods. At $t = 0$, the manager starts with cash reserves, ω_0, and invests, $I_0 \leq \omega_0$. At $t = 1$, the manager receives an endowment, ω_1, and decides whether to pay dividends, D_1. Next, cash flows are realized, $Y_1 = f(I_o) + \nu$, where f is a production function with $f' > 0$, $f'' < 0$, and $f''' > 0$; the shock ν is distributed according to function G, with expected value $\mathbb{E}(\nu)$ that we normalize to 0, and a known variance σ^2, with $\mid \nu \mid << Y$. We denote $\mathbb{E}[Y_1] = Y$.[7] After dividends are paid and cash flows are realized, the manager invests any remaining cash, $I_1 = \omega_1 + Y_1 - D_1 + (\omega_0 - I_0)$. At $t = 2$, the manager pays out the final cash flows, $Y_2 = f(I_1) + \nu$.[8] The interest rate equals zero. Thus, the timeline is as follows:

Time 0: Firm gets endowment ω_0; wlog invests $I_0 = \omega_0$;

Time 1: Firm gets endowment ω_1; firm decides how much dividend D_1 to pay; after D_1 is paid, $Y_1 = f(I_0) + \nu$ is realized; next, the firm invests $I_1 = \omega_1 + Y_1 - D_1$;

Time 2: $Y_2 = f(I_1) + \nu$ is realized; remaining cash is paid out; the world ends.

Throughout the analysis, we assume the existence of financial constraints. To illustrate our results in the starkest manner, we completely shut down the firm's access to financial markets, although our results only require that external financing not be perfectly costless. Similarly, we maintain that managers cannot perfectly hedge the risk of the firm's future cash flows.[9]

In this setting, the manager chooses the dividend payment to maximize

$$\begin{aligned}
&\max_{D_1} \quad D_1 + \mathbb{E}[Y_2] \\
&\text{subject to} \\
&Y_2 = f(I_1) + \nu \\
&D_1 \leq \omega_1,
\end{aligned}$$

which implies, assuming for illustration that the second constraint is slack, $D_1 < \omega_1$,

$$\max_{D_1} \quad D_1 + f\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right),$$

where $\mathbb{E}[Y_2] = \mathbb{E}[f(I_1) + \nu] = f\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right)$ and a is the certainty equivalent

[7] We rule out extreme negative realizations to avoid that at $t = 2$ the firm goes bankrupt.

[8] All values I_0, I_1, Y_1, Y_2, D_1 can be thought of as being *per share*, without loss of generality.

[9] With perfect financial risk management and hedging, a firm's earnings become fully informative about the firm's future prospects, thereby limiting any information content of dividend policy (see, e.g., DeMarzo and Duffie (1995)).

coefficient in the sense of Arrow-Pratt.[10] To understand this formulation, note that in our framework, randomness in Y reduces the expected profits if the function $f(.)$ is concave, in which case the firm is essentially risk averse with respect to fluctuations in Y, in the precise sense that $\mathbb{E}[f(Y)] < f(\mathbb{E}[Y])$, that is, Jensen's inequality.[11] The first-order condition is $1 - f'\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right) \geq 0$.

Prediction 1 (baseline). The following result is straightforward:

$$\frac{\partial \sigma^2}{\partial D_1} = -\frac{2}{a} < 0.$$

Larger dividends should be associated with subsequent lower cash-flow volatility. Because managers pay dividends before the cash flows are realized, managers take into account, in a certainty-equivalence sense, that paying higher dividends will increase the probability of foregoing future investment opportunities, as the (expected) volatility of cash flows grows higher.

This stylized model already delivers the main hypothesis of our paper; that is, dividend changes should be followed by changes in cash-flow volatility in the opposite direction. Of course, this model is too stylized along several dimensions. Most notably, it cannot account for the evidence that announcements of dividends result in positive announcement returns, because the information set of investors does not change after observing the dividend. More generally, several alternative ways exist through which dividend changes and changes in cash-flow volatility can be negatively correlated. For example, more mature firms may pay a higher dividend as well as experience lower cash-flow volatility going forward. Thus, in the next section, we address these issues and refine our understanding of the economic mechanism by adding asymmetric information about future cash-flow volatility to our basic setting. Our purpose is to account for the announcement returns evidence, as well as to generate additional empirical predictions,

[10] We assume in the main text that the Arrow-Pratt coefficient is scale-invariant, i.e., $a(I_1^*) \equiv a$, for clarity of illustration, which is the case, for example, for exponential production functions. We analyze the general case in the appendix.

[11] This insight exactly parallels the one in Froot, Scharfstein, and Stein (1993) about conditions under which risk management increases firm value. See also Rampini and Viswanathan (2013).

which we will then take to the data.[12]

B. A Signaling Model of Dividends

We introduce asymmetric information by assuming the manager learns σ^2 at $t = 1$ before paying dividends, whereas investors only observe D_1. As a result, at $t = 1$, asymmetric information exists concerning the variance of the firm's cash flows, σ^2, which is distributed according to function Ξ over $[\sigma^2_{\min}, \sigma^2_{\max}]$. Prior to $t = 1$, the investors and the manager have symmetric information on σ^2 with $\mathbb{E}[\sigma^2] = \sigma^2_p$, that is, the prior. Both the investors and the manager also know $\mathbb{E}[\nu] = 0$. Therefore, whereas the manager knows the true σ^2, investors attempt to infer σ^2 from the dividend policy.

For signaling to have scope, at least some investors need shorter horizons than others. Consistent with the signaling literature (e.g., Miller and Rock (1985)), we assume some investors are hit by an idiosyncratic liquidity shock at $t = 1$ and as a result must sell their shares. To be precise, we assume a fraction k of these investors sell after dividends D_1 are paid and before cash flows Y_1 are realized, whereas the remaining fraction $(1-k)$ will hold their shares until $t = 2$, at which time they will learn the realization of σ^2. Investors may trade shares continuously between $t = 0$ and $t = 2$. We can summarize the information set of the two groups of investors with respect to endowment, investment, random shock, and net dividends at the time of the announcement of D_1 as

$$\begin{aligned} \left\{\omega_0, \omega_1, I_0, D_1, \mathbb{E}(\nu) = 0, Var(\nu) = \sigma^2\right\} &= \phi^h \\ \{\omega_0, \omega_1, I_0, D_1, \mathbb{E}(\nu) = 0\} &= \phi^s, \end{aligned}$$

where ϕ^h is the information set of the investors who continue holding their shares, and ϕ^s is the information set of those who decide to sell. The perceived value of the firm at time

[12]In addition, our formulation with a constant Arrow-Pratt parameter a only delivers a time-series, "before-after," prediction, with no cross-sectional variation (e.g., in this basic setting, $\frac{\partial^2\sigma^2}{\partial D_1 \partial Y} = 0$). We show in the appendix that in the more general case, $a = a(I_1^*)$, the cross-sectional prediction is indeterminate, $\frac{\partial^2\sigma^2}{\partial D_1 \partial Y} \gtreqless 0$. We examine these predictions empirically in Section V.

1 by those who decide to sell is thus

$$\begin{aligned} V_1^s &= D_1 + \mathbb{E}\left[Y_2 \mid \phi^s\right] \\ &= D_1 + \mathbb{E}\left[f(I_1) + \nu \mid \phi^s\right] = D_1 + \mathbb{E}\left[f(I_1) \mid \phi^s\right] \\ &= D_1 + \mathbb{E}\left[f(\omega_1 + Y_1 - D_1) \mid \phi^s\right]). \end{aligned}$$

Similarly, the perceived value of the firm at time 1 by those who decide to hold is

$$\begin{aligned} V_1^h &= D_1 + \mathbb{E}\left[Y_2 \mid \phi^h\right] \\ &= D_1 + \mathbb{E}\left[f(\omega_1 + Y_1 - D_1) \mid \phi^h\right]. \end{aligned}$$

The manager acts in the interest of investors who own the firm at $t = 1$, and maximizes

$$\begin{aligned} \max_{\{D_1\}} \quad & W_1 = kV_1^s + (1-k)V_1^h \\ & \text{subject to} \\ & Y_2 = f\left(I_1\right) + \nu \\ & D_1 \leq \omega_1, \end{aligned}$$

where we assume ω_1 is sufficiently large and investors know the investment at time 1 will be $I_1 = \omega_1 + Y_1 - D_1$ after the realization of Y_1.

In the Appendix, we show the concavity of the production function guarantees the single-crossing property of signaling games is satisfied. More broadly, we show this problem satisfies the Riley (1979) conditions for games of incomplete information.

C. Solving the Model

Assume we can associate to each level of variance σ^2 a level of dividends D_1 that solves the optimization problem of the manager. We write this correspondence as $\sigma^2(D_1)$. If $\sigma^2(D_1)$ is single-valued and if the market is rational, we get the following condition,

$$V^s(D_1) = V^h(\sigma^2(D_1), D_1) = V^h(\sigma^2, D_1).$$

We then obtain

$$\begin{aligned} V^s(-\sigma^2(D_1), D_1) &= D_1 + f(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1)), \\ V^h(-\sigma^2, D_1) &= D_1 + f(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2). \end{aligned}$$

Valuation schedules that satisfy the conditions above and solve the maximization problem of the manager are termed "informationally consistent price functions" (Riley (1979)). To find the Pareto-dominant schedule, we start from the boundary condition that the worst firm that has the highest variance, that is, σ^2_{max}, will choose the same optimal dividend D_1 as it would in the full-information case, so that

$$\begin{aligned} 1 - f'(\omega_1 + Y - D_1^\star - \frac{a}{2}\sigma^2) &= 0 \\ \sigma^2(D_1{}^\star) &= \sigma^2_{max}. \end{aligned}$$

Because $V^s(D_1) = V^h(\sigma^2(D_1), D_1) = V^h(\sigma^2, D_1)$, the first-order condition is

$$kV^h_{-\sigma^2}(-\sigma^2(D_1), D_1)\frac{\partial(-\sigma^2)}{\partial D_1} + kV^h_d(-\sigma^2(D_1), D_1) + (1-k)V^h_d(-\sigma^2, D_1) = 0.$$

Given $\sigma^2(D_1) = \sigma^2$, the first-order condition is equivalent to the condition

$$kV^h_{-\sigma^2}(-\sigma^2(D_1), D_1)\frac{\partial(-\sigma^2)}{\partial D_1} + V^h_d(-\sigma^2, D_1) = 0;$$

that is,

$$1 - f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2) - \frac{ka}{2} \cdot f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1)) \cdot \frac{\partial \sigma^2(D_1)}{\partial D_1} = 0.$$

Then the ordinary differential equation (ODE) together with the boundary condition above uniquely determine the schedule. The worst firm type with the highest variance, σ^2_{max}, sets dividends $D_1^\star$ as in the first-best, full-information case. As variance decreases, firms pay more dividends and forego more investment opportunities. Therefore, relative to the first-best case with full information, the signaling equilibrium features excessive dividend payment and under-investment. Figure 1 illustrates the equilibrium.

We can establish the relevant solution informally by checking the second-order conditions for a maximum of the optimization problem of the manager

$$\frac{\partial}{\partial D_1}\left[kV^h_{-\sigma^2}(-\sigma^2(D_1),D_1)\frac{\partial(-\sigma^2)}{\partial D_1}+kV^h_d(-\sigma^2(D_1),D_1)+(1-k)V^h_d(-\sigma^2,D_1)\right]<0.$$

Substituting the first-order condition leads to a simple condition guaranteeing a maximum,

$$-V^h_{d\sigma^2}(\sigma^2,D_1)\frac{\partial\sigma^2}{\partial D_1}<0.$$

Because $V^h_{d\sigma^2}(\sigma^2,D_1)=\frac{a}{2}f''(\omega_1+Y-D_1-\frac{a}{2}\sigma^2)<0$, a maximum occurs if and only if $\frac{\partial\sigma^2}{\partial D_1}<0$. The relevant solution must lie on the right-hand side of the red line in Figure 1 where higher dividends are associated with a lower variance of cash flow. Thus, only dividends that exceed $D_1^\star$ are optimal. This solution is the Riley equilibrium outcome. In the Appendix, we show this equilibrium is the unique separating equilibrium of our game, by applying the results of Mailath (1987), and we show it is the unique equilibrium that survives standard refinement concepts for this class of games (Esö and Schummer (2009); see also Ramey (1996) and Cho and Sobel (1990)).

In this model, dividends are a signal to the market about the cash-flow volatility. Because managers care about short-term institutional investors, they would like to signal that their cash flows have low volatility and therefore higher value. For this signal to be credible, it must be costly. To prevent imitation and thus generate a separating equilibrium, the signal must be costlier for low types than for high types. This conclusion follows from the concavity of the production function, because riskier firms have more to lose in terms of foregone investment if they pay a larger dividend in an attempt to imitate safer firms.

D. Comparative Statics and Testable Implications

We now derive the main comparative statics, which will guide our empirical analysis in the next section. The first comparative static indicates dividend changes should be followed by changes in future cash-flow volatility in the opposite direction.

Prediction 1 (signaling). Changes in dividends should be followed by changes in future cash-flow volatility in the opposite direction; that is, $\frac{\partial \sigma^2(D_1)}{\partial D_1} < 0$.

As in the basic setting, paying higher dividends will increase the probability of needing to forego future investment opportunities, as the (expected) volatility of future cash flows increases. Asymmetric information amplifies this channel, because riskier firms will not be able to afford paying out higher dividends to imitate safer firms.

The second comparative static provides the more nuanced cross-sectional prediction of our model.

Prediction 2 (signaling). Following a dividend increase (re. decrease), a larger decrease (re. increase) occurs in cash-flow volatility for firms with smaller (re. larger) current earnings:

$$\frac{\partial^2 \sigma^2 (D_1)}{\partial D_1 \partial Y} = -\frac{2 f''(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1)}{k \cdot a \cdot \left[f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1) \right]^2} > 0.$$

Prediction 2 states the cross derivative of cash-flow volatility with respect to dividends and (current) earnings is positive. The intuition is that the smaller the earnings, the larger the foregone investment opportunities for a given level of dividend payment. Therefore, the same dividend should carry a larger information content for future changes in cash-flow volatility for firms with smaller earnings. This prediction depends crucially on asymmetric information about future cash-flow volatility and does not obtain in the basic setting with symmetric information of Section IIA.

Our next predictions relate to the effect of dividend announcements on firm value. In a fully separating equilibrium, investors perfectly learn the firm's type, σ^2, from the dividend announcement. Then, recalling that σ_p^2 indicates the prior belief about cash-flow volatility, we obtain by Taylor-series approximation the change in firm value upon the dividend announcement, ΔV, as follows:

$$\Delta V \approx D_1 - \mathbb{E}\left[D_1\right] - \frac{a}{2}(\sigma^2 - \sigma_p^2) f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2),$$

where $\mathbb{E}[D_1]$ indicates the prior expectation of dividends. As in the dividend-signaling literature, $\frac{\Delta V}{\Delta D_1} > 0$, thus reflecting the fact that larger dividend announcements represent news about better future prospects. In our framework and contrary to the extant literature, better future firm prospects refer not to the first but to the second moment of future cash flows. This line of reasoning leads us to an additional testable prediction.

Prediction 3. Denote with $\Delta\sigma^2 = \left(\sigma^2 - \sigma_p^2\right)$ the change in (expected) future cash-flow volatility. Also, denote with $\Delta D = D_1 - \mathbb{E}[D_1]$ the (unexpected) change in dividends. We then obtain

$$\frac{\Delta V}{\Delta\sigma^2} = -\frac{a}{2} f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2) < 0, \; \frac{\Delta V}{\Delta D} = 1 > 0;$$

that is, larger dividend announcement returns should be associated with larger dividend changes and larger subsequent reductions in cash-flow volatility.

Prediction 3 implies announcements of dividend changes should carry a larger information content (i.e., have a larger announcement return), as the expected reduction in future cash-flow volatility increases. Note also that Prediction 3 does not obtain in the basic setting of Section II*A*., because that setting was based on fully symmetric information.

Finally, in our framework, dividends and share repurchases are two equivalent ways to return cash to shareholders. As a result, Predictions 1 and 3 should also apply to share repurchases.[13]

III Method

To test our hypotheses on changes in cash-flow volatility following dividend changes, we require a measure of cash-flow volatility. We borrow a method from asset pricing to estimate the first and second moment of future cash flows and discount rates, and use it to test our hypotheses.

[13] Prediction 2, which is about percent changes in cash payouts, is not defined for dividend initiations or for share repurchases, because in those cases, the beginning-of-period level of cash returned to shareholders is zero.

To see the intuition underlying the method, consider a simple discounted cash-flow model, with expected future cash flows in the numerator and expected future discount rates in the denominator. In this framework, returns today can be unexpectedly high due to either positive news about current or future cash flows—the numerator—or due to negative discount-rate news—the denominator. This method allows us to (i) test our hypotheses on changes in expected cash-flow volatility (measured by the second moment of cash-flow news) following dividend changes, (ii) revisit the prior literature on earnings changes (measured by the first moment of cash-flow news) following dividend changes, and (iii) examine discount-rate changes (measured by discount-rate news) following dividend changes.

A large literature in economics and finance employs this method, initially developed by Campbell (1991), to decompose returns into news originating from cash flows and discount rates. Bernanke and Kuttner (2005) and Weber (2015) find cash-flow news is as important as discount-rates news for stock returns to monetary policy shocks following FOMC announcements. Vuolteenaho (2002) extends the VAR methodology to the individual firm level and finds cash-flow news is the main driver of stock returns at the firm level.[14]

The method provides an empirical counterpart to our theoretical predictions about *cash-flow* volatility. By contrast, other measures of volatility (e.g., implied volatility from option prices) do not allow a decomposition into components originating from cash flows or discount rates. Furthermore, the method is not subject to the bias arising from non-stationarity when estimating cash flows from accounting information.[15] In fact, because corporate earnings are not stationary, measuring cash-flow volatility using the realized variance of earnings might pick up such non-stationarity rather than any information content of dividends. A large literature in accounting has implicitly recognized the non-stationarity and has adopted a variety of adjustments for linear or non-linear trends

[14]Cash-flow news is almost uncorrelated across firms, which explains why discount-rate news is a main driver for stock returns of broad indices (see Campbell (1991) and Cochrane (1992, 2008)). van Binsbergen and Koijen (2010) combine a latent-variables approach with a present-value relationship and also find predictability for dividend-growth rates.

[15]We use the terms earnings and cash flows interchangeably for much of this paper. In robustness tests, we attempt to weed out the discretionary component of earnings to focus on cash flows, consistent with theoretical predictions.

in corporate earnings.[16] The observation that earnings are non-stationary is akin to the observation by Fama (1965) and others that stock prices are non-stationary, which prompted the field of asset pricing to focus on stock returns, that is, stock price changes, rather than levels of stock prices.

A. Stock-Return Decomposition

We decompose stock returns into estimates of cash-flow and discount-rate news before and after dividend announcements. Because this method has so far not been applied in a corporate finance context, we briefly review the basic ingredients and closely follow the original notation.

Vuolteenaho (2002) takes the dividend-discount model of Campbell and Shiller (1988a) for the aggregate market return as a starting point and applies it to the individual firm. He adapts the present-value formula to accounting data, because many individual firms do not pay dividends. Three main assumptions are necessary to achieve this goal. First, the clean surplus identity holds; that is, earnings (X) equal the change in the book-value of equity (ΔB_t) minus dividends (D). Second, the book value of equity, dividends, and the market value of equity (M) are strictly positive. Third, log book and market equity and log dividends and log book equity are cointegrated.[17]

These assumptions allow us to write the log book-to-market ratio, θ, as

$$\theta_{t-1} = k_{t-1} + \sum_{s=0}^{\infty} \rho^s r_{t+s} - \sum_{s=0}^{\infty} \rho^s (roe_{t+s} - f_{t+s}). \tag{1}$$

roe is log return on equity, which we define as $roe_t = \log(1 + X_t/B_{t-1})$, r_t denotes the excess log stock return, $r_t = \log(1 + R_t + F_t) - f_t$, R_t is the simple excess return, F_t is the interest rate, f_t is log of 1 plus the interest rate, k summarizes linearizion constants, which are not essential for the analysis, and ρ is a discount factor. The book-to-market ratio can be low, because market participants expect low future discount rates; that is, they discount a given stream of cash flows at a low rate (first component on the right-hand

[16] See, e.g., DeAngelo, DeAngelo, and Skinner (1996) and Grullon, Michaely, and Swaminathan (2002). However, no consensus exists on which adjustment is more appropriate (see, e.g., DeAngelo et al. (2009)).

[17] We use small letters to denote the log of a variable unless specified otherwise.

side of equation (1)), or because they expect high future cash flows (second component on the right-hand side of equation (1)).

We can follow Campbell (1991) to get return news from changes in expectations from $t-1$ to t and reorganizing equation (1):

$$r_t - \mathbb{E}_{t-1} r_t = \Delta \mathbb{E}_t \sum_{s=0}^{\infty} \rho^s (roe_{t+s} - f_{t+s}) - \Delta \mathbb{E}_t \sum_{s=1}^{\infty} \rho^s r_{t+s}. \tag{2}$$

$\Delta \mathbb{E}_t$ denotes the change in the expectations operator from $t-1$ to t, that is, $\mathbb{E}_t(\cdot) - \mathbb{E}_{t-1}(\cdot)$. Therefore, returns can be high, if we have news about higher current and future cash flows or lower future excess returns.

We then introduce notation and write unexpected returns as the difference in cash-flow news, $\eta_{cf,t}$, and discount-rate news, $\eta_{r,t}$:

$$r_t - \mathbb{E}_{t-1} r_t = \eta_{cf,t} - \eta_{r,t}. \tag{3}$$

B. Vector Autoregression

A VAR provides a simple time-series model to infer long-horizon properties of returns from a short-run model and to implement the return decomposition. Let $z_{i,t}$ be a vector at time t containing firm-specific state variables. We assume a first-order VAR describes the evolution of the state variables well.[18] We can then write the system as

$$z_{i,t} = \Gamma z_{i,t-1} + u_{i,t}. \tag{4}$$

Σ denotes the variance-covariance matrix of u_{t+1}, and we assume it is independent of the information set at time $t-1$.

We assume the state vector z contains firm returns as the first component, and we define the vector $\boldsymbol{e1'} = [1\ 0\ \ldots\ 0]$. We can now write unexpected stock returns as

$$r_{i,t} - \mathbb{E}_{t-1} r_{i,t} = \boldsymbol{e1'} u_{i,t}. \tag{5}$$

[18]The assumption of a first-order VAR is not restrictive, because we can add lags of the state variables and adjust the notation accordingly.

Discount-rate news is

$$\eta_{r,t} = \Delta\,\mathbb{E}_t \sum_{s=1}^{\infty} \rho^s r_{t+s}, \tag{6}$$

which we can now simply write as

$$\begin{aligned}\eta_{r,t} &= \boldsymbol{e1'} \sum_{s=1}^{\infty} \rho^s \Gamma^s u_{i,t+s} && (7)\\ &= \boldsymbol{e1'} \rho\Gamma(\mathbb{1} - \rho\Gamma)^{-1} u_{i,t} && (8)\\ &= \lambda' u_{i,t}, && (9)\end{aligned}$$

where $\mathbb{1}$ is an identity matrix of suitable dimension and the last line defines notation.

We can now write cash-flow news as

$$\eta_{cf,t} = (\boldsymbol{e1'} + \lambda')u_{i,t}, \tag{10}$$

and the variance of cash-flows as

$$\mathrm{var}(\eta_{cf,t}) = (\boldsymbol{e1'} + \lambda')\Sigma(\boldsymbol{e1} + \lambda). \tag{11}$$

Armed with the above equations, we now turn to our data on the intensive margin (increases and decreases) and extensive margin (initiations and omissions) of dividends and share repurchases.

IV Data

We use balance-sheet data from the quarterly Compustat file and stock-return data from the monthly CRSP file. We follow Grullon, Michaely, and Swaminathan (2002) and Michaely, Thaler, and Womack (1995) in defining quarterly dividend changes and dividend omissions and initiations and Vuolteenaho (2002) in the sample and variable construction of the state variables of the VAR we defined in Section III. We detail both below. The sample period is 1964-2013.

A. Cash-Flow and Return News: Sample Screens

We follow Vuolteenaho (2002) and impose the following data screens. A firm must have quarter $t-1$, $t-2$, and $t-3$ book equity and $t-1$ and $t-2$ net income and long-term debt data. Market equity must be available for quarters $t-1$, $t-2$, and $t-3$. A valid trade exists during the month immediately preceding quarter t returns. A firm has at least one monthly return observation during each of the preceding five years. We exclude firms with quarter $t-1$ market equity less than USD 10 million and book-to-market ratio of more than 100 or less than 1/100.

B. Cash-Flow and Return News: Variable Definitions

The simple stock return is the 3-month cumulative monthly return, recorded from m to $m+2$ for $m \in \{Feb, May, Aug, Nov\}$. We follow Shumway (1997) and assume a delisting return of -30% if a firm is delisted for cause and has a missing delisting return. Market equity is the total market equity at the firm level from CRSP at the end of each quarter. If quarter t market equity is missing, we compound the lagged market equity with returns without dividends.

Book equity is shareholders' equity, plus balance-sheet deferred taxes and investment tax credit (item TXDITCQ) if available, minus the book value of preferred stock. Depending on availability, we use stockholders' equity (item SEQQ), or common equity (item CEQQ) plus the carrying value of preferred stock (item PSTKQ), or total assets (item ATQ) minus total liabilities (item LTQ) in that order as shareholders' equity. We use redemption value (item PSTKRQ) if available, or carrying value for the book value of preferred stock. If book equity is unavailable, we proxy it by the last period's book equity plus earnings, less dividends. If neither earnings nor book equity are available, we assume the book-to-market ratio has not changed, and compute the book-equity proxy from the last period's book-to-market ratio and this period's market equity. We set negative or zero book-equity values to missing.

GAAP (US Generally Accepted Accounting Principles) ROE is the earnings over the last period's book equity. We use earnings available for common equity, in the ROE formula. When earnings are missing, we use the clean-surplus formula to compute a proxy for earnings. In either case, we do not allow the firm to lose more than its book equity. Hence, the minimum GAAP ROE is truncated to −100%. We calculate leverage as book equity over the sum of book equity and book debt. Book debt is the sum of debt in current liabilities, total long-term debt, and preferred stock.

Each quarter, we log transform market equity, stock returns, and return on equity and cross-sectionally demean it. A log transformation may cause problems if returns are close to −1 or if book-to-market ratios are close to zero or infinity. We mitigate these concerns by redefining a firm as a portfolio of 90% common stock and 10% Treasury bills, using market values. Every period, the portfolio is rebalanced to these weights.

C. Dividend Changes

We use the CRSP daily file to identify dividend changes and follow Grullon, Michaely, and Swaminathan (2002) in the sample screens and to construct quarterly dividend changes. We use all dividend changes for common stocks of U.S. firms listed on NYSE, Amex, and Nasdaq that satisfy the following criteria. The distribution is a quarterly taxable cash dividend, and the previous cash-dividend payment was within a window of 20–90 trading days prior to the current dividend announcement. We focus on dividend changes between 12.5% and 500%. The lower bound ensures we include only economically meaningful dividend changes, and the upper bound eliminates outliers. We also ensure no other non-dividend distribution events, such as stock splits, stock dividends, mergers, and so on, occur within 15 trading days surrounding the dividend announcement. We end up with 2,441 dividend increases and 2,461 dividend decreases over 1964–2013.

D. Initiations and Omissions

We follow Michaely, Thaler, and Womack (1995) to construct our dividend initiation and omission sample. We require the following criteria for initiations to be in our sample. We focus on common stocks of U.S. companies that have been traded on the NYSE or AMEX for two years prior to the initiation of the first cash dividend. This screen eliminates new listings of firms that had previously traded on NASDAQ or on another exchange and switched the exchange with the pre-announced intention of paying dividends in the near future. We end up with 1,069 dividend initiations over 1964–2013.

For omissions, the sample must meet one of the following three criteria: (i) the company declared at least six consecutive quarterly cash payments and then paid no cash payment in a calendar quarter; (ii) the company declared at least three consecutive semi-annual cash payments and then paid no cash payments in the next six months; (iii) the company declared at least two consecutive annual cash payments and then paid no cash payments in the next year. We first identify potential omission quarters using the three conditions. We then use the Wall Street Journal (WSJ) Index to extract all information about dividend omissions. We enrich the WSJ Index data with searches on Factiva and ProQuest for any additional information regarding dividend omissions. We end up with 1,233 dividend omissions over 1964–2013.

E. Share Repurchases

We use Thomson ONE to construct our share-repurchase sample. We use all repurchases of common stock announced between 1980 and 2013 for which we can determine the amount announced. Our procedure follows Jagannathan, Stephens, and Weisbach (2000), but they also study repurchases of preferred stock, which is not relevant for our purpose of studying payout policy to common stockholders, and Grullon and Michaely (2002), who use the Compustat definition of share repurchases and report a correlation of 0.97 between the Compustat and the SDC measures of share repurchases.

We end up with 2,662 share-repurchases announcements over 1964–2013. Table 1 reports descriptive statistics for our sample. Despite imposing both the dividend sample screens above and the VAR restrictions of Section III, our sample sizes are comparable to those in prior studies on dividend changes (e.g., see Grullon et al. (2002)), dividend initiations and omissions (e.g., Michaely et al. (1995)), and share repurchases (e.g., Grullon and Michaely (2004)). Relaxing these restrictions does not affect our results on dividend changes, dividend initiations and omissions, and share repurchases (see Table 4).

We ensure across specifications that we have non-overlapping data for the two VARs before and after dividend events and share repurchases; that is, two events at the firm level are at least 10 years apart.

V Results

In this section, we report our empirical results. In Section V*A*., we report the estimates of the VAR and the VAR-implied importance of cash-flow news and return news for our sample of firms. In Section V*B*., we report our univariate tests of Prediction 1. In Section V*C*., we present cross-sectional tests of the more nuanced predictions of our mechanism, including Prediction 2. In Section V*D*., we examine cumulative abnormal returns to the announcements of dividend events and we present tests of our Prediction 3. In Section V*E*., we examine share repurchases.

A. Estimates of the VAR System

Following our discussion in Section III, a central ingredient for our analysis is an estimate of the transition matrix Γ of the VAR system and the discount factor ρ. We estimate ρ as the regression coefficient of the excess log ROE minus the excess log stock return, plus the lagged book-to-market ratio on the book-to-market ratio. We find an estimate of 0.986, which is almost identical to the estimate of Vuolteenaho (2002).

Table 2 reports point estimates of a constant VAR across firms and time with t-stats in parentheses. Consistent with findings in the literature, we find returns are positively autocorrelated, load positively on the log book-to-market ratio, and log profitability. The quarterly book-to-market ratio is highly autocorrelated and loads positively on lagged returns, and negatively on lagged profitability. Profitability is autocorrelated at the quarterly frequency, and loads positively on lagged returns and negatively on the lagged book-to-market ratio. The dynamics of our state variables are broadly consistent with findings in the literature, particularly Vuolteenaho (2002).

B. Dividend Events and Cash-Flow Variance

We estimate a VAR before and after each dividend event-quarter using all available firm observations with non-missing balance-sheet data but requiring at least five years of data. We then use equation (11) to calculate the cash-flow variance and compare the variability of cash flows after dividend events relative to before. According to our Prediction 1 in Section II, we expect announcements of dividend increases and dividend initiations to result in lower cash-flow volatility after the announcement (relative to before) and announcements of dividend cuts and dividend omissions to higher cash-flow volatilities after the announcement. To ensure overlapping dividend events do not drive our results, we randomly drop one of the two events.[19]

Table 3 reports changes in cash-flow news and discount-rate news after dividend events relative to before separately for dividend increases, decreases, initiations, and omissions. We estimate for each dividend event two VARs before and after the quarter of the event using all firm observations with non-missing data. We then create cash-flow and discount-rate news at the firm level using 60 months of data before and after the dividend event, winsorize the data at the 1% and 99% level, and report the average changes for a given firm across events in the table.

Using our novel method, we first revisit results reported in earlier literature and examine changes in the first moment following dividend changes. In Panel A, we find positive dividend changes, dividend initiations, negative dividend changes or dividend omissions or pooling across events do not result in a statistically significant change in cash-flow news after the event relative to before the event. These findings are consistent with the earlier literature, which does not detect any predictive power of dividend events for the first moment of future realized earnings.

In Panel B, we also find dividend events are not followed by changes in discount-rates news. These results indicate market expectations of lower future discount rates are unlikely to drive the positive announcement returns to increases in dividends or dividend initiations.

We then turn to testing our main hypothesis. Consistent with our hypothesis, we

[19] Results are robust to which event we drop and to not dropping any event.

find in Panel C dividend increases are followed by a decrease in the variance of cash-flow news in the five years after the event relative to the variance of cash-flow news in the five years before. Similarly, for dividend decreases, we see an increase in the variability of cash-flow news after the event relative to before. Changes in dividends are followed by changes in cash-flow volatility in the opposite direction, consistent with Prediction 1 in Section II.

The numbers in Panel C are difficult to interpret. We therefore scale the changes in cash-flow news variance around the dividend events by the average variance in cash-flow-news before the event in Panel D. We see the variance of cash-flow news drops by on average 15% of the average variance before the event after announcements of dividend increases (see column (1)) but increases by more than 7% after dividend cuts (see column (4)). Dividend initiations result in a variance of cash-flow news which is on average 20% lower than the average variance before the dividend event. Dividend omissions lead to an increase in the cash-flow variance of 6%, which is highly statistically significant (see columns (2) and (5)).

Vuolteenaho (2002) argues large amounts of data are necessary to get precise estimates of the transition matrix Γ of the VAR. So far, we have used separate estimates for the transition matrix to get residuals for the five years before and after each dividend event. In Table 4, we impose more stringent restrictions on Γ, thus trading off efficiency with precision. At the same time, we have used a limited sample, because we jointly impose the same restrictions as Vuolteenaho (2002), Grullon et al. (2002), and Michaely et al. (1995). To increase our sample sizes, we now also report results for a specification in which we do not impose some of the restrictions of the initial papers we follow.

Table 4 directly reports the change in the variance of cash-flow news after the dividend event relative to before as a fraction of the average variance before the event. In Panel A, we estimate one VAR for the whole sample period and then use the estimate for Γ to calculate both residuals in the five years before and after the dividend event and the cash-flow news.[20] In Panel B, we combine the previous two approaches and estimate one VAR across all firms and events to get an estimate of Γ, but then estimate separate VARs

[20]Recall cash-flow news is a function of the transition matrix Γ of the VAR, because it is a transformation of the residuals from the VAR.

before and after each dividend events to get the VAR residuals. Panel C requires only 12 non-missing quarters within five years before and after the dividend event. We do not restrict our sample to non-overlapping event windows within firms, and if no return data are available, we substitute zeros for both returns and dividends.

All three panels confirm our baseline results. Announcements of dividend increases or initiations result in lower cash-flow volatility after the announcement relative to before, whereas announcements of dividend cuts or omissions result in an increased cash-flow volatility.

The possibility of structural breaks during our sample period may raise the concern that our results are concentrated in the earlier part of the sample. For example, return predictability decreased in the 1990s (see Lettau and Van Nieuwerburgh (2007)). Clean surplus accounting might also be more likely to break in the same period, and many firms stopped paying dividends (Fama and French (2001)) or started more intensively substituting dividends for repurchases (Grullon and Michaely (2002)). Panel A and B of Table 5 split our sample in half (1964–1988 and 1989–2013) and repeat our baseline analysis for both subsamples separately.[21]

We see in Panel A that results for the early part of our sample are similar to our baseline results: dividend increases and initiations result in lower future cash-flow volatility, whereas dividend cuts and omissions are associated with increases in cash-flow volatility. More importantly, we also find very similar results in Panel B despite the various potential structural changes, including a significant change in dividend taxation in the middle of the second period (in 2003). To directly test whether the change in taxation can partially explain our findings, we also report in Panel C results for a sub-sample beginning in 2003. We find similar results to our baseline findings. The sub-sample test we perform here also allows us to draw some insight on the role of differential taxation in dividend signaling. We discuss this issue in Section VI*B.*

One concern with our findings so far is that dividend events might coincide with market-wide breakpoints in cash-flow volatility, so that we might merely capture an overall market-wide phenomenon for mature firms with similar observable characteristics, and

[21] We estimate a constant Γ matrix within each sample to ensure we have enough data points for reliable estimates.

unrelated to dividend changes.

Table 6 considers this alternative explanation. We report the scaled change in the volatility of cash-flow news for our event firms relative to the scaled change in the volatility of cash-flow news of observationally similar firms that do not have dividend events. Specifically, we use a nearest-neighbor algorithm to match firms based on propensity scores. We estimate propensity scores with a logit regression of the treatment indicator on the book-to-market ratio, leverage, age, and size (the same variables we use in our regression analysis of Table 7 below).[22] We see in Table 6 that this alternative story cannot explain our findings. Firms that increase their dividends see a large drop of 15% in the variance of their cash-flow news after the announcement relative to before and relative to observationally similar firms that do not have a dividend event. The drop in variance is similar in magnitude to our baseline specification. For decreases in dividends, instead, we see an increase in the variance of cash-flow news following the cut relative to before and to matched firms. Results for dividend initiations and omissions are consistent with our baseline analysis.

Our results indicate dividend changes are followed by changes in cash-flow volatility in the opposite direction. This result is novel, consistent with Prediction 1 of our model. Furthermore, our results indicate that following dividend changes the cash-flow levels are unchanged. These results are inconsistent with prior dividend-signaling models, but consistent with earlier empirical literature that used accounting-based measures of cash-flow volatility. Finally, our results indicate that following dividend changes, the firm's discount-rate news is unchanged. This result is also novel and clarifies the earlier evidence of Grullon et al. (2002) and Hoberg and Prabhala (2009) that beta and other measures of firm risk are lower following dividend payments. Our results clarify that only cash-flow volatility changes, and discount rates do not. Therefore, our evidence is consistent with our model with precautionary savings and also potentially consistent with our signaling framework, and is inconsistent with a host of other discount-rate-based explanations. Of course, so far, we have only conducted a time-series, before-after analysis; to analyze more thoroughly the theoretical channels at play, we now move to cross-sectional analysis.

[22]We lose few observations relative to our baseline analysis due to missing matches.

C. Cross-Sectional Variation

To examine the theoretical mechanism underlying our findings, we turn to a regression framework to examine cross-sectional variation in the response of cash-flow volatility to dividend changes. Specifically, for each dividend change in our sample, we now estimate a regression of percent changes in cash-flow volatility, $\Delta\,\mathbb{Var}(\eta\_cf_{it})$, for firm i and dividend event t, which we measure from stock returns using the methodology in Section III, on the percent changes in dollar dividends, ΔD_{it}

$$\Delta\,\mathbb{Var}(\eta\_cf_{it}) = \alpha + \gamma \cdot \Delta D_{it} + \delta \cdot X_{it} + \varepsilon_{it}. \tag{12}$$

We control for a host of additional potential determinants of cash-flow volatility and dividend payments, X_i, such as firm age, size, book-to-market, and financial leverage, as well as year and industry fixed effects at the Fama and French 17-industry level, and cluster standard errors at the dividend-quarter level. We impose non-overlapping events so we can consider equation (12) as a purely cross-sectional test. We expect $\gamma < 0$ following Prediction 1.

To test the cross-sectional predictions of our signaling model, we then estimate the following specification

$$\Delta\,\mathbb{Var}(\eta\_cf_{it}) = \alpha + \beta_1 \cdot \Delta D_{it} + \beta_2 \cdot eps_{it} + \beta_3 \cdot \Delta D_{it} \cdot eps_{it} + \delta \cdot X_{it} + \varepsilon_{it}, \tag{13}$$

where eps is earnings per share. Our main coefficient of interest is β_3. From our signaling model of Section II*B*., we should expect $\beta_3 > 0$. According to the baseline setting of Section II*A*. with constant Arrow-Pratt coefficient and symmetric information, we should expect $\beta_3 = 0$. We should also expect $\beta_1 < 0$ as per our baseline Prediction 1, and also $\beta_2 < 0$, reflecting a scale effect. Therefore, by estimating equation (13), we can tease out the nuanced cross-sectional predictions of our signaling model and distinguish it from other explanations that might drive our baseline univariate results.

Table 7 reports our estimates. Column (1) confirms our baseline finding in a regression framework: dividend changes correlate with a subsequent change in the variance of cash-flow news in the opposite direction. The interpretation is that firms change their dividend payout in anticipation of future changes in cash-flow volatility. In column (2), we add earnings per share (*eps*) as an additional covariate. Adding *eps* slightly increases the drop in variance following dividend increases. Firms with higher *eps* have a smaller variance in cash-flow news. Column (3) confirms our novel Prediction 2, consistent with our signaling model, and inconsistent with the baseline setting: dividend increases result in a drop in the variance of cash-flow news, but this drop is muted for firms with higher *eps*. Column (4) adds a host of potential determinants of cash-flow volatility and dividend payments such as firm age, size, book-to-market, and financial leverage. None of these additional covariates has a large impact on our main estimates of interest. Positive dividend changes are followed by a decline in cash-flow volatility, which is muted for firms with higher earnings per share. Columns (5) to (8) add year and industry fixed effects at the Fama and French 17-industry-level definition and confirm our basic findings.

We show in the Online Appendix that results are robust when we add the initial variance of cash-flow news (see Table A.1), when we add the level of cash and equivalents as control variable (see Table A.2) and when we use cash flows rather than earnings (see Table A.3). Therefore, the data strongly support Prediction 2 from our signaling model in that the cross-sectional change in cash-flow volatility following dividend changes is muted for firms with larger earnings.

D. Returns around Dividend Events

So far, we have shown dividends changes are associated with a reduction in future cash-flow volatility. Consistent with our Prediction 2, the larger the extent of the reduction, the smaller the current level of earnings. We now turn to a test of our Prediction 3. Crucially, in our separating signaling equilibrium, investors (i) update their expectations about future cash-flow volatility upon observing the dividend announcement, and (ii) are correct on average. Accordingly, Prediction 3 states announcements of larger dividends should come with both larger cumulative announcement returns and larger subsequent changes in cash-flow volatility in the opposite direction.

To this end, we study how the immediate market reaction to dividend changes is related to the subsequent change in cash-flow volatility and to the size of the dividend change itself. We first confirm in Table A.4 in the Appendix that in our sample, dividends do represent good news for investors, consistent with previous findings.[23]

We then turn to a direct test of our Prediction 3. We split the data into two subsamples by the size of the dividend changes, using the median dividend change as the break point. Table 8 reports the results. In Panel A of Table 8, we see in column (1) that for large increases in dividends, the variance of cash-flow news drops by more than 19% on average after the announcement. The drop in variance is 8% smaller in column (2) when we instead study increases in dividends that are below the median increase. Column (3) shows the difference is highly statistically significant. We bootstrap the difference to calculate standard errors. Columns (4) and (5) instead show that announcements of large dividend cuts drive the increase in cash-flow-news variance. The difference is again highly statistically significant (see column (6)).

In Panel B of Table 8, we find in columns (1) to (3) announcement returns for above-median dividend increases are significantly larger than announcement returns for below-median dividend increases; and we find in columns (4) to (6) that announcement returns for above-median dividend decreases are significantly larger in absolute terms (i.e., they are more negative) than announcement returns for below-median dividend decreases. Together with our earlier results in Panel A, these results indicate larger changes in dividends carry more information, because they are associated with larger announcement returns and larger subsequent changes in cash-flow volatility in the opposite direction, consistent with Prediction 3 from our signaling model.

Finally, we examine a premise of our framework, namely, that external financing and hedging are not costless. Extending this line of reasoning, one would expect our results to be stronger for firms that are more financially constrained. To examine this premise empirically, we use the financial-constraints proxy of Kaplan and Zingales (1997), the KZ index, and we split the sample by the median KZ index. Consistent with our

[23] Table A.4 reports the univariate market response to dividend changes in a three-day window bracketing the dividend event. Columns (1) to (3) show positive announcement returns for dividend increases, dividend initiations, and the pooled sample ranging between 0.7% and 2.37%. For cuts in dividends, columns (4) to (6) show a negative announcement return of 0.7% and a negative return of 8.7% for omissions. All results are almost identical when we look at market-adjusted returns.

premise, we find that following dividend changes, the change in cash-flow volatility (in the opposite direction) and the abnormal returns are larger for firms that are more financially constrained. We report these results in the Online Appendix, Table A.5.

E. Repurchases

We now examine announcements of share repurchases. Together with dividends, share-repurchase decisions constitute the firm's overall payout policy. Unlike dividends, which are sticky and regular, share repurchases tend to be lumpy and infrequent. However, because share repurchases are yet another way to return cash to shareholders, our framework in Section II predicts patterns of cash-flow volatility following announcements of share repurchases similar to the results following announcements of dividend increases and initiation.

Table 9 reports the results for scaled changes in the variance of cash-flow news after the repurchase announcement relative to before. We find the variance of cash-flow news is on average 15% lower after the repurchase announcement relative to before. We then split the data into two sub-samples by the size of the share-repurchase announcement, using the median amount as cutoff. Consistent with our results for changes in dividends and with the predictions of our model, we see in columns (2) and (3) of Panel A large repurchase announcements are followed by a drop in cash-flow volatility that is more than 6% larger than the drop in variance for repurchase announcements below the median.

We then examine announcement returns to share repurchases in Panel B of Table 9. Consistent with prior literature, we find an announcement return of about 2% for all repurchase announcements. We see in columns (2) to (4) that announcement returns are almost 1.5% larger for large repurchase announcements relative to small ones.

These findings imply share-repurchase announcements convey information similar to announcements of dividend increases and initiations. Prior research (e.g., Jagannathan et al. (2000), Grullon and Michaely (2002)) emphasized differences in the timing and scope of dividends and share repurchases. Our novel result is that share repurchases and dividend announcements convey very similar information to the market regarding changes in future cash-flow volatility.

VI Alternative Explanations and Further Tests

In this section, we discuss alternative explanations for our results. Section VI*A.* examines agency-based explanations, and Section VI*B.* examines tax-based explanations.

A. Agency

An alternative explanation of dividend policy is that dividends can help address managerial agency problems. The fact that cash is paid out to investors as dividends, rather than being wasted in managerial private benefits, represents good news for investors. In addition, paying dividends may expose companies to the possible need to raise external funds in the future, which may further shift control to outside investors and reduce agency problems (e.g., Easterbrook (1984); see also Fluck (1999), Myers (2000), and Lambrecht and Myers (2012) for additional examinations of these ideas).

To nest some of these ideas into the same baseline model of Section II*A.*, we assume the manager bears some private agency costs $c(D_1)$ from paying a dividend D_1, where the function c is convex, that is, $c' > 0$ and $c'' > 0$.[24] In this setting, the manager chooses the dividend payment to maximize

$$\begin{aligned}
&\max_{D_1} D_1 + \mathbb{E}\left[Y_2\right] - c\left(D_1\right), \\
&\text{subject to} \\
&Y_2 = f\left(I_1\right) + \nu \\
&D_1 \leq \omega_1.
\end{aligned}$$

The first-order condition is $1 - f'\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right) - c'\left(D_1\right) \geq 0$.

Therefore, we obtain

Prediction 1 (agency).

$$\frac{\partial \sigma^2}{\partial D_1} = -\frac{2}{a} + \frac{2 \cdot c''\left(D_1\right)}{a\left[f''\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right)\right]} < 0.$$

[24] This formulation is quite standard in corporate finance, and is akin to assuming the existence of (concave) private benefits of control, which increase in a concave manner with the cash flows that are not distributed to the shareholders, $Y - D$.

As in the baseline setting and in the signaling model, higher dividends should correlate with lower future cash-flow volatility. Two effects are at play. First, as in the baseline setting, lower future cash-flow volatility implies a higher income available for paying dividends, holding investment opportunities fixed. Second, lower future cash-flow volatility enables managers to more easily extract private benefits (re. incur lower agency costs) and pay more dividends, again holding investment fixed.

Now, however, the *larger* the current earnings, the larger the reduction in cash-flow volatility should be following the same dollar of dividend paid

Prediction 2 (agency).

$$\frac{\partial^2 \sigma^2}{\partial D_1 \partial Y} = -\frac{2 \cdot c''(D_1) \cdot f'''\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right)}{a\left[f''\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right)\right]^2} < 0.$$

Unlike Prediction 2 from the signaling model, in this case, larger current earnings make extracting more private benefits (re. incur lower agency costs) easier, for a given dollar of dividends. The reason is larger earnings allow the manager not only to pay dividends, but also to extract private benefits, holding fixed future investment. Therefore, by examining how the changes in volatility following dividend changes vary in the cross section as a function of the level of earnings, that is, by estimating equation (13), we can shed light on the economic mechanism driving our results and distinguish between a signaling and an agency theory.

In other words, our theoretical framework provides a cross-sectional test in which the predictions of signaling and agency theory move in the opposite directions.[25]

Indeed, the empirical results in Table 7, namely that the same dollar of dividend is followed by a larger reduction in cash-flow volatility for firms with smaller (and not larger) earnings, is inconsistent with agency motives.

Beyond our specific framework in which investment opportunities are held fixed, other applications of agency theory predict dividends should imply reduced agency problems, especially when investment opportunities are low (see, e.g., Jensen (1986), DeAngelo

[25] Bernheim and Wantz (1995) proposed a test to distinguish between signaling and agency theories of dividends, although the conclusions of such tests are sensitive to the econometric techniques employed (see Bernhardt et al. (2005)).

et al. (2009), and Grullon et al. (2002)). To test this prediction, we employ two proxies for investment opportunities, namely, the book-to-market ratio and idiosyncratic volatility. The book-to-market ratio is a standard proxy for investment opportunities, and has a strong industry component (e.g., see Cohen and Polk (1995) and Daniel et al. (1997)). Idiosyncratic volatility also picks up within-industry variation. According to these applications of agency theory, we would expect that the larger the book-to-market ratio and the smaller the idiosyncratic volatility, the larger the reduction in cash-flow volatility following dividend changes.

In Table 10, we split firms by their ex-ante idiosyncratic volatility. Specifically, we first calculate a firm's ex-ante idiosyncratic volatility on a four-quarter rolling basis relative to a Fama and French three-factor model using daily data. We then assign a firm into the large idiosyncratic volatility sample if it had a volatility above the 30th percentile of firm volatility in the respective Fama and French 17 industry in the quarter before the dividend event. Large heterogeneity exists in firms' idiosyncratic volatility, and our procedure ensures we do not simply split our sample based on industry.

We find in columns (1) and (2) of Panel A of Table 10 that dividend increases for firms with large idiosyncratic volatility result in a decrease in the average cash-flow volatility of 17%, which is almost 5% larger than the drop for firms with low idiosyncratic volatility. The bootstrapped difference between the changes in cash-flow volatility within high- and low-volatility firms is highly statistically significant. We also find that firms with large ex-ante volatility largely drive the increase in cash-flow volatility after announced cuts in dividends, with the difference being statistically significant (see columns (4) to (6)).[26] In addition, we repeat the sample splits for announcement returns. Panel B of Table 10 reports announcement returns, separately for firms with high and low idiosyncratic volatility. We find larger announcement returns in absolute value for firms with higher idiosyncratic volatility, and the difference is highly statistically significant.[27] These results are inconsistent with the predictions of agency theory. If anything, our results are more consistent with the predictions of signaling, because firms with larger ex-ante idiosyncratic

[26]Results for sample splits based on total volatility are similar; see Table A.6 in the Online Appendix.

[27]Again, we find similar results when we split samples based on total volatility, see Table A.6 in the Online Appendix.

volatility drive the findings.

In Panel A of Table 11, we split firms by their ex-ante book-to-market ratio. We find that firms with larger book-to-market ratios experience a very similar reduction in cash-flow volatility following dividend increases to firms with low book-to-market ratios. Following dividend decreases, firms with high book-to-market ratios experience a somewhat larger increase in cash-flow volatility, although the difference is not statistically significant. Panel B of Table 11 reports announcement returns, separately for firms with high and low book-to-market ratio. We find very similar announcement returns in both sub-samples. The sample split by book-to-market ratio does not produce significant differences in either cash-flow volatility or announcement returns. These results are inconsistent with the predictions of agency theory.

Finally, we examine whether our evidence on share repurchases changes with investment opportunities. In Table 12, we find that firms with larger ex-ante idiosyncratic volatility experience both a much larger reduction in cash-flow volatility and larger announcement returns relative to firms with low idiosyncratic volatility. Again, this finding is inconsistent with the predictions of agency theory and, if anything, more consistent with signaling. Furthermore, we find no significant difference in either cash-flow volatility or announcement returns between firms with high book-to-market ratios relative to firms with low book-to-market ratios.

Taken together, this evidence indicates agency theory does not explain our evidence on payout policy and cash-flow volatility.

B. Taxes

Many theoretical and empirical papers on dividend policy rely, directly or indirectly, on tax arguments. In some signaling models, the cost of the signal is the deadweight cost of the taxes paid on dividends relative to the (lower) tax that would be paid on capital gains (see, e.g., John and Williams (1985), and Bernheim (1991)). In other models (e.g., Shleifer and Vishny (1986) Section V and Allen et al. (2000)), differential taxation across different shareholders (institutions vs. retail investors) explains dividend policy as a way for corporations to attract institutions as large shareholders.

These tax-based explanations have been helpful in thinking about dividend policy. However, since the Jobs and Growth Tax Relief Reconciliation Act of 2003 in the United States, dividends are taxed at the same rate as capital gains even for individual investors (and for many classes of institutional investors, taxation has been the same even before the Jobs Act). In this more recent tax regime, 2003–2013, we find in Panel C of Table 5 results similar to those we obtained in the full sample, as well as in the early 1964–1988 sub-sample characterized by differential taxation.

As a result, constructing a dividend equilibrium, signaling or otherwise, in which differential taxation plays any role, whether differential corporate taxation of dividends vs capital gains, or differential personal taxation across different investors, has become challenging. For these reasons, we abstract from taxation in our analysis of dividend policy.

VII Conclusion

The notion that changes in dividend policy convey information to the market is intuitive, and managers support it in surveys. The strong market reaction to announcements of dividend changes further suggests dividend policy *does* contain value-relevant information. But empirical research so far has found no support for dividend-signaling models in the data: no meaningful relation exists between changes in dividends and changes in future earnings, and "the wrong firms are paying dividends, and the right firms are not" (DeAngelo et al. (2009), p.185). Consistent with existing theories, the empirical literature has focused on the relationship between dividend changes and changes in earnings—the first moment—rather than between dividend changes and changes in earnings volatility—the second moment.

In this paper, we propose a theoretical framework in which firms use payout policy to signal the riskiness of their future cash flows. To test our predictions, we use the Campbell (1991) return decomposition to estimate cash-flow volatility from data on stock returns. Consistent with the model's predictions, we find cash-flow volatility decreases following dividend increases (and initiations), and cash-flow volatility increases following dividend decreases (and omissions). Furthermore, larger dividend changes are followed by larger changes in cash-flow volatility in the expected direction. In the cross section, we find that the same dollar of dividend paid is followed by a larger reduction in cash-flow volatility for firms with smaller current earnings. This result is consistent with our model's prediction that the firms for which signaling has the greatest impact are those with lower current profits, because the cost of the signal is foregone investment opportunities; in addition, this result is inconsistent with the predictions of an agency model. Importantly, the stock-market reactions to dividend announcements support our theoretical notion that expected changes in cash-flow volatility represent the information content of dividends. In fact, larger dividend changes come with both larger announcement returns and larger changes in cash-flow volatility in the expected direction.

We also examine share repurchases and find results on changes in cash-flow volatility and on the stock-market reaction to share-repurchase announcements mirroring those around announcements of dividend increases and initiations. Hence, payout policy does convey information about the riskiness of future cash flows.

Payout policies have attracted voluminous research, both theoretical and empirical, over the past 60 years. Our contributions are threefold. First, we provide an innovative method in a corporate finance context to measure the first and second moment of future cash flows; second, we provide a host of new facts about cash-flow volatility and payout policy; and third, we offer both a simple model to rationalize our empirical results, and an empirical test to distinguish between alternative (signaling vs agency) explanations of our evidence. Our static model rationalizes at the same time our novel empirical results on payout policy and expected cash-flow volatility, as well as many results from the prior literature. The main takeaway of our analysis is that the riskiness of future cash flows is a central determinant of firms' payout policies. Therefore, having a robust method to measure cash-flow volatility is crucial.

Signaling models in corporate finance have fallen out of favor since empirical research failed to find support for their central predictions that cash flows should change after dividend changes in the same direction, and that younger and riskier firms should pay more dividends than mature ones. Our paper shows the importance of considering precisely which moment of the distribution of future cash flows dividend changes might signal. Far beyond our specific application, our evidence suggests a need to reconsider more broadly the predictions of signaling models in corporate finance and beyond.

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Figure 1: **Model Solution**

This figure plots the solution of the signaling model of Section IIB. The red line depicts the equilibrium downward sloping relationship between dividends, D_1, and cash flow volatility, σ^2. The worst firm type with the highest variance, σ^2_{max}, sets dividends $D_1^\star$ as in the first-best, full-information case.

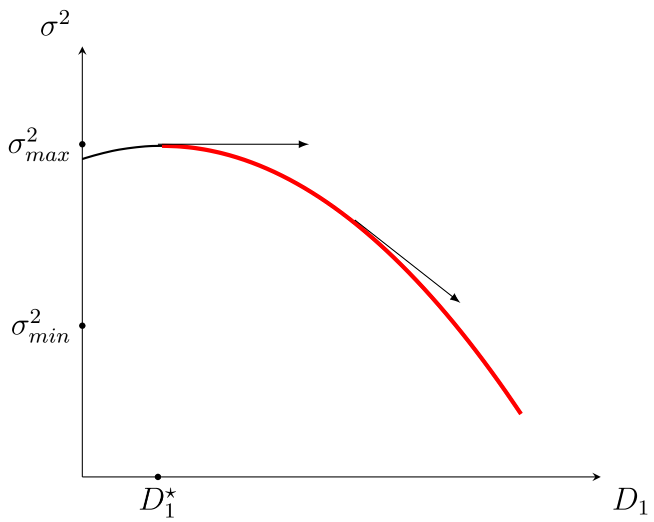

Table 1: **Descriptive Statistics**

This table reports descriptive statistics. $\Delta \mathbb{Var}(\eta\_cf)/mean(\eta\_cf)$ *is the scaled change in the variance of cash-flow news around dividend events,* $\Delta\eta\_cf$ *is the change in cash-flow news,* $\Delta\eta\_dr$ *is the change in discount-rate news, BM Ratio is the book-to-market-ratio, and Market Cap is the market capitalization. We calculate cash-flow and discount-rate news following Vuolteenaho (2002). Our sample period is 1964 till 2013.*

	$\Delta Div > 0$				$\Delta Div < 0$			
	Nobs	Median	Mean	Std	Nobs	Median	Mean	Std
$\Delta \mathbb{Var}(\eta\_cf)/mean(\eta\_cf)$	2,441	-0.13	-0.15	0.76	2,461	0.06	0.07	0.83
$\Delta\eta\_cf$	2,441	0.00	0.00	0.02	2,461	0.00	0.00	0.02
$\Delta\eta\_dr$	2,441	0.00	0.00	0.00	2,461	0.00	0.00	0.00
BM Ratio	2,441	1.05	1.36	3.17	2,461	1.10	1.48	2.97
Market Cap	2,441	0.45	4.34	19.23	2,461	0.44	3.53	13.70
	Initiations				**Omissions**			
	Nobs	Median	Mean	Std	Nobs	Median	Mean	Std
$\Delta \mathbb{Var}(\eta\_cf)/mean(\eta\_cf)$	1,069	-0.21	-0.20	1.30	1,233	0.05	0.06	0.88
$\Delta\eta\_cf$	1,069	0.00	0.00	0.02	1,233	0.00	0.00	0.01
$\Delta\eta\_dr$	1,069	0.00	0.00	0.00	1,233	0.00	0.00	0.00
BM Ratio	1,069	1.01	1.29	0.86	1,233	1.39	1.93	2.76
Market Cap	1,069	0.20	1.67	5.34	1,233	0.15	1.88	11.24

Table 2: **Estimate of Transition Matrix of VAR System**

This table reports point estimates of a constant VAR for all firms following the method we outline in Section III. r_t denotes the excess log stock return, θ is the log book-to-market ratio, and roe is the log return-on-equity. The sample period from 1964 till 2013.

	r	θ	roe
	(1)	(2)	(3)
r	0.02	0.01	0.28
	(2.12)	(9.87)	(13.61)
θ	0.10	0.94	-0.65
	(4.07)	(223.29)	(-9.67)
roe	0.01	-0.02	0.36
	(2.02)	(-29.49)	(28.85)

Table 3: **Change in Cash-Flow and Discount-Rate News Around Dividend Events**

This table reports changes in cash-flow and discount-rate news around dividend events using the methodology of Vuolteenaho (2002) which we describe in Section III. Panel A reports the average change in mean cash-flow news across firm events ($\Delta\eta\_cf$), Panel B reports the average change in mean discount-rate news ($\Delta\eta\_dr$), Panel C reports the average change in the variance of cash-flow news ($\Delta\,\mathbb{Var}(\eta\_cf)$), and Panel D reports the average change in the variance of cash-flow news scaled by the average variance of cash-flow news before the event ($\Delta\,\mathbb{Var}(\eta\_cf)/mean(\mathbb{Var}(\eta\_cf))$). Our sample period is 1964 till 2013.

	$\Delta Div > 0$ (1)	Initiation (2)	Pooled (3)	$\Delta Div < 0$ (4)	Omission (5)	Pooled (6)
Panel A. Δ Cash-flow News: $\Delta\eta\_cf$						
	-0.0001	0.0000	0.0000	-0.0003	0.0001	-0.0002
	(-0.22)	(0.47)	(-0.37)	(-1.08)	(0.85)	(-0.82)
Panel B. Δ Discount-rate News: $\Delta\eta\_dr$						
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(-0.70)	(1.22)	(-1.17)	(-0.81)	(0.93)	(-0.15)
Panel C. Δ Variance Cash-flow News: $\Delta\,\mathbb{Var}(\eta\_cf)$						
	-0.0015	-0.0027	-0.0019	0.0006	0.0005	0.0006
	(-9.65)	(-4.94)	(-8.63)	(4.38)	(2.42)	(4.95)
Panel D. Δ Scaled Variance Cash-flow News: $\Delta\,\mathbb{Var}(\eta\_cf)/mean(\mathbb{Var}(\eta\_cf))$						
	-14.86%	-20.01%	-16.43%	7.29%	6.09%	6.89%
	(-9.65)	(-4.94)	(-9.33)	(4.38)	(2.42)	(4.95)
Nobs	2,441	1,069	3,510	2,461	1,233	3,694

Table 4: **Scaled Change in Variance of Cash-Flow News Around Dividend Events: Robustness**

This table reports robustness results for changes in cash-flow news around dividend events using the methodology of Vuolteenaho (2002) which we describe in Section III. Panel A estimates one VAR for the whole sample period and then uses the estimate for Γ to calculate both residuals in the five years before and after the dividend event and the cash-flow news. Panel B estimates one VAR across all firms and events to get an estimate of Γ, but then estimates separate VARs before and after each dividend events to get the news terms. Panel C requires only 12 non-missing quarters within five years before and after the dividend event and we do not restrict our sample to non-overlapping event windows within firms. Our sample period is 1964 till 2013.

	$\Delta Div > 0$	Initiation	Pooled	$\Delta Div < 0$	Omission	Pooled
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A. Constant Gamma					
	−14.06%	−25.45%	−17.53%	17.70%	10.50%	15.27%
	(−9.39)	(−7.33)	(−11.08)	(8.13)	(3.94)	(9.01)
	Panel B. Mezzanine Gamma					
	−15.96%	−23.25%	−18.18%	10.72%	14.10%	11.84%
	(−11.47)	(−6.03)	(−11.05)	(6.57)	(5.79)	(8.70)
Nobs	2,441	1,069	3,510	2,461	1,233	3,694
	Panel C. Extended Sample					
	−12.76%	−16.73%	−13.80%	9.06%	6.26%	8.71%
	(−6.93)	(−4.87)	(−8.26)	(4.51)	(2.57)	(5.32)
Nobs	4,869	1,732	6,601	4,709	1,233	5,942

Table 5: **Scaled Change in Variance of Cash-Flow News Around Dividend Events: Sample Split**

This table reports changes in cash-flow news around dividend events using the methodology of Vuolteenaho (2002) which we describe in Section III. Panel A reports results for the first half of the sample, Panel B reports results for the second half of the sample, and Panel C reports results for a sample from 2003 until 2013.

	$\Delta Div > 0$ (1)	Initiation (2)	Pooled (3)	$\Delta Div < 0$ (4)	Omission (5)	Pooled (6)
			Panel A. 1964 – 1988			
	−12.53%	−5.72%	−11.10%	8.23%	11.19%	9.36%
	(−6.34)	(−0.80)	(−5.35)	(3.90)	(3.79)	(5.46)
Nobs	1,155	307	1,462	1,175	533	1,708
			Panel B. 1989 – 2013			
	−15.47%	−25.83%	−19.32%	16.61%	8.43%	13.16%
	(−6.69)	(−5.27)	(−8.54)	(6.02)	(2.54)	(6.23)
Nobs	1,286	762	2,048	1,286	700	1,986
			Panel C. 2003 – 2013			
	−11.31%	−31.85%	−18.84%	20.31%	18.59%	19.58%
	(−2.99)	(−5.27)	(−5.80)	(3.91)	(3.05)	(4.95)
Nobs	848	491	1,339	609	491	1,100

Table 6: **Scaled Change in Variance of Cash-Flow News Around Dividend Events: Matched Sample**

This table reports scaled changes in cash-flow news around dividend events using the methodology of Vuolteenaho (2002) which we describe in Section III. The table reports scaled changes in the variance of cash-flow news for firms with dividend events relative to scaled changes in the variance of cash flow news for similar firms without dividend events. We match firms based on the propensity score using the book-to-market ratio, leverage, age, and size. Our sample period is 1964 till 2013.

	$\Delta Div > 0$	Initiation	Pooled	$\Delta Div < 0$	Omission	Pooled
	(1)	(2)	(3)	(4)	(5)	(6)
	-14.81%	-25.72%	-17.80%	7.25%	5.36%	6.68%
	(-9.57)	(-5.90)	(-9.89)	(4.32)	(2.27)	(4.87)
Nobs	2,401	906	3,307	2,419	1,051	3,470

Table 7: **Regression of Changes in Variance of Cash-Flow News Around Dividend Events**

This table reports estimates from the following specification:

$$\Delta\,\mathbb{Var}(\eta\_cf_{it}) = \alpha + \beta_1 \cdot \Delta D_{it} + \beta_2 \cdot eps_{it} + \beta_3 \cdot \Delta D_{it} \cdot eps_{it} + \delta \cdot X_{it} + \varepsilon_{it}.$$

We regress changes in the scaled variance of cash-flow news around dividend events using the methodology of Vuolteenaho (2002) which we describe in Section III of firm i at event t, $\Delta\,\mathbb{Var}(\eta\_cf_{it})$, on the dividend change, ΔD_{it}, earnings per share, eps_{it}, the interaction between the two, as well as additional covariates, X_{it}, with t-statistics in parentheses. Additional covariates include firm age, size, book-to-market, and financial leverage. We add year and industry fixed effects at the Fama & French 17 industry level whenever indicated. We cluster standard errors at the dividend-quarter level. Our sample period is 1964 till 2013.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔDiv	−0.26	−0.24	−0.37	−0.35	−0.15	−0.14	−0.25	−0.23
	(−5.55)	(−5.31)	(−5.94)	(−6.06)	(−4.92)	(−4.66)	(−5.01)	(−5.00)
eps		−0.17	−0.12	−0.17		−0.14	−0.10	−0.11
		(−1.56)	(−1.87)	(−2.71)		(−1.41)	(−1.75)	(−1.76)
$\Delta Div \times eps$			0.24	0.21			0.19	0.18
			(3.12)	(3.19)			(2.64)	(2.51)
Age				0.00				0.00
				(1.37)				(1.20)
Book-to-market				28.21				132.62
				(0.33)				(2.41)
Leverage				−0.35				−0.14
				(−2.54)				(−1.13)
Size				0.05				0.01
				(3.06)				(1.10)
Constant	0.03	0.12	0.08	−0.86				
	(0.45)	(1.22)	(1.01)	(−2.75)				
Year FE					X	X	X	X
Industry FE					X	X	X	X
R2	2.06%	2.89%	3.89%	5.11%	30.60%	31.15%	31.80%	32.24%
Nobs	3,127	3,127	3,127	3,127	3,127	3,127	3,127	3,127

Table 8: **Scaled Change in Variance of Cash-Flow News and Announcement Returns Around Dividend Events: Heterogeneity**

This table reports the average change in the variance of cash-flow news scaled by the average variance of cash-flow news before the event ($\Delta\mathbb{V}\mathrm{ar}(\eta\_cf)/mean(\mathbb{V}\mathrm{ar}(\eta\_cf))$) *using the methodology of Vuolteenaho (2002) which we describe in Section III in Panel A and announcement returns in Panel B. The Table splits dividend events by the size of the dividend change using the median dividend change as cutoff. Announcement returns are cumulative returns in a three-day window bracketing the dividend event. We bootstrap the difference between large and small changes. Our sample period is 1964 till 2013.*

	$\Delta Div > 0$			$\Delta Div < 0$		
	Large Increase	Small Increase	Δ	Large Cut	Small Cut	Δ
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A. Δ Scaled Variance Cash-flow News: $\Delta\mathbb{V}\mathrm{ar}(\eta\_cf)/mean(\mathbb{V}\mathrm{ar}(\eta\_cf))$					
	−19.02%	−10.56%	−8.11%	8.64%	5.95%	2.42%
	(−8.28)	(−5.18)	(−22.98)	(3.61)	(2.57)	(6.01)
Nobs	1,243	1,198		1,230	1,231	
	Panel B. Cumulative Returns					
	0.76%	0.67%	0.05%	−1.14%	−0.25%	−0.85%
	(5.68)	(5.19)	(2.46)	(−6.09)	(−1.97)	(−37.62)
Nobs	1,243	1,198		1,230	1,231	

Table 9: **Share Repurchases: Heterogeneity**

This table reports the average change in the variance of cash-flow news scaled by the average variance of cash-flow news before the event ($\Delta \mathbb{Var}(\eta\_cf)/mean(\mathbb{Var}(\eta\_cf))$) using the methodology of Vuolteenaho (2002) which we describe in Section III in Panel A and announcement returns in Panel B. The Table splits repurchase announcements by the size of the repurchase using the median repurchase as cutoff. Announcement returns are cumulative returns in a three-day window bracketing the dividend event. We bootstrap the difference between large and small changes. Our sample period is 1964 till 2013.

	Baseline	Large Repurchase	Small Repurchase	Δ
	(1)	(2)	(3)	(4)
	Panel A. Δ Scaled Variance Cash-flow News: $\Delta \mathbb{Var}(\eta\_cf)/mean(\mathbb{Var}(\eta\_cf))$			
	−14.79%	−18.05%	−11.54%	−5.39%
	(−6.51)	(−5.65)	(−3.56)	(−13.19)
Nobs	2,662	1,331	1,331	
	Panel B. Cumulative Returns			
	1.91%	2.62%	1.19%	1.41%
	(12.11)	(10.15)	(6.68)	(36.01)
Nobs	2,662	1,331	1,331	

Table 10: **Sample split by Idiosyncratic Volatility: Scaled Change in Variance of Cash-Flow News and Announcement Returns Around Dividend Events**

This table reports the average change in the variance of cash-flow news scaled by the average variance of cash-flow news before the event ($\Delta\mathbb{Var}(\eta\_cf)/mean(\mathbb{Var}(\eta\_cf))$) using the methodology of Vuolteenaho (2002) which we describe in Section III in Panel A and announcement returns in Panel B. The table splits firms by their ex ante idiosyncratic volatility. Specifically, we first calculate a firms' ex ante idiosyncratic volatility on a four-quarter rolling basis relative to a Fama & French three-factor model using daily data. We then assign a firm into the large idiosyncratic volatility sample if it had a volatility above the 30% percentile of firm volatility in the respective Fama & French 17 industry in the quarter before the dividend event. Announcement returns are cumulative returns in a three-day window bracketing the dividend event. We bootstrap the difference between large and small changes. Our sample period is 1964 till 2013.

	$\Delta Div > 0$			$\Delta Div < 0$		
	Large Vol	Small Vol	Δ	Large Vol	Small Vol	Δ
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A. Δ Scaled Variance Cash-flow News: $\Delta\mathbb{Var}(\eta\_cf)/mean(\mathbb{Var}(\eta\_cf))$					
	−17.27%	−12.89%	−4.73%	11.43%	3.07%	8.41%
	(−6.98)	(−6.66)	(−12.57)	(4.60)	(1.38)	(25.76)
Nobs	1,102	1,339		1,244	1,217	
	$\Delta Div > 0$			$\Delta Div < 0$		
	Large Vol	Small Vol	Δ	Large Vol	Small Vol	Δ
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel B. Announcement Returns					
	0.79%	0.65%	0.16%	−0.83%	−0.57%	−0.27%
	(4.78)	(6.47)	(6.58)	(−4.34)	(−4.55)	(−11.09)
Nobs	1,243	1,198		1,230	1,231	

Table 11: **Sample Split by Book-to-Market: Scaled Change in Variance of Cash-Flow News and Announcement Returns Around Dividend Events**

This table reports the average change in the variance of cash-flow news scaled by the average variance of cash-flow news before the event ($\Delta \mathbb{V}\mathrm{ar}(\eta\_cf)/mean(\mathbb{V}\mathrm{ar}(\eta\_cf))$) using the methodology of Vuolteenaho (2002) which we describe in Section III in Panel A and announcement returns in Panel B. The table splits firms by their book-to-market ratio using the median ratio as cutoff. Announcement returns are cumulative returns in a three-day window bracketing the dividend event. We bootstrap the difference between large and small changes. Our sample period is 1964 till 2013.

	$\Delta Div > 0$			$\Delta Div < 0$		
	High BM	Low BM	Δ	High BM	Low BM	Δ
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A. Δ Scaled Variance Cash-flow News: $\Delta \mathbb{V}\mathrm{ar}(\eta\_cf)/mean(\mathbb{V}\mathrm{ar}(\eta\_cf))$					
	−14.89%	−14.84%	−0.05%	8.00%	6.57%	1.42%
	(−6.74)	(−6.91)	(−0.01)	(3.49)	(2.72)	(0.43)
Nobs	1,245	1,216		1,245	1,216	
	$\Delta Div > 0$			$\Delta Div < 0$		
	High BM	Low BM	Δ	High BM	Low BM	Δ
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel B. Announcement Returns					
	0.75%	0.62%	0.13%	−0.65%	−0.65%	0.00%
	(6.97)	(6.13)	(0.90)	(−4.98)	(−5.42)	(−0.01)
Nobs	1,219	1,222		1,245	1,216	

Table 12: **Share Repurchases: Investment Opportunities**

This table reports the average change in the variance of cash-flow news scaled by the average variance of cash-flow news before the event ($\Delta \mathbb{Var}(\eta\_cf)/mean(\mathbb{Var}(\eta\_cf))$) using the methodology of Vuolteenaho (2002) which we describe in Section III in Panel A and announcement returns in Panel B. The table splits firms by their ex ante idiosyncratic volatility and book-to-market ratio using the median ratio as cutoff. For idiosyncratic volatility, we first calculate a firms' ex ante idiosyncratic volatility on a four-quarter rolling basis relative to a Fama & French three-factor model using daily data. We then assign a firm into the large idiosyncratic volatility sample if it had a volatility above the 30% percentile of firm volatility in the respective Fama & French 17 industry in the quarter before the dividend event. Announcement returns are cumulative returns in a three-day window bracketing the dividend event. We bootstrap the difference between large and small changes. Our sample period is 1964 till 2013.

	Panel A. Δ Scaled Variance Cash-flow News: $\Delta \mathbb{Var}(\eta\_cf)/mean(\mathbb{Var}(\eta\_cf))$					
	Large Vol	Small Vol	Δ	High BM	Low BM	Δ
	(1)	(2)	(3)	(4)	(5)	(6)
	−21.61%	−10.20%	−12.58%	−21.05%	−14.78%	−3.81%
	(−4.24)	(−3.20)	(−6.18)	(−4.81)	(−3.05)	(−1.58)
Nobs	1,286	1,376		1,140	1,097	

	Panel B. Cumulative Returns					
	Large Vol	Small Vol	Δ	High BM	Low BM	Δ
	(1)	(2)	(3)	(4)	(5)	(6)
	2.55%	1.30%	1.29%	1.76%	2.10%	−0.29%
	(9.19)	(8.28)	(13.02)	(7.34)	(7.73)	(−1.38)
Nobs	1,286	1,376		1,140	1,097	

Online Appendix: The Information Content of Dividends: Safer Profits, not Higher Profits

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Not for Publication

I Theoretical Appendices

In this Section we present our theoretical proofs. Appendix A analyzes the general case of our baseline setting of Section IIA. Appendix B examines the our signaling model of Sections IIB-IID and verifies that the six assumptions given by Riley (1979) hold in our framework. Henceforth we refer to the best separating equilibrium outcome discussed in the text as the "Riley outcome". Appendix C verifies that the assumptions of Theorem 1, Theorem 2 and Corollary of Mailath (1987) hold for our signaling model, which implies that the Riley outcome is the unique separating equilibrium of our model. Appendix D verifies that the assumptions of Theorem 1 of Esö and Schummer (2009) hold for our signaling model, which implies that the Riley outome is the unique equilibrium that survives the "credible deviations" refinement (Esö and Schummer (2009); see also Cho and Sobel (1990) and Ramey (1996)). Appendix E states Theorem 1, Theorem 2 and Corollary of Mailath (1987). Appendix F states Theorem 1 of Esö and Schummer (2009). Appendix G presents an example with the log production function. Appendix H proves the main comparative statics results.

A. Baseline Setting: General Case

Recall the manager's maximization problem is,

$$\begin{aligned} \max_{D_1} \quad & D_1 + \mathbb{E}\left[Y_2\right] \\ & s.t. \\ & Y_2 = f(I_1) + \nu \\ & D_1 \leq \omega_1 \end{aligned}$$

We can rewrite $D_1 + \mathbb{E}(Y_2)$ as

$$\begin{aligned} D_1 + \mathbb{E}(Y_2) &= D_1 + \mathbb{E}(f(I_1) + \nu) \\ &= D_1 + \mathbb{E}(f(\omega_1 + Y_1 - D_1)) \qquad \text{(since } \mathbb{E}(\nu) = 0) \\ &= D_1 + \mathbb{E}(f(\omega_1 + Y + \nu - D_1)) \qquad \text{(since } \mathbb{E}(Y_1) = f(I_0) = Y) \end{aligned}$$

Let $f(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2) = \mathbb{E}\left[f(\omega_1 + Y + \nu - D_1)\right]$. By first order Taylor expansion of the left-hand side (LHS),

$$f(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2) \approx f(\omega_1 + Y - D_1) + f'(\omega_1 + Y - D_1)(-\frac{a}{2}\sigma^2)$$

By second order Taylor expansion of the right-hand side (RHS),

$$\begin{aligned} f(\omega_1 + Y + \nu - D_1) &= f(\omega_1 + Y - D_1 + \nu) \\ &\approx f(\omega_1 + Y - D_1) + f'(\omega_1 + Y - D_1)\nu + \frac{f''(\omega_1 + Y - D_1)}{2}\nu^2 \end{aligned}$$

Taking expectation in both sides, obtain

$$\begin{aligned} \mathbb{E}\left[f(\omega_1 + Y + \nu - D_1)\right] &\approx f(\omega_1 + Y - D_1) + f'(\omega_1 + Y - D_1)\mathbb{E}(\nu) + \frac{f''(\omega_1 + Y - D_1)}{2}\mathbb{E}(\nu^2) \\ &= f(\omega_1 + Y - D_1) + \frac{f''(\omega_1 + Y - D_1)}{2}\mathbb{E}(\nu^2) \quad \text{(since } \mathbb{E}(\nu) = 0\text{)} \\ &= f(\omega_1 + Y - D_1) + \frac{f''(\omega_1 + Y - D_1)}{2}\sigma^2 \end{aligned}$$

Comparing Taylor expansions of LHS and RHS, we obtain $a(Y, D_1) = -\frac{f''(\omega_1 + Y - D_1)}{f'(\omega_1 + Y - D_1)}$. It is not only a function of Y, but also a function of D_1. Therefore, $D_1 + \mathbb{E}(Y_2)$ can be expressed as $D_1 + f(\omega_1 + Y - D_1 - \frac{a(Y, D_1)}{2}\sigma^2)$. The F.O.C. of the problem is

$$1 - f'(\omega_1 + Y - D_1 - \frac{a(Y, D_1)}{2}\sigma^2) - \frac{\sigma^2}{2} f'(\omega_1 + Y - D_1 - \frac{a(Y, D_1)}{2}\sigma^2)\frac{\partial a(Y, D_1)}{\partial D_1} = 0$$

Prediction 1
$\frac{\partial \sigma^2}{\partial D_1} < 0$ if

$$\frac{a(Y, D_1) f''(\omega_1 + Y - D_1 - \frac{a(Y, D_1)}{2}\sigma^2)}{2 f'(\omega_1 + Y - D_1 - \frac{a(Y, D_1)}{2}\sigma^2)} - \frac{1}{\sigma^2}\left[1 - f'(\omega_1 + Y - D_1 - \frac{a(Y, D_1)}{2}\sigma^2)\right] < 0.$$

Proof. Let $G(D_1, \sigma^2) = 1 - f'(\omega_1 + Y - D_1 - \frac{a(Y, D_1)}{2}\sigma^2) - \frac{\sigma^2}{2} f'(\omega_1 + Y - D_1 -$

$$\frac{a(Y,D_1)}{2}\sigma^2)\frac{\partial a(Y,D_1)}{\partial D_1}=0,$$

$$\begin{aligned}
\frac{\partial \sigma^2}{\partial D_1} &= -\frac{\frac{\partial G}{\partial D_1}}{\frac{\partial G}{\partial \sigma^2}} \\
&= -\frac{f''(\omega_1+Y-D_1-\frac{a(Y,D_1)}{2}\sigma^2)\left[1+\frac{\sigma^2}{2}\frac{\partial a(Y,D_1)}{\partial D_1}\right]^2-\frac{\sigma^2}{2}f'(\omega_1+Y-D_1-\frac{a(Y,D_1)}{2}\sigma^2)\frac{\partial^2 a(Y,D_1)}{\partial D_1^2}}{f''(\omega_1+Y-D_1-\frac{a(Y,D_1)}{2}\sigma^2)\left[1+\frac{\sigma^2}{2}\frac{\partial a(Y,D_1)}{\partial D_1}\right]\frac{a(Y,D_1)}{2}-\frac{1}{2}f'(\omega_1+Y-D_1-\frac{a(Y,D_1)}{2}\sigma^2)\frac{\partial a(Y,D_1)}{\partial D_1}}
\end{aligned}$$

Recalling the F.O.C.,

$$1-f'(\omega_1+Y-D_1-\frac{a(Y,D_1)}{2}\sigma^2)-\frac{\sigma^2}{2}f'(\omega_1+Y-D_1-\frac{a(Y,D_1)}{2}\sigma^2)\frac{\partial a(Y,D_1)}{\partial D_1}=0, \quad \text{(A.1)}$$

we have $\frac{\partial a(Y,D_1)}{\partial D_1}=\frac{2}{\sigma^2}\left[\frac{1}{f'(\omega_1+Y-D_1^\star-\frac{a(Y,D_1)}{2}\sigma^2)}-1\right]$. The S.O.C. is

$$f''(\omega_1+Y-D_1-\frac{a(Y,D_1)}{2}\sigma^2)\left[1+\frac{\sigma^2}{2}\frac{\partial a(Y,D_1)}{\partial D_1}\right]^2-\frac{1}{2}f'(\omega_1+Y-D_1-\frac{a(Y,D_1)}{2}\sigma^2)\frac{\partial^2 a(Y,D_1)}{\partial D_1^2}<0$$

Thus,

$$\begin{aligned}
\frac{\partial^2 a(Y,D_1)}{\partial D_1^2} &> \frac{\partial\left(\frac{2}{\sigma^2}\left[\frac{1}{f'(\omega_1+Y-D_1-\frac{a(Y,D_1)}{2}\sigma^2)}-1\right]\right)}{\partial D_1} \\
&= \frac{2}{\sigma^2}\frac{f''(\omega_1+Y-D_1-\frac{a(Y,D_1)}{2}\sigma^2)\left[1+\frac{\sigma^2}{2}\frac{\partial a(Y,D_1)}{\partial D_1}\right]}{f'(\omega_1+Y-D_1-\frac{a(Y,D_1)}{2}\sigma^2)^2} \\
&= \frac{2}{\sigma^2}\frac{f''(\omega_1+Y-D_1-\frac{a(Y,D_1)}{2}\sigma^2)}{f'(\omega_1+Y-D_1-\frac{a(Y,D_1)}{2}\sigma^2)^3}
\end{aligned}$$

Thus, if $f''\frac{a(Y,D_1)}{2f'}-\frac{f'}{2}\frac{\partial a(Y,D_1)}{\partial D_1}<0$ (i.e., $f''\frac{a(Y,D_1)}{2f'}-\frac{1}{\sigma^2}\left[1-f'\right]<0$),

$$\frac{\partial\sigma^2}{\partial D_1} < -\frac{\dfrac{f''}{f'^2} - \dfrac{\sigma^2}{2} f' \dfrac{2f''}{\sigma^2 f'^3}}{f'' \dfrac{a(Y,D_1)}{2f'} - \dfrac{f'}{2}\dfrac{\partial a(Y,D_1)}{\partial D_1}} \Rightarrow \frac{\partial\sigma^2}{\partial D_1} < 0$$

where $f' = f'(\omega_1 + Y - D_1 - \dfrac{a(Y,D_1)}{2}\sigma^2)$, $f'' = f''(\omega_1 + Y - D_1 - \dfrac{a(Y,D_1)}{2}\sigma^2)$ and $f''' = f'''(\omega_1 + Y - D_1 - \dfrac{a(Y,D_1)}{2}\sigma^2)$. ■

Prediction 2

The sign of $\dfrac{\partial^2\sigma^2}{\partial D_1 \partial Y}$ can be positive, zero or negative.

Proof.

$$\frac{\partial^2\sigma^2}{\partial D_1 \partial Y} = \frac{\partial(\frac{\partial\sigma^2}{\partial D_1})}{\partial Y}$$

According to the proof of Prediction 1,

$$\frac{\partial\sigma^2}{\partial D_1} = \frac{-f''\left[1 + \dfrac{\sigma^2}{2}\dfrac{\partial a(Y,D_1)}{\partial D_1}\right]^2 + \dfrac{\sigma^2}{2} f' \dfrac{\partial^2 a(Y,D_1)}{\partial D_1^2}}{f''\left[1 + \dfrac{\sigma^2}{2}\dfrac{\partial a(Y,D_1)}{\partial D_1}\right]\dfrac{a(Y,D_1)}{2} - \dfrac{1}{2} f' \dfrac{\partial a(Y,D_1)}{\partial D_1}}$$

where $f' = f'(\omega_1 + Y - D_1 - \dfrac{a(Y,D_1)}{2}\sigma^2)$, $f'' = f''(\omega_1 + Y - D_1 - \dfrac{a(Y,D_1)}{2}\sigma^2)$ and $f''' = f'''(\omega_1 + Y - D_1 - \dfrac{a(Y,D_1)}{2}\sigma^2)$. Let A denote the numerator of $\dfrac{\partial\sigma^2}{\partial D_1}$ and B denote the denominator of $\dfrac{\partial\sigma^2}{\partial D_1}$, then

$$\frac{\partial^2\sigma^2}{\partial D_1 \partial Y} = \frac{A'B - AB'}{B^2}$$

where

$$\begin{aligned} A'B = & \left\{\left[\frac{\sigma^2 f''}{2}\frac{\partial^2 a}{\partial D_1^2} - f'''(1 + \frac{\sigma^2}{2}\frac{\partial a}{\partial D_1})^2\right]\left[1 + \frac{\sigma^2}{2}\frac{\partial a}{\partial D_1}\right] + \frac{\sigma^2}{2} f' \frac{\partial(\frac{\partial^2 a}{\partial D_1^2})}{\partial Y} - 2f''\left[1 + \frac{\sigma^2}{2}\frac{\partial a}{\partial D_1}\right]\frac{\sigma^2}{2}\frac{\partial^2 a}{\partial D_1 \partial Y}\right\} \\ & \times\left\{f''\left[1 + \frac{\sigma^2}{2}\frac{\partial a}{\partial D_1}\right]\frac{a}{2} - \frac{1}{2} f' \frac{\partial a}{\partial D_1}\right\} \end{aligned}$$

and

$$
\begin{aligned}
AB' &= \{-f''\left[1+\frac{\sigma^2}{2}\frac{\partial a(Y,D_1)}{\partial D_1}\right]^2+\frac{\sigma^2}{2}f'\frac{\partial^2 a(Y,D_1)}{\partial D_1^2}\} \\
&\quad \times\{f'''(1+\frac{\sigma^2}{2}\frac{\partial a}{\partial D_1})^2\frac{a}{2}-\frac{1}{2}f''\frac{\partial a}{\partial D_1}(1+\frac{\sigma^2}{2}\frac{\partial a}{\partial D_1})+\frac{a}{2}f''\frac{\sigma^2}{2}\frac{\partial^2 a}{\partial D_1\partial Y}-\frac{f'}{2}\frac{\partial^2 a}{\partial D_1\partial Y}\}
\end{aligned}
$$

Since $a=-\dfrac{f''(\omega_1+Y-D_1)}{f'(\omega_1+Y-D_1)}$,

$$
\begin{aligned}
\frac{\partial a}{\partial D_1} &= \frac{f'''(\omega_1+Y-D_1)f'(\omega_1+Y-D_1)-2f''^2(\omega_1+Y-D_1)}{f'^2(\omega_1+Y-D_1)} \\
&= -\frac{\partial a}{\partial Y}
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial^2 a}{\partial D_1\partial Y} &= -\frac{\partial^2 a}{\partial D_1^2} \\
&= \frac{\tilde{f}''''\tilde{f}'^3-\tilde{f}'^2 f''\tilde{f}'''-2\tilde{f}'^3\tilde{f}''\tilde{f}'''-2\tilde{f}'^2\tilde{f}''^3}{\tilde{f}'^4}
\end{aligned}
$$

where $\tilde{f}''''=f''''(\omega_1+Y-D_1)$, $\tilde{f}'''=f'''(\omega_1+Y-D_1)$, $\tilde{f}''=f''(\omega_1+Y-D_1)$ and $\tilde{f}'=f'(\omega_1+Y-D_1)$.

$$
\begin{aligned}
\frac{\partial^3 a}{\partial D_1^2\partial Y} &= -\frac{\partial^3 a}{\partial D_1^3} \\
&= \frac{\tilde{f}'''''\tilde{f}'^2-\tilde{f}'\tilde{f}'''^2-2\tilde{f}'\tilde{f}''\tilde{f}''''-2\tilde{f}'^2\tilde{f}'''^2-2\tilde{f}'^2\tilde{f}''\tilde{f}''''-4\tilde{f}''^4+10\tilde{f}'\tilde{f}''^2\tilde{f}'''}{\tilde{f}'^3}
\end{aligned}
$$

As shown above, the fourth and fifth order derivatives of function $f(\cdot)$ enters the expression of $\dfrac{\partial^2\sigma^2}{\partial D_1\partial Y}$ and these terms cannot be cancelled out. As a result, the sign of $\dfrac{\partial^2\sigma^2}{\partial D_1\partial Y}$ is indeterminate. ■

Special Case

Assume $f(x) = A - e^{-kx}$ with constants $A > 0$ and $k > 0$. To begin with,

$$\begin{aligned} f'(x) &= -(-ke^{-kx}) = ke^{-kx} \\ f''(x) &= -k^2 e^{-kx} \end{aligned}$$

In this case, $a = \dfrac{-f''(\omega_1 + Y - D_1)}{f'(\omega_1 + Y - D_1)} = k$ is constant.
The F.O.C. will be

$$1 - f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2) = 0$$

Prediction 1 (Special Case).
$\dfrac{\partial \sigma^2}{\partial D_1} < 0$

Proof. Let $J = 1 - f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2) = 0$,

$$\frac{\partial \sigma^2}{\partial D_1} = -\frac{\frac{\partial J}{\partial D_1}}{\frac{\partial J}{\partial \sigma^2}} = -\frac{f''(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2)}{f''(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2)\frac{a}{2}} = -\frac{2}{a} < 0$$

Because $a = k > 0$. ■

Prediction 2 (Special Case).
$\dfrac{\partial^2 \sigma^2}{\partial D_1 \partial Y} = 0$

Proof. $\dfrac{\partial^2 \sigma^2}{\partial D_1 \partial Y} = \dfrac{\partial \frac{\partial \sigma^2}{\partial D_1}}{\partial Y} = \dfrac{\partial(-\frac{2}{a})}{\partial Y} = 0$ ■

B. Proof of Riley (1979) conditions

This Section shows that our signaling model of Sections IIB-IID satisfies the Riley (1979) conditions for signaling games. **Proof.** Let

$$\begin{aligned} W &= k \cdot V^s + (1-k) \cdot V^h \\ V^s &= D_1 + f\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)\right) \\ V^h &= D_1 + f\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right) \end{aligned}$$

so that

$$W = D_1 + k \cdot f\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)\right) + (1-k) \cdot f\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right).$$

Riley (1979) assumptions:

A1. The unobservable attribute, σ^2, is distributed on $[\sigma^2_{min}, \sigma^2_{max}]$ according to a strictly increasing distribution function

A2. The functions $W(\cdot)$, $V^h(\cdot)$ are infinitely differentiable in all variables

A3. $\frac{\partial W}{\partial V^s} > 0$

A4. $V^h(-\sigma^2, D_1) > 0$; $\frac{\partial V^h(-\sigma^2, D_1)}{\partial(-\sigma^2)} > 0$

A5. $\frac{\partial}{\partial(-\sigma^2)}\left(\frac{-\frac{\partial W}{\partial D_1}}{\frac{\partial W}{\partial V^s}}\right) < 0$

A6. $W\left(-\sigma^2; D_1, V^h(-\sigma^2, D_1)\right)$ has a unique maximum over D_1.

Assumptions **A1-A4** are immediate.

Condition **A5** is also known as the "single crossing condition" of signaling games and is that $\frac{\partial}{\partial(-\sigma^2)}\left(\frac{-\frac{\partial W}{\partial D_1}}{\frac{\partial W}{\partial V^s}}\right) < 0$.

$\frac{\partial W}{\partial D_1} = 1 - f'\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right)$

$\frac{\partial W}{\partial V^s} = k.$

Hence:

$$\begin{aligned} \frac{\partial}{\partial(-\sigma^2)}\left(\frac{-\frac{\partial W}{\partial D_1}}{\frac{\partial W}{\partial V^s}}\right) &= \frac{\partial}{\partial(-\sigma^2)}\left(\frac{-1 + f'\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right)}{k}\right) \\ &= \frac{a \cdot f''\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right)}{2k} < 0 \end{aligned}$$

because $f''(\cdot) < 0$.

Condition **A6** requires that $V^h\left(-\sigma^2, D_1\right)$ has a unique maximum over D_1, which it does at the point $D_1^\star$ such that

$$f'\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right) = 1 \tag{A.2}$$

with the S.O.C. $f''\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right) < 0$ satisfied. ■

Because the Riley conditions are satisfied, we refer to the separating equilibrium of Section IIC in the main text as the "Riley equilibrium" and to the separating equilibrium outcome of Section IIC in the main text as the "Riley outcome".

C. Uniqueness of the Separating Equilibrium

This section shows that the Riley equilibrium is the unique separating equilibrium of our model.

According to Theorem 1, Theorem 2 and Corollary in Mailath (1987) (see Appendix D), if the payoff function satisfies Mailath (1987)'s conditions (1)-(5) and the single crossing condition (7), together with the initial value condition (6), then the Riley equilibrium is the unique separating equilibrium solution.

To begin with, in the dividend framework, the set of possible types is the interval $[\sigma^2_{min}, \sigma^2_{max}] \subset \mathbb{R}$ and the set of possible actions is $\mathbb{R}$. Let $\tau^{-1}(D_1) = \sigma^2(D_1)$ where $\tau : [\sigma^2_{min}, \sigma^2_{max}] \to \mathbb{R}$ is the proposed equilibrium one-to-one strategy.

Recall that

$$\begin{aligned}
W &= k \cdot V^s + (1-k) \cdot V^h \\
V^s &= D_1 + f\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)\right) \\
V^h &= D_1 + f\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right)
\end{aligned}$$

so the expected payoff function is

$$W\left(-\sigma^2,-\sigma^2(D_1),D_1\right) = D_1+k\cdot f\left(\omega_1+Y-D_1-\frac{a}{2}\cdot\sigma^2(D_1)\right) \\ +(1-k)\cdot f\left(\omega_1+Y-D_1-\frac{a}{2}\cdot\sigma^2\right)$$

As we already shown $\sigma^2(D_1)$ $(i.e., \tau^{-1}(D_1))$ solves the optimization problem, it satisfies *incentive compatibility*:

$$(IC) \quad \tau\left(\sigma^2\right)\in \underset{D_1\in\tau\left(\left[\sigma^2_{min},\sigma^2_{max}\right]\right)}{\text{argmax}} W\left(-\sigma^2,-\tau^{-1}\left(D_1\right),D_1\right),\ \forall\sigma^2\in[\sigma^2_{min},\sigma^2_{max}]$$

Mailath (1987)'s regularity conditions on the payoff function W,

(1) $W\left(-\sigma^2,-\sigma^2(D_1),D_1\right)$ is C^2 on $\left[\sigma^2_{min},\sigma^2_{max}\right]^2\times\mathbb{R}$ (smoothness)

(2) W_2 never equals zero, and so is either positive or negative (belief monotonicity)

(3) W_{13} never equals zero, and so is either positive or negative (type monotonicity)

(4) $W_3\left(-\sigma^2,-\sigma^2,D_1\right)=0$ has a unique solution in D_1, denoted $\phi\left(\sigma^2\right)$, which maximizes $W\left(-\sigma^2,-\sigma^2,D_1\right)$, and $W_{33}\left(-\sigma^2,-\sigma^2,\phi\left(\sigma^2\right)\right)<0$ ("strict" quasi-concavity)

(5) there exists $k>0$ such that for all $\left(-\sigma^2,D_1\right)\in\left[\sigma^2_{min},\sigma^2_{max}\right]\times\mathbb{R}$, $W_{33}\left(-\sigma^2,-\sigma^2,D_1\right)\geq 0 \Rightarrow \mid W_3\left(-\sigma^2,-\sigma^2,D_1\right)\mid > k$ (boundedness)

The other two conditions which play a role in what follows are

(6) $\tau\left(\sigma^2_w\right)=\phi\left(\sigma^2_w\right)$, where $\sigma^2_w=\sigma^2_{max}$ if $W_2>0$ and σ^2_{min} if $W_2<0$ (initial value)

(7) $\frac{W_3\left(-\sigma^2,-\sigma^2(D_1),D_1\right)}{W_2\left(-\sigma^2,-\sigma^2(D_1),D_1\right)}$ is a strictly monotonic function of $-\sigma^2$ (single crossing).

Condition (1) is satisfied because it is obvious that $W\left(-\sigma^2,-\sigma^2(D_1),D_1\right)$ is C^2 on $\left[\sigma^2_{min},\sigma^2_{max}\right]^2\times\mathbb{R}$.

Condition (2) is satisfied because W_2 is always negative and will never be zero.

$$W_2=\frac{\partial W}{\partial(-\sigma^2(D_1))}=\frac{k\cdot a}{2}f'\left(\omega_1+Y-D_1-\frac{a}{2}\cdot\sigma^2(D_1)\right)>0 \tag{A.3}$$

since $f'(\cdot)>0$.

Condition (3) is satisfied because $W_{13} < 0$ is always negative and will never equal zero.

$$\begin{aligned}
W_{13} &= \frac{\dfrac{\partial W}{\partial(-\sigma^2)}}{\partial D_1} \\
&= \frac{\dfrac{(1-k)\cdot a}{2} f'\left(\omega_1 + Y - D_1 - \frac{a}{2}\cdot\sigma^2\right)}{\partial D_1} \\
&= \frac{-(1-k)\cdot a}{2} f''\left(\omega_1 + Y - D_1 - \frac{a}{2}\cdot\sigma^2\right) > 0
\end{aligned}$$

since $f''(\cdot) < 0$.

Condition (4) is satisfied because $f'(\cdot)$ is monotonic with $f''(\cdot) < 0$.

$$\begin{aligned}
W_3\left(-\sigma^2, -\sigma^2, D_1\right) &= 0 \\
&\Longleftrightarrow \\
1 - f'\left(\omega_1 + Y - D_1 - \frac{a}{2}\cdot\sigma^2\right) &= 0
\end{aligned}$$

Since $f'(\cdot) > 0$ is monotonic, $W_3\left(-\sigma^2, -\sigma^2, D_1\right) = 0$ has a unique solution in D_1, denoted $\phi(\sigma^2)$. It is easy to show that $\phi(\sigma^2)$ also maximizes $W\left(-\sigma^2, -\sigma^2, D_1\right)$.

$W\left(-\sigma^2, -\sigma^2, D_1\right) = D_1 + f\left(\omega_1 + Y - D_1 - \frac{a}{2}\cdot\sigma^2\right)$

To find the optimal D_1 that maximizes $W\left(-\sigma^2, -\sigma^2, D_1\right)$, the F.O.C. is $W_3\left(-\sigma^2, -\sigma^2, D_1\right) = 0$ which is already shown above and the S.O.C. is $W_{33}\left(-\sigma^2, -\sigma^2, D_1\right) < 0$ which is shown below,

$$\begin{aligned}
W_{33}\left(-\sigma^2, -\sigma^2, D_1\right) &= \frac{\partial W_3}{\partial D_1} \\
&= \frac{1 - f'\left(\omega_1 + Y - D_1 - \frac{a}{2}\cdot\sigma^2\right)}{\partial D_1} \\
&= f''\left(\omega_1 + Y - D_1 - \frac{a}{2}\cdot\sigma^2\right) < 0
\end{aligned}$$

since $f''(\cdot) < 0$.

Condition (5) is satisfied because if for all $(-\sigma^2, D_1) \in [\sigma^2_{min}, \sigma^2_{max}] \times \mathbb{R}$, $W_{33}\left(-\sigma^2, -\sigma^2, D_1\right) \geq 0$ then there exist some $k > 0$ such that $\mid W_3\left(-\sigma^2, -\sigma^2, D_1\right) \mid > k$.

$$
\begin{aligned}
W_{33}\left(-\sigma^2, -\sigma^2, D_1\right) &\geq 0 \\
&\Longleftrightarrow \\
f''\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right) &\geq 0
\end{aligned}
$$

Thus, to maximize the expected payoff function, the manager will never choose $D_1^\star$ where $D_1^\star$ is the solution of $1 - f'\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right) = 0$. The reason is that $D_1^\star(\sigma^2)$ will minimize the expected utility payoff function instead of maximizing it.

$$
W_3 = 1 - f'\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right) \neq 1 - f'\left(\omega_1 + Y - D_1^\star - \frac{a}{2} \cdot \sigma^2\right) = 0 \qquad \text{(A.4)}
$$

Thus, $\mid W_3\left(-\sigma^2, -\sigma^2, D_1\right) \mid > 0$. It means we can always find some $k > 0$ such that $\mid W_3\left(-\sigma^2, -\sigma^2, D_1\right) \mid > k$.

The next step is to show that both the initial value condition and the single crossing condition hold.

Condition (6) holds because $W_2 < 0$, in the solution proposed the worst-type firm behaves as if it is in the full information case in equilibrium, i.e. $\tau(\sigma^2_{max}) = \phi(\sigma^2_{max})$.

Condition (7) holds because

$$
\begin{aligned}
W_3\left(-\sigma^2, -\sigma^2(D_1), D_1\right) &= 1 - k \cdot f'\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)\right) \\
&\quad + \frac{k \cdot a}{2} f'\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)\right) \frac{\partial(-\sigma^2(D_1))}{\partial D_1} \\
&\quad - (1-k) \cdot f'\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right) \\
W_2\left(-\sigma^2, -\sigma^2(D_1), D_1\right) &= \frac{\partial W}{\partial(-\sigma^2(D_1))} \\
&= \frac{k \cdot a}{2} f'\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)\right) \\
\text{Then, } \frac{\partial \dfrac{W_3\left(-\sigma^2, -\sigma^2(D_1), D_1\right)}{W_2\left(-\sigma^2, -\sigma^2(D_1), D_1\right)}}{\partial(-\sigma^2)} &= -\frac{a}{2} \cdot \frac{2(1-k)}{k \cdot a} \frac{f''\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)\right)}{f'\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)\right)} \\
&= -\frac{1-k}{k} \cdot \frac{f''\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)\right)}{f'\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)\right)} > 0
\end{aligned}
$$

Thus $\dfrac{W_3\left(-\sigma^2, -\sigma^2(D_1), D_1\right)}{W_2\left(-\sigma^2, -\sigma^2(D_1), D_1\right)}$ is a strictly increasing function of $(-\sigma^2)$.

Since Mailath (1987)'s conditions (1)-(7) are satisfied, the Riley equilibrium is the unique separating equilibrium of our model.

D. Equilibrium Refinement and Uniqueness

In this Section we want to show that our game belongs to the class of monotonic signaling games discussed in Section 3 of Esö and Schummer (2009), (see also Cho and Sobel (1990) and Ramey (1996)) and thus we can apply theorem 1 of Esö and Schummer (2009) to show that in this game the Riley equilibrium (i.e., the unique separating equilibrium as per above) is also the unique equilibrium that is immune to Credible Deviations.

First, let's check the 5 assumptions of Esö and Schummer (2009), A1 to A5, one by one. The firm (Sender) with variance σ^2 (type) decides to pay D_1 (signal). The investors (receivers) in the market buy the share of the firm at price $V^s(D_1)$ in the belief that the dividend D_1 reflect the value of the firm as a function of the unobserved variance, which can be denoted as $\sigma^2(D_1)$.

A1. $W(-\sigma^2, D_1, V^s(D_1))$ is strictly increasing in $V^s(D_1)$ for all $(-\sigma^2, D_1)$. In order to avoid solutions involving arbitrarily large messages and actions we assume that $\lim_{D_1 \to \infty} W(-\sigma^2, D_1, V^s(D_1)) = -\infty$.

Proof.

$$\frac{\partial W(-\sigma^2, D_1, V^s(D_1))}{\partial V^s(D_1)} = k > 0$$

■

A2. Assume that $V^s(D_1)$ is such that, for any type σ^2 and message D_1, the Receiver has a unique best response, i.e. that $BR(-\sigma^2, D_1)$ is a singleton.

Proof. Since the investors (Receivers) act as price takers, they purchase the shares of the firm at the price $V^s(D_1)$. Their best response $BR(-\sigma^2, D_1)$ is a singleton $\{V^s(D_1) : V^s(D_1) = V^h(D_1)\}$. ■

A3. Assume that $V^s(D_1)$ is strictly increasing in $(-\sigma^2(D_1)$ for all (D_1, V^s).

Proof.

$$\frac{\partial V^s}{\partial(-\sigma^2(D_1))} = \frac{a}{2} f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1)) > 0.$$

In particular,

$$\frac{\partial V^h}{\partial(-\sigma^2)} = \frac{a}{2} f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2) > 0.$$

■

Together with monotonicity, A3 captures the idea that the manager (Sender) wants to induce the investors (Receivers) to buy the firm at a larger price by trying to convince them that the firm type is better (its variance is lower).

A4. Assume the game satisfies the central assumption in Spencian signaling games, the single crossing condition, that $-(\partial W/\partial D_1)/(\partial W/\partial(V^s(D_1)))$ is strictly decreasing in $-\sigma^2$.

Proof. According to the proof of Riley (1979)'s assumption A5 (see Appendix A), this assumption obviously holds. ■

A5. Assume that $W(-\sigma^2, D_1, V^h(D_1))$ is strictly quasi-concave in D_1.

Proof. Similar with the proof of Mailath (1987)'s condition (4) (see Appendix B), this assumption obviously holds. In detail,

$$
\begin{aligned}
W(-\sigma^2, D_1, V^h(D_1)) &= V^h(D_1) \\
&= D_1 + f\left(\omega_1 + Y - D_1 - \frac{a}{2}\cdot\sigma^2\right).
\end{aligned}
$$

We have

$$
\frac{\partial W(-\sigma^2, D_1, V^h(D_1))}{\partial D_1} = 1 - f'\left(\omega_1 + Y - D_1 - \frac{a}{2}\cdot\sigma^2\right) = 0
$$

has a unique solution and

$$
\frac{\partial^2 W(-\sigma^2, D_1, V^h(D_1))}{\partial D_1^2} = f''\left(\omega_1 + Y - D_1 - \frac{a}{2}\cdot\sigma^2\right) < 0.
$$

Thus, $W(-\sigma^2, D_1, V^h(D_1))$ is strictly quasi-concave in D_1. ■

Thus, our game satisfies the assumptions of monotonic signaling games discussed in Esö and Schummer (2009). As a result, the Riley outcome is the unique equilibrium outcome that is immune to Credible Deviations.

E. Mailath (1987)

This Section states results in Mailath (1987) that are used above.

Suppose the set of possible types is the interval $[m, M] \subset \mathbb{R}$ and the set of possible actions is $\mathbb{R}$. If $\tau : [m, M] \to \mathbb{R}$ is an equilibrium one-to-one strategy for the informed agent, then when he chooses $y \in \tau([m, M])$ the uninformed agents infer his type is $\tau^{-1}(y)$. Thus, his expected payoff is $U(\alpha, \tau^{-1}(y), y)$. Furthermore, τ is an optimal strategy for the informed agent, so that $\tau(\alpha)$ maximizes the expected payoff. So, for τ to be a separating equilibrium strategy it must be one-to-one and satisfy *incentive compatibility* (IC):

$$
(IC) \quad \tau(\alpha) \in \underset{y\in\tau([m,M])}{\operatorname{argmax}} U(\alpha, \tau^{-1}(y), y), \ \forall \alpha \in [m, M]
$$

If $U(\alpha, \tau^{-1}(y), y)$ has no other maximizer for $y \in \tau([m, M])$ for all $\alpha \in [m, M]$, then τ satisfies strict incentive compatibility (SIC), i.e.,

$$
(SIC) \quad \tau(\alpha) = \underset{y\in\tau([m,M])}{\operatorname{argmax}} U(\alpha, \tau^{-1}(y), y) \ \forall \alpha \in [m, M].
$$

The regularity conditions on U are (where subscripts denote partial derivatives):

(1) $U(\alpha, \hat{\alpha}, y)$ is C^2 on $[m, M]^2 \times \mathbb{R}$ (smoothness)

(2) U_2 never equals zero, and so is either positive or negative (belief monotonicity)

(3) U_{13} never equals zero, and so is either positive or negative (type monotonicity)

(4) $U_3(\alpha, \alpha, y) = 0$ has a unique solution in y, denoted $\phi(\alpha)$, which maximizes $U(\alpha, \alpha, y)$, and $U_{33}(\alpha, \alpha, \phi(\alpha)) < 0$ ("strict" quasi-concavity)

(5) there exists $k > 0$ such that for all $(\alpha, y) \in [m, M] \times \mathbb{R}$ $U_{33}(\alpha, \alpha, y) \geq 0 \Rightarrow \mid U_3(\alpha, \alpha, y) \mid > k$ (boundedness)

The other two conditions which play a role in what follows are

(6) $\tau(\alpha^w) = \phi(\alpha^w)$, where $\alpha^w = M$ if $U_2 < 0$ and m if $U_2 > 0$ (initial value)

(7) $\frac{U_3(\alpha,\hat{\alpha},y)}{U_2(\alpha,\hat{\alpha},y)}$ is a strictly monotonic function of α (single crossing)

Theorem 1 *Suppose (1) - (5) are satisfied and $\tau : [m, M] \to \mathbb{R}$ is one-to-one and satisfies incentive compatibility. Then τ has at most one discontinuity on $[m, M]$, and where it is continuous on (m,M), it is differentiable and satisfies (DE) $\quad \dfrac{d\tau}{d\alpha} = \dfrac{-U_2(\alpha, \alpha, \tau)}{U_3(\alpha, \alpha, \tau)}$. Furthermore, if τ is discontinuous at a point, α' say, then τ is strictly increasing on one of $[m, \alpha')$ or $(\alpha', M]$ and strictly decreasing on the other, and the jump at α' is of the same sign as U_{13}.*

Theorem 2 *Suppose, in addition, that either the initial value condition or the single crossing condition for $(\hat{\alpha}, y)$ in the graph of τ is satisfied. Then τ is strictly monotonic on (m, M) and hence continuous and satisfies the differential equation (DE) there. If the initial value condition is satisfied, then in fact τ is continuous on $[m, M]$ and $\dfrac{d\tau}{d\alpha}$ has the same sign as U_{13}.*

The following corollary shows that incentive compatibility and the initial value condition together imply uniqueness. Let $\tilde{\tau}$ denote the unique solution to the following restricted initial value problem: (DE), $\tau(\alpha^w) = \phi(\alpha^w)$ and $(d\tau/d\alpha)U_{13} > 0$.

Corollary: suppose (1)-(5) are satisfied and the initial value condition holds. If τ satisfies incentive compatibility, then $\tau = \tilde{\tau}$.

F. Esö and Schummer (2009)

This Section states results in Esö and Schummer (2009) that are used above.

Define the Sender-Receiver game which is denoted by the tuple (Θ, π, u_S, u_R). The Sender has private information that is summarized by his type $\theta \in \Theta = \{\theta_1,\ \theta_2, \cdots,\ \theta_n\} \subset \mathbb{R}$, where $\theta_1 < \theta_2 < \cdots < \theta_n$. The commonly known prior probability that the Sender's type is θ is $\pi(\theta)$. Upon realizing his type, the Sender chooses a message $m \in \mathbb{R}_+$. A strategy for the Sender is a function $M : \Theta \to \mathbb{R}_+$. The Sender and Receiver receive respective payoffs of $u_S(\theta, m, a)$ and $u_R(\theta, m, a)$, which are both continuously differentiable in (m, a).

The Receiver's (posterior) beliefs upon receiving the Sender's message is a function $\mu : \mathbb{R}_+ \to \Delta(\Theta)$, where $\Delta(\Theta)$ refers to the set of probability distributions on Θ. For any message $m \in \mathbb{R}_+$ and any fixed (posterior belief) distribution $\tilde{\pi} \in \Delta(\Theta)$, denote the Receiver's best responses to m (given $\tilde{\pi}$) by $BR(\tilde{\pi}, m) \equiv \text{argmax}_{a \in \mathbb{R}} \mathbb{E}\left[u_R(\theta, m, a) \mid \tilde{\pi}\right]$.

Formalizing Credible Deviations

Definition 1 *(Vulnerability to a Credible Deviation) Given an equilibrium (M, A, μ), we say that an out-of-equilibrium message $m \in \mathbb{R}_+ \backslash M(\Theta)$ is a Credible Deviation if the following condition holds for exact one (non-empty) set of types $C \subseteq \Theta$.*

$$C = \{\theta \in \Theta : u_S^\star(\theta) < \min_{a \in BR(C,m)} u_S(\theta, m, a)\} \tag{A.5}$$

We call C the (unique) Credible Deviators' Club for message m. If such a message exits, the equilibrium is Vulnerable to a Credible Deviation.

Monotonic Signaling Games and the Uniqueness of the Equilibrium

Following Cho and Sobel (1990) and Ramey (1996), monotonic signaling games are defined as follows,

A1. $u_S(\theta, m, a)$ is strictly increasing in a for all (θ, m). One can think of a as some sort of compensation for the Sender. In order to avoid solutions involving arbitrarily large messages and actions we assume that $\lim_{m\to\infty} u_S(\theta, m, a) = -\infty$.

A2. Assume that u_R is such that, for any type θ and message m, the Receiver has a unique best response, i.e. that $BR(\theta, m)$ is a singleton. We denote this action as $\{\beta(\theta, m)\} \equiv BR(\theta, m)$ and $\beta(\theta, m)$ is uniformly bounded from above.

A3. Assume that $BR(\tilde{\pi}, m)$ is greater for beliefs that are greater in the first-order stochastic sense, and in particular, $\beta(\theta, m)$ is strictly increasing in θ for all (m, a) (Cho and Sobel 1990, p. 392).

A4. Assume the game satisfies the central assumption in Spencian signaling games, the single crossing condition, that $-(\partial u_S/\partial m)/(\partial u_S/\partial a)$ is strictly decreasing in θ.

A5. Assume that $u_S(\theta, m, \beta(\theta, m))$ is strictly quasi-concave in m.

An additional piece of notation simplifies the exposition. For any θ and m, let $\hat{a}(\theta, m)$ be the action to satisfy,

$$u_S(\theta, m, \hat{a}(\theta, m)) = u_S^{\star}(\theta) \tag{A.6}$$

if such an action exists, and denote $\hat{a}(\theta, m) = \infty$ otherwise. This action by the Receiver would give Sender-type θ his equilibrium payoff after sending m. If such an action exists, it is unique by monotonicity.

Lemma 3 *If an equilibrium (M, A, μ) is not Vulnerable to Credible Deviations, it is a separating equilibrium - no two types send the same message.*

Lemma 4 *Any equilibrium whose outcome is different from the Riley outcome is Vulnerable to Credible Deviations.*

Theorem *The Riley outcome is the unique equilibrium outcome that is not Vulnerable to Credible Deviations.*

G. An Example

For this example, define $f(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2) = \ln(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2)$.

The ODE (i.e. FOC)

$$1 - f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1)) - \frac{ka}{2} \cdot f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1)) \cdot \frac{\partial \sigma^2(D_1)}{\partial D_1} = 0 \tag{A.7}$$

becomes

$$\frac{\partial \sigma^2 (D_1)}{\partial D_1} = \frac{2(\omega_1 + Y - D_1 - 1 - \frac{a}{2}\sigma^2)}{k \cdot a}. \tag{A.8}$$

Together with the boundary condition which says the worst type chooses the dividend such that $\sigma^2(D_1^\star) = \sigma^2_{max}$, we get the solution to this problem,

$$\sigma^2 (D_1) = \frac{2(\omega_1 - Y - 1 - \frac{a}{2}\sigma^2)D_1 - D_1^2 + a \cdot k \cdot \sigma^2_{max} + D_1^{\star 2} - 2(\omega_1 + Y - 1 - \frac{a}{2}\sigma^2)D_1^\star}{k \cdot a} \tag{A.9}$$

where $D_1 \geq D_1^\star$.

H. Proof of Comparative Statics

Here we state and prove the main comparative statics.

Prediction 1 (signaling). The dividend changes should be followed by changes in future cash flow volatility in the opposite direction, i.e. $\frac{\partial \sigma^2(D_1)}{\partial D_1} < 0$

Proof. The proof is immediately given in the analysis of the schedules in the main text.

Combining the FOC and SOC of the manager's optimization problem we get a simple condition guaranteeing a maximum

$$- V^h_{d\sigma^2}(\sigma^2, D_1)\frac{\partial \sigma^2}{\partial D_1} < 0 \tag{A.10}$$

With $V^h_{d\sigma^2}(\sigma^2, D_1) = \frac{a}{2}f''(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2) < 0$, a maximum occurs if and only if $\frac{\partial \sigma^2}{\partial D_1} < 0$.

■

Prediction 2 (signaling). Following a dividend increase (re. decrease), there's a larger decrease (re. increase) in cash flow volatility for firms with smaller (re. larger) current earnings, i.e. $\frac{\partial^2 \sigma(D_1)}{\partial D_1 \partial Y} > 0$

Proof. Recall the FOC,

$$1 - f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2) - \frac{ka}{2} \cdot f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1)) \cdot \frac{\partial \sigma^2(D_1)}{\partial D_1} = 0, \tag{A.11}$$

we get

$$\frac{\partial \sigma^2(D_1)}{\partial D_1} = \frac{1 - f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2)}{\frac{ka}{2} \cdot f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1))} \tag{A.12}$$

Then

$$\begin{aligned}
\frac{\partial^2 \sigma^2(D_1)}{\partial D_1 \partial Y} &= \frac{\partial\Big(\frac{1 - f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2)}{\frac{ka}{2} \cdot f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1))}\Big)}{\partial Y} \\
&= -\frac{2f''(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1))}{k \cdot a \cdot \Big[f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1)\Big]^2} > 0
\end{aligned}$$

because $f'' < 0$. ■

Table A.1: **Regression of Changes in Variance of Cash-Flow News Around Dividend Events: Initial Variance**

This table reports estimates from the following specification:

$$\Delta\, \mathbb{Var}(\eta\_cf_{it}) = \alpha + \beta_1 \cdot \Delta D_{it} + \beta_2 \cdot eps_{it} + \beta_3 \cdot \Delta D_{it} \cdot eps_{it} + \delta \cdot X_{it} + \varepsilon_{it}.$$

We regress changes in the scaled variance of cash-flow news around dividend events using the methodology of Vuolteenaho (2002) which we describe in Section III of firm i at event t, $\Delta\, \mathbb{Var}(\eta\_cf_{it})$, on the dividend change, ΔD_{it}, earnings per share, eps_{it}, the interaction between the two, as well as additional covariates, X_{it}, with t-statistics in parentheses. Additional covariates include firm age, size, book-to-market, and financial leverage. We add year and industry fixed effects at the Fama & French 17 industry level whenever indicated. We cluster standard errors at the dividend-quarter level. Our sample period is 1964 till 2013.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔDiv	−0.26	−0.24	−0.37	−0.13	−0.15	−0.14	−0.25	−0.11
	(−5.55)	(−5.29)	(−5.94)	(−2.76)	(−4.92)	(−4.64)	(−5.04)	(−2.90)
eps		−0.17	−0.12	−0.22		(−0.14)	(−0.10)	(−0.16)
		(−1.59)	(−1.91)	(−4.41)		(−1.43)	(−1.77)	(−3.21)
$\Delta Div \times eps$			0.24	0.17			0.20	0.16
			3.13	3.18			2.67	2.87
$\mathbb{Var}_{t-1}(\eta\_cf)$				−93.65				−80.83
				(−29.17)				(−32.08)
Age				0.00				0.00
				(1.23)				(0.24)
Book-to-market				81.87				112.71
				(0.93)				(1.81)
Leverage				0.16				0.14
				(1.36)				(1.33)
Size				0.04				0.01
				(2.57)				(0.87)
Constant	0.03	0.12	0.08	0.09				
	(0.45)	(1.24)	(1.04)	(0.29)				
Year FE					X	X	X	X
Industry FE					X	X	X	X
R2	2.06%	2.89%	3.89%	39.16%	30.60%	31.15%	31.80%	52.24%
Nobs	3,127	3,127	3,127	3,127	3,127	3,127	3,127	3,127

Table A.2: **Regression of Changes in Variance of Cash-Flow News Around Dividend Events**

This table reports estimates from the following specification:

$$\Delta\,\mathbb{Var}(\eta\_cf_{it}) = \alpha + \beta_1 \cdot \Delta D_{it} + \beta_2 \cdot eps_{it} + \beta_3 \cdot \Delta D_{it} \cdot eps_{it} + \delta \cdot X_{it} + \varepsilon_{it}.$$

We regress changes in the scaled variance of cash-flow news around dividend events using the methodology of Vuolteenaho (2002) which we describe in Section III of firm i at event t, $\Delta\,\mathbb{Var}(\eta\_cf_{it})$, on the dividend change, ΔD_{it}, earnings per share, eps_{it}, the interaction between the two, as well as additional covariates, X_{it}, with t-statistics in parentheses. Additional covariates include firm age, size, book-to-market, financial leverage, and cash. We add year and industry fixed effects at the Fama & French 17 industry level whenever indicated. We cluster standard errors at the dividend-quarter level. Our sample period is 1964 till 2013.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔDiv	−0.26	−0.24	−0.37	−0.35	−0.15	−0.14	−0.25	−0.23
	(−5.55)	(−5.31)	(−5.94)	(−6.05)	(−4.92)	(−4.66)	(−5.01)	(−5.03)
eps		−0.17	−0.12	−0.18		−0.14	−0.10	−0.23
		(−1.56)	(−1.87)	(−2.76)		(−1.41)	(−1.75)	(−1.78)
$\Delta Div \times eps$			0.24	0.21			0.19	0.18
			(3.12)	(3.20)			(2.64)	(2.54)
Age				0.00				0.00
				(1.44)				(1.21)
Book-to-Market				34.02				134.39
				(0.40)				(2.44)
Leverage				−0.35				−0.14
				(−2.58)				(−1.12)
Size				0.05				0.02
				(3.35)				(1.23)
Cash				−0.00				−0.00
				(−2.35)				(−1.40)
Constant	0.03	0.12	0.08	−0.86				
	(0.45)	(1.22)	(1.01)	(−2.75)				
Year FE					X	X	X	X
Industry FE					X	X	X	X
R2	2.06%	2.89%	3.89%	5.24%	30.60%	31.15%	31.80%	32.27%
Nobs	3,127	3,127	3,127	3,127	3,127	3,127	3,127	3,127

Table A.3: **Regression of Changes in Variance of Cash-Flow News Around Dividend Events**

This table reports estimates from the following specification:

$$\Delta\,\mathbb{Var}(\eta\_cf_{it}) = \alpha + \beta_1 \cdot \Delta D_{it} + \beta_2 \cdot CF_{it} + \beta_3 \cdot \Delta D_{it} \cdot CF_{it} + \delta \cdot X_{it} + \varepsilon_{it}.$$

We regress changes in the scaled variance of cash-flow news around dividend events using the methodology of Vuolteenaho (2002) which we describe in Section III of firm i at event t, $\Delta\,\mathbb{Var}(\eta\_cf_{it})$, on the dividend change, ΔD_{it}, cash flow, CF_{it}, the interaction between the two, as well as additional covariates, X_{it}, with t-statistics in parentheses. Additional covariates include firm age, size, book-to-market, financial leverage, and cash. We add year and industry fixed effects at the Fama & French 17 industry level whenever indicated. We cluster standard errors at the dividend-quarter level. Our sample period is 1964 till 2013.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔDiv	−0.26	−0.27	−0.26	−0.25	−0.15	−0.16	−0.15	−0.14
	(−5.55)	(−5.62)	(−5.47)	(−5.71)	(−4.92)	(−5.11)	(−4.82)	(−4.90)
CF		−0.09	−0.11	−0.09		−0.06	−0.08	−0.08
		(−2.54)	(−3.53)	(−2.87)		(−2.47)	(−3.17)	(−3.20)
$\Delta Div \times CF$			0.02	0.02			0.02	0.02
			(3.05)	(2.91)			(2.40)	(2.62)
Age				0.00				0.00
				(1.38)				(1.23)
Book-to-market				57.49				150.01
				(0.62)				(2.55)
Leverage				−0.33				−0.11
				(−2.43)				(−0.95)
Size				0.03				0.00
				(1.92)				(−0.16)
Constant	0.03	0.03	0.02	−0.53				
	(0.45)	(0.34)	(0.32)	(−1.76)				
Year FE					X	X	X	X
Industry FE					X	X	X	X
R2	2.06%	2.61%	2.75%	3.52%	30.60%	30.80%	30.94%	31.45%
Nobs	3,127	3,127	3,127	3,127	3,127	3,127	3,127	3,127

Table A.4: **Announcement Returns**

This table reports three-day cumulative returns on dividend event days for a sample period from 1964 till 2013.

	$\Delta Div > 0$ (1)	Initiation (2)	Pooled (3)	$\Delta Div < 0$ (4)	Omission (5)	Pooled (6)
	0.72%	2.37%	1.22%	-0.70%	-8.68%	-3.38%
	(7.69)	(11.00)	(13.11)	(-6.11)	(-29.77)	(-24.37)
Nobs	2,441	1,069	3,510	2,461	1,233	3,694

Table A.5: **Sample Split by Financial Constraints: Scaled Change in Variance of Cash-Flow News and Announcement Returns Around Dividend Events**

This table reports the average change in the variance of cash-flow news scaled by the average variance of cash-flow news before the event ($\Delta\,\mathbb{Var}(\eta\_cf)/mean(\mathbb{Var}(\eta\_cf))$) *using the methodology of Vuolteenaho (2002) which we describe in Section III in Panel A and announcement returns in Panel B. The Table splits dividend events by the Kaplan-Zingales index using the median dividend change as cutoff. Announcement returns are cumulative returns in a three-day window bracketing the dividend event. We bootstrap the difference between large and small financial constraints. Our sample period is 1964 till 2013.*

	$\Delta Div > 0$			$\Delta Div < 0$		
	Small KZ Index	Large KZ Index	Δ	Small KZ Index	Large KZ Index	Δ
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A. Δ Scaled Variance Cash-flow News: $\Delta\,\mathbb{Var}(\eta\_cf)/mean(\mathbb{Var}(\eta\_cf))$					
	−14.46%	−17.05%	−3.07%	3.04%	7.85%	4.47%
	(−6.67)	(−7.52)	(−4.44)	(1.27)	(3.14)	(5.69)
Nobs	1,157	1,157		1,129	1,129	
	Panel B. Cumulative Returns					
	0.70%	0.77%	0.11%	−0.62%	−0.82%	−0.27%
	(5.05)	(5.75)	(2.67)	(−3.46)	(−5.06)	(−5.00)
Nobs	1,157	1,157		1,129	1,129	

Table A.6: **Scaled Change in Variance of Cash-Flow News and Announcement Returns Around Dividend Events: Total Vol**

This table reports the average change in the variance of cash-flow news scaled by the average variance of cash-flow news before the event ($\Delta\mathbb{Var}(\eta\_cf)/mean(\mathbb{Var}(\eta\_cf))$) using the methodology of Vuolteenaho (2002) which we describe in Section III in Panel A and announcement returns in Panel B. The table splits firms by their ex ante total stock return volatility. Specifically, we first calculate a firms' ex ante total volatility on a four-quarter rolling basis using daily data. We then assign a firm into the large total volatility sample if it had a volatility above the 30% percentile of firm volatility in the respective Fama & French 17 industry in the quarter before the dividend event. Announcement returns are cumulative returns in a three-day window bracketing the dividend event. We bootstrap the difference between large and small changes. Our sample period is 1964 till 2013.

	$\Delta Div > 0$			$\Delta Div < 0$		
	Large Vol	Small Vol	Δ	Large Vol	Small Vol	Δ
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A. Δ Scaled Variance Cash-flow News: $\Delta\mathbb{Var}(\eta\_cf)/mean(\mathbb{Var}(\eta\_cf))$					
	−16.49%	−13.13%	−3.74%	9.61%	3.79%	3.45%
	(−7.23)	(−6.39)	(−6.27)	(4.28)	(1.55)	(4.64)
Nobs	1,262	1,179		1,482	979	

	$\Delta Div > 0$			$\Delta Div < 0$		
	Large Vol	Small Vol	Δ	Large Vol	Small Vol	Δ
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel B. Announcement Returns					
	0.93%	0.48%	0.44%	−0.93%	−0.31%	−0.73%
	(5.97)	(5.10)	(11.15)	(−5.44)	(−2.85)	(16.34)
Nobs	1,262	1,179		1,482	979	