Signaling Safety*

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Abstract
Contrary to signaling models’ central predictions, changes in the level of cash flows do not empirically follow changes in dividends. We use the Campbell (1991) decomposition to construct cash-flow and discount-rate news from returns and find: (1) both dividend changes and repurchase announcements signal changes in cash-flow volatility (in opposite direction); (2) larger cash-flow volatility changes come with larger announcement returns; and (3) neither discount-rate, nor the level of cash-flow news, or total stock return volatility change following dividend changes. We conclude cash-flow news— and not discount-rate news—drive payout policy; and payout policy conveys information about future cash-flow volatility.

JEL classification: G35

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I Introduction

Dividends represent one of the major financial decisions corporations make. Yet, despite extensive research, financial economists still do not fully understand why investors value dividends or what determines a given firm’s payout policies.\(^1\) 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 signaling 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., Denis and Osobov (2008), 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).\(^4\)

In this paper, we argue that perhaps the conclusion above is premature. We show that dividends do convey information, but it is information about the second moment

\(^1\)The empirical evidence shows 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.


\(^4\)But not everyone agrees. For example, Ham et al. (2019) suggest that dividend changes do convey information about future changes in accounting earnings, at least in the short term.
of earnings, and not about the first moment. Introducing a technique new to corporate finance research we are able to identify cash-flow volatility as the source of this effect. To some extent, the kernel of this idea goes back to Lintner (1956) who argues that managers increase dividends only when they believe earnings have increased “permanently”, and is also consistent with the survey evidence that CFOs only increase dividends when the risk of future cuts is lower (Brav et al. (2005)). To address the question of whether dividend changes convey information about the first or second moment of earnings, we borrow a method from asset pricing, the Campbell (1991) and Campbell and Shiller (1988a,b) decomposition, initially proposed to study aggregate market return predictability. The method allows us to decompose movements in stock returns into parts coming from news about future cash flows and parts coming from news about future discount rates.\(^5\)

We follow Vuolteenaho (2002) who applies the method at the individual firm level and construct measures of cash-flow and discount-rate news, and examine whether they vary around dividend events such as initiations, omissions, increases, and decreases. Specifically, 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. The method has the advantage that it directly uses information in returns to infer cash-flow news rather than relying on balance-sheet variables such as earnings or cash flows that are only available at lower frequency, are prone to manipulation in the short run, and are non-stationary in levels.

Consistent with our hypothesis, we find that changes in dividend policy are followed by changes in the volatility of cash flows in the opposite direction. These results hold both on the extensive margin, initiations and omissions, and on the intensive margin, increases and decreases. Specifically, we find that the volatility of cash flows decreases on average by 15% in the five years after dividend increases relative to the prior five-year average, whereas it increases by 7% after dividend cuts. Furthermore, volatility decreases by 20% after dividend initiations and it increases by 6% after dividend omissions. In addition,

\(^{5}\)Bernanke and Kuttner (2005) and Weber (2015) use the method to study the response of stock returns to monetary policy shocks.
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.

It can be argued that an alternative to the return decomposition is to study directly
the volatility of returns. Yet, returns might vary because investors value a given stream
of cash flows with a different discount rate or because investors change their expectations
of future cash flows, which is precisely the intuition underlying our return decomposition.7
Using a comprehensive sample from 1964 until 2013, we directly show that no systematic
change occurs in stock return volatility around dividend events, and at the same time we
document significant changes in cash-flow volatility. An important benefit of our return
decomposition is that we can provide novel evidence on changes in discount rates and its
relation to corporate decisions (Cochrane (2011)). We do not find any significant change
in discount rates around dividend events, indicating that discount rate news do not drive
corporate dividend policies, possibly because they do not vary across firms in the long
run (see Keloharju, Linnainmaa, and Nyberg (2019)).

What about the first moment of expected cash flows? Our method allows us to
analyze changes in the first moment of earnings following changes in dividends together
with other possible changes in the components of stock returns: discount rate news and
the volatility of cash-flow news. We find that corporate earnings do not change in the same
direction as dividend changes, which is inconsistent with the idea that dividends convey
information about the first moment. Because we show that neither discount-rate news
nor total stock-return volatility changes following dividend changes, we establish that
any possible 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 total stock return volatility and beta (e.g., Grullon
et al. (2002); Hoberg and Prabhala (2009)). Our results indicate the evidence in Grullon

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6Venkatesh (1989) and Jones et al. (2014) report that total return volatility and implied volatility
from option prices decrease after dividend initiations; Jayaraman and Shastri (1993) document that
implied volatility from option prices is lower after dividend increases; Chay and Suh (2009) document in
a cross-country sample a negative correlation between total return volatility and cash payouts.

7A similar reasoning applies to option-implied measures of volatility. In addition, option-implied
measures are only available for a shorter period, starting in 1996.
et al. (2002) of a decrease in beta, following dividend increases is exclusively driven by changes in the volatility of cash-flow news and not by changes in discount-rates news or the level of cash-flow news.

What can explain the negative relation between changes in dividends and subsequent changes in cash-flow volatility? Our empirical evidence might be due to precautionary savings motives on the side of managers; or due to managers wanting to signal information to the market; or possibly to the presence of managerial agency costs. While signaling and agency theories are popular in the context of dividend policies, none of these theories are typically cast with reference to the dynamic pattern of cash-flow volatility. To study the driving forces behind our findings, we embed all three channels into a single framework and derive predictions that allow us to better understand the forces behind the empirical results we find. The first reason, a pure precautionary channel is unlikely to solely explain our results because the information set of investors does not change around dividend events and hence it cannot rationalize the abnormal return evidence around the announcement of dividend policies.

In our framework, both signaling and agency considerations predict 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. Thus both theories predict larger decreases in cash-flow volatility and larger cumulative abnormal returns around the announcement of larger dividend increases. These predictions are consistent with our novel empirical findings. The signaling and agency mechanisms are quite different, though, in one specific, cross-sectional dimension. In our signaling model, as in Miller and Rock (1985), the cost of the signal is foregone investment opportunities. Consequently, following a dividend change, we should expect a larger change in future cash-flow volatility for firms with smaller current earnings. The reason is that when 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. The agency channel has the opposite prediction. The reason is that in the presence of agency costs, lower future cash-flow volatility enables managers to both incur lower agency costs and pay more
dividends without foregoing future investment opportunities. By relaxing the budget constraint, larger current earnings amplify this effect: with larger current earnings, corporate managers can both have their cake (extract private benefits) and eat it (pay dividends), without foregoing future investment. In the data, we find that the same dollar of dividend paid is followed by a 25% larger reduction in cash-flow volatility for firms with smaller current earnings, consistent with the prediction of the signaling channel.

Given our results so far, one natural question arises as to whether total cash payouts, comprising both dividends and share repurchases, reflect similar dynamics of future cash flows. This question is particularly relevant given the path of payout policies in the past four decades, whereby share repurchases have become the dominant form of cash payouts. Strikingly and in line with our results on dividends, we find a strong 15% 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. In addition, consistent with our results on dividends and with the signaling hypothesis, we find that larger share-repurchase programs are 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 results yield four important implications. First, dividends do convey information. But the information or the signal is about expected earnings volatility. We also confirm that the information conveyed in dividends is not about the first moment of earnings: The level of earnings does not increase after a dividend increase. Second, our framework and results are able to explain why stable and mature firms signal by making the largest cash payouts, a finding that was otherwise puzzling under the idea that the attribute being signaled was the first moment of cash flows. Third, whereas prior literature rightly suggested that dividends and share repurchases have many different features, we document a key and novel shared attribute: both dividends and share repurchases signal future changes in cash-flow volatility. Finally, our method and our evidence speak to the debate on whether cash flow or discount rates drive corporate finance decisions (e.g., Fama and French (1988), Cochrane (2011)). Our finding that dividends do not convey information
about discount rate news reinforce the notion that cash flows—and not discount rates—drive corporate financial decisions, at least with respect to payout policies.

II Method

To test our hypotheses on changes in cash flows and discount rates following dividend changes, we require measures of the first and second moment of expected cash flows and discount rates. 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.

To see the intuition underlying the method, consider a simple discounted cash-flow model, with current and 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 Federal Open Market Committee monetary policy 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.8

The method provides a direct empirical counterpart to our hypotheses about cash-flows volatility. By contrast, other measures of volatility (e.g., total stock return

8Cash-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.
volatility, implied volatility from option prices) do not allow a decomposition into components originating from cash flows or discount rates. As we show below, total stock return volatility does not change following dividend changes, implying that total stock return volatility is a poor proxy for cash-flow volatility. Furthermore, the method is not subject to the bias arising from non-stationarity when estimating cash flows from accounting information. 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 in corporate earnings. 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. 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 ($\Delta B_t$) 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.\textsuperscript{11}

\textsuperscript{9}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 our hypotheses.

\textsuperscript{10}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)).

\textsuperscript{11}We use small letters to denote the log of a variable unless specified otherwise.
These assumptions allow us to write the log book-to-market ratio, $\theta$, as

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

(1)

$\text{roe}$ is log return on equity, which we define as $\text{roe}_t = \log(1 + X_t/B_{t-1})$, $r_t$ 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 linearization constants, which are not essential for the analysis, and $\rho$ 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 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):

$$
 r_t - E_{t-1} r_t = \Delta E_t \sum_{s=0}^{\infty} \rho^s (\text{roe}_{t+s} - f_{t+s}) - \Delta E_t \sum_{s=1}^{\infty} \rho^s r_{t+s}.
$$

(2)

$\Delta E_t$ denotes the change in the expectations operator from $t - 1$ to $t$, that is, $E_t(\cdot) - E_{t-1}(\cdot)$. 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, $\eta_{c,t}$, and discount-rate news, $\eta_{r,t}$:

$$
 r_t - E_{t-1} r_t = \eta_{c,t} - \eta_{r,t}.
$$

(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.\footnote{The assumption of a first-order VAR is not restrictive, because we can add lags of the state variables and adjust the notation accordingly.} We can then write the system as

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

$\Sigma$ 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 $e1' = [1 \ 0 \ldots \ 0]$. We can now write unexpected stock returns as

$$r_{i,t} - \mathbb{E}_{t-1} r_{i,t} = e1'u_{i,t}. \quad (5)$$

Discount-rate news is

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

which we can now simply write as

$$\eta_{r,t} = e1' \sum_{s=1}^{\infty} \rho^s \Gamma^s u_{i,t+s} \quad (7)$$

$$= e1' \rho \Gamma (1 - \rho \Gamma)^{-1} u_{i,t} \quad (8)$$

$$= \lambda' u_{i,t}, \quad (9)$$

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

We can now write cash-flow news as

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

and the variance of cash-flows as

$$\text{var}(\eta_{cf,t}) = (e1' + \lambda')\Sigma(e1 + \lambda). \quad (11)$$
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.

III 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 II. We detail both below. The sample period for dividend events is 1964-2013, because we require sufficient post-event data to estimate the VAR.

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. $r_t$ is then the market-adjust log return following Vuolteenaho (2002). 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 defined as in Weber (2018) and D’Acunto et al. (2018) and equals 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 debt 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. Table 1 reports descriptive statistics for our sample. Despite imposing both the dividend sample screens above and the VAR restrictions of Section II, 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.

IV Results

In this section, we report our main empirical results. In Section IV.A., we report the estimates of the VAR and the VAR-implied importance of cash-flow news and discount-rate news for our sample of firms. In Section IVB., we report our univariate tests on the first and second moment of cash-flow and discount-rate news. In Section IVC., we examine cumulative abnormal returns to the announcements of dividend events.

A. Estimates of the VAR System

Following our discussion in Section II, a central ingredient for our analysis is an estimate of the transition matrix $\Gamma$ of the VAR system and the discount factor $\rho$. We estimate
\( \rho \) 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 Volatility

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 first and second moment of cash-flow news and discount-rate news and compare these statistics after dividend events relative to before. If dividends convey information about cash flows or discount rates, their first or second moment or both will be different after the dividend events relative to before. To ensure overlapping dividend events do not drive our results, we randomly drop one of the two events.\(^{13}\)

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\(^{13}\)Results are robust to which event we drop and to not dropping any event.
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 most of 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 cash-flow volatility. Consistent with our hypothesis, we find in Panel C that 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 our hypothesis that dividends convey information about cash flow volatility.

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 $\Gamma$ 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 $\Gamma$, 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 $\Gamma$ to calculate both residuals in the five years before and after the dividend event and the cash-flow news.\footnote{Recall cash-flow news is a function of the transition matrix $\Gamma$ of the VAR, because it is a transformation of the residuals from the VAR.} In Panel B, we combine the previous two approaches and estimate one VAR across all firms and events to get an estimate of $\Gamma$, but then estimate separate VARs 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) and Chinco et al. (2019)). 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.\footnote{We estimate a constant $\Gamma$ matrix within each sample to ensure we have enough data points for reliable estimates.}

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 more detail below.

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 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.\textsuperscript{16} 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 8 below).\textsuperscript{17} 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.

\textsuperscript{16}See D’Acunto et al. (2016) for a recent application and detailed discussion.
\textsuperscript{17}We lose few observations relative to our baseline analysis due to missing matches. Table A.1 reports the characteristics we use for the matching exercise both for event firms and observationally-similar firms. Characteristics are similar for both set of firms both for the averages as well as for the standard deviations.
Our results indicate dividend changes are followed by changes in cash-flow volatility in the opposite direction. This result is novel. 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 or earnings levels. Moreover, in Table A.2 in the Online Appendix we show the variance of cash-flow news and total-return volatility are only mildly positively correlated with each other, which makes it unlikely that changes in generic return volatility can explain our findings. In Table A.3 in the Online Appendix, we directly show that annualized stock return volatility does not change around the dividend events or the change has the “wrong” sign. We use five years of daily return data before and after the dividend events to calculate stock return volatility consistent with the windows we use in the VAR.\footnote{Our results might differ from the previous literature because we use a different window to calculate total return volatility and the fact we have a substantially larger sample period.} 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 the hypothesis that dividends convey information about cash-flow volatility, that is, the second moment of future earnings. The evidence indicates that discount rate news do not drive corporate dividend policies. Next, we examine cumulative abnormal returns to the announcement of dividend events, and how such dividend announcement returns relate to subsequent changes in cash flow volatility.

C. Returns around Dividend Events and Changes in Cash-Flow Volatility

So far, we have shown dividends changes are associated with a reduction in future cash-flow volatility. We now turn to examining dividend announcement returns and how they are related to subsequent changes in cash-flow volatility. If dividend changes
convey information about subsequent changes in cash-flow volatility, then announcements of larger dividends should come with both larger cumulative announcement returns and larger subsequent changes in cash-flow volatility in the opposite direction.

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. We then turn to a test of our hypothesis. We split the data into two sub-samples by the size of the dividend changes, using the median dividend change as the break point. Table 7 reports the results. In Panel A of Table 7, 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 7, 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 the hypothesis that dividend changes convey information about future cash-flow volatility.

19Table 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.

20
V Why are Dividend Changes followed by Changes in Cash-Flow Volatility?

In this section, we develop a framework to account for our empirical results of Section IV. We begin by showing in Section VA that a simple framework with symmetric information and a precautionary savings motive is sufficient to generate the prediction that dividend payments should correlate negatively with subsequent changes in cash-flow volatility. This baseline framework, however, cannot account for our announcement return evidence. We consider two alternative ways to augment the basic setting. First, in Section VB we consider a setting with asymmetric information about future cash-flow volatility and we derive additional cross-sectional predictions. Next, in Section VC we consider a setting with agency costs, and we derive additional cross-sectional predictions. These alternative cross-sectional predictions will then allow us to go back to the data to establish the mechanism driving our results.

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, \(\omega_0\), and invests, \(I_0 \leq \omega_0\). At \(t = 1\), the manager receives an endowment, \(\omega_1\), and decides whether to pay dividends, \(D_1\). Next, cash flows are realized, \(Y_1 = f(I_0) + \nu\), where \(f\) is a production function with \(f' > 0, f'' < 0,\) and \(f''' > 0\); the shock \(\nu\) is distributed according to function \(G\), with expected value \(E(\nu)\) that we normalize to 0, and a known variance \(\sigma^2\), with \(|\nu|<< Y\). We denote \(E[Y_1] = Y\).\(^{20}\) 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, \(Y_2 = f(I_1) + \nu\).\(^{21}\) The interest rate equals zero. Thus, the timeline is as follows:

**Time 0:** Firm gets endowment \(\omega_0\); wlog invests \(I_0 = \omega_0\);

**Time 1:** Firm gets endowment \(\omega_1\); firm decides how much dividend \(D_1\) to pay; after \(D_1\)

---

\(^{20}\)We rule out extreme negative realizations to avoid that at \(t = 2\) the firm goes bankrupt.

\(^{21}\)All values \(I_0, I_1, Y_1, Y_2, D_1\) can be thought of as being per share, without loss of generality.
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.

This setting captures a seasoned firm that has been in operation well before the dividend decision and expects to continue to operate in the future. Accordingly, we can think of Time 0 as “the distant past,” Time 1 as “now,” and Time 2 as “the distant future”. Similarly, we can interpret the endowments as the cash flows resulting from past investment decisions. 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.\(^{22}\)

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

\[
\max_{D_1} \quad D_1 + \mathbb{E}[Y_2]
\]

subject to

\[
Y_2 = f(I_1) + \nu
\]

\[
D_1 \leq \omega_1,
\]

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 coefficient in the sense of Arrow-Pratt.\(^{23}\) 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

\(^{22}\)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)).

\(^{23}\)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.
precise sense that $\mathbb{E}[f(Y)] < f(\mathbb{E}[Y])$, that is, Jensen’s inequality.\textsuperscript{24} The first-order condition is $1 - f'(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2) \geq 0$.

**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 increases. This prediction follows from the precautionary savings motive, because in our setting lower dividends directly translate in higher cash balances available for future investment.\textsuperscript{25}

This stylized model already rationalizes the main finding of our paper; that is, dividend changes should be followed by changes in cash-flow volatility in the opposite direction (see Tables 3, 4, and 6). Of course, this model is too stylized along several dimensions. Most notably, it cannot account for our evidence in Table A.4 that announcements of dividends result in positive abnormal returns and the large positive announcement returns reflect the subsequent reduction in cash-flow volatility, as we show in Table 7. The reason is that in this model 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

\textsuperscript{24}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).

\textsuperscript{25}Together with Jensen’s inequality, this equivalence between cash balances and the negative of cash payouts implies that lower cash-flow volatility will eventually result in higher investment and cash flows at Time 2. In a richer model with a wedge between cash holdings and cash payouts, this prediction would no longer necessarily hold.
empirical predictions, which we will then take to the data.\textsuperscript{26}

\section*{B. A Signaling Model of Dividends and Cash-Flow Volatility}

We introduce asymmetric information by assuming the manager learns $\sigma^2$ 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, $\sigma^2$, which is distributed according to function $\Xi$ over $[\sigma^2_{\text{min}}, \sigma^2_{\text{max}}]$. Prior to $t = 1$, the investors and the manager have symmetric information on $\sigma^2$ 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 $\sigma^2$, investors attempt to infer $\sigma^2$ 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 $\sigma^2$. 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

\[ \{\omega_0, \omega_1, I_0, D_1, \mathbb{E}(\nu) = 0, \text{Var}(\nu) = \sigma^2\} = \phi^h \]
\[ \{\omega_0, \omega_1, I_0, D_1, \mathbb{E}(\nu) = 0\} = \phi^s, \]

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

\textsuperscript{26}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, $\frac{\partial^2 \sigma^2}{\partial D_1 \partial \nu} = 0$). We show in the appendix that in the more general case, $a = a(I_1^*)$, the cross-sectional prediction is indeterminate, $\frac{\partial^2 \sigma^2}{\partial I_1^* \partial \nu} \gtrless 0$. We examine these predictions empirically in Section IV.

24
1 by those who decide to sell is thus

\[ V_1^s = D_1 + \mathbb{E} [Y_2 | \phi^s] = D_1 + \mathbb{E} [f(\omega_1 + Y_1 - D_1) | \phi^s]. \]

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

\[ V_1^h = D_1 + \mathbb{E} [Y_2 | \phi^h] = D_1 + \mathbb{E} [f(\omega_1 + Y_1 - D_1) | \phi^h]. \]

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

\[
\max_{\{D_1\}} \quad W_1 = kV_1^s + (1-k)V_1^h
\]

subject to

\[
Y_2 = f(I_1) + \nu
\]

\[ D_1 \leq \omega_1, \]

where we assume \( \omega_1 \) 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 \( Y_1 \).

Figure 1 illustrates the equilibrium. The worst firm type with the highest variance, \( \sigma_{\text{max}}^2 \), sets dividends \( D_1^* \) 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.\(^{27}\)

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

\(^{27}\)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, and we derive the ordinary differential equation (ODE) together with a boundary condition that uniquely determines the schedule. Furthermore, we prove that this solution is the Riley equilibrium outcome and it is the unique separating equilibrium of our game, by applying the results of Mailath (1987), and 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)).
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.

We can now derive the main comparative statics, which will guide our interpretation of the data. 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 baseline 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. Again, this is consistent with our baseline results in Tables 3, 4, and 6.

The second comparative static provides the more nuanced cross-sectional prediction of our signaling 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:

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

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
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, $\sigma^2$, from the dividend announcement. Then, recalling that $\sigma_p^2$ indicates the prior belief about cash-flow volatility, we obtain by Taylor-series approximation the change in firm value upon the dividend announcement, $\Delta V$, as follows:

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

where $E[D_1]$ 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 prediction.

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

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

that is, larger dividend announcement returns should be associated with larger dividend changes and larger subsequent reductions in cash-flow volatility which is consistent with our empirical findings in Table 7.

---

This prediction is also unique within the class of signaling models and crucially depends on the cost of the signal being foregone investment opportunities. In a model in which the cost of the signal is an exogenously assumed “flotation cost” of having to issue equity in the future following a negative shock, Kale and Noe (1990) obtain that idiosyncratic volatility should decrease following dividend increases, but systematic volatility should change non-monotonically with dividend payments. Because the cost of the signal is exogenous, there is no cross-sectional variation in Kale and Noe (1990) in the expected change in volatility following dividend changes.
C. An Agency Model of Dividends and Cash-Flow Volatility

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), Lambrecht and Myers (2012), and Wu (2018) for additional examinations of these ideas).

To nest some of these ideas into the same baseline model of Section V.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 \( c'' > 0 \).\(^{29}\) In this setting, the manager chooses the dividend payment to maximize

\[
\max_{D_1} D_1 + \mathbb{E} [Y_2] - c(D_1),
\]

subject to

\[
Y_2 = f(I_1) + \nu
\]

\[
D_1 \leq \omega_1.
\]

The first-order condition is

\[
1 - f' (\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2) - c'(D_1) \geq 0.
\]

Therefore, we obtain:

**Prediction 1 (agency).**

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

As in the baseline setting and in the signaling model, and consistent with our empirical findings in Tables 3, 4, and 6, 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,

\(^{29}\)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, \( Y - D \).
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).

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

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.\(^\text{30}\)

VI Inspecting the Mechanism

In this section, we report additional empirical tests designed to establish the economic mechanism driving our main results. In Section VI.A., we present cross-sectional tests of our theoretical Prediction 2, with the purpose to distinguish between a signaling and an agency explanation of our results. In Section VI.B., we examine share repurchases. In Section VI.C, we examine additional implications of an agency channel. In Section VI.D, we examine the extent to which tax arguments can explain our results. In Section VI.E, we study the temporal build-up of the change in dividend policy on the variance of cash flows.

\(^\text{30}\)Bernheim and Wantz (1995) proposed a different test to distinguish between signaling and agency theories of dividends, although the conclusions of such test are sensitive to the econometric techniques employed (see Bernhardt et al. (2005)).
A. Cross-Sectional Variation

To examine the 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, $\Delta \text{Var}(\eta_{cf_{it}})$, for firm $i$ and dividend event $t$, which we measure from stock returns using the methodology in Section II, on the percent changes in dollar dividends, $\Delta D_{it}$

$$
\Delta \text{Var}(\eta_{cf_{it}}) = \alpha + \gamma \cdot \Delta D_{it} + \delta \cdot X_{it} + \varepsilon_{it}.
$$

We control for a host of additional potential determinants of cash-flow volatility and dividend payments, $X_{it}$, 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 that allow us to disentangle signaling motives from agency, we then estimate the following specification:

$$
\Delta \text{Var}(\eta_{cf_{it}}) = \alpha + \beta_{1} \cdot \Delta D_{it} + \beta_{2} \cdot \text{eps}_{it} + \beta_{3} \cdot \Delta D_{it} \cdot \text{eps}_{it} + \delta \cdot X_{it} + \varepsilon_{it},
$$

where $\text{eps}$ is earnings per share. Our main coefficient of interest is $\beta_{3}$. From our signaling model of Section V.B., we should expect $\beta_{3} > 0$. According to the baseline setting of Section V.A. with constant Arrow-Pratt coefficient and symmetric information, we should expect $\beta_{3} = 0$. The agency model instead predicts $\beta_{3} < 0$. 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 that allow us to distinguish between alternative explanations that might drive our baseline univariate results.

Table 8 reports our estimates. Column (1) confirms our baseline finding in a
regression framework: dividend changes predict 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 \((\text{eps})\) as an additional covariate. Adding \(\text{eps}\) slightly increases the drop in variance following dividend increases. Firms with higher \(\text{eps}\) have a smaller variance in cash-flow news. Column (3) confirms our novel Prediction 2, consistent with the signaling model, and inconsistent with the precautionary savings and agency models: dividend increases result in a drop in the variance of cash-flow news, but this drop is muted for firms with higher \(\text{eps}\). 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 have 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.5), when we add the level of cash and equivalents as control variable (see Table A.6) and when we use cash flows rather than earnings (see Table A.7). Therefore, the data strongly support Prediction 2 of the signaling model in that the cross-sectional change in cash-flow volatility following dividend changes is muted for firms with larger earnings.

B. 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 more lumpy. However, because share repurchases are yet another way to return cash to shareholders, Predictions 1 and 3 in Section V.B. should also apply to share repurchases and predict patterns of cash-flow volatility following announcements of share repurchases similar to the results following
announcements of dividend increases and initiation.\textsuperscript{31}

Table 9 reports the results for scaled changes in the variance of cash-flow news after the repurchase announcements relative to before. We find the variance of cash-flow news is on average 15% lower after the repurchase announcements relative to before. We then split the data into two sub-samples by the size of the share-repurchase announcements, using the median amount as cutoff. Consistent with our results for changes in dividends and with the predictions of the signaling 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 similar information to the market regarding changes in future cash-flow volatility.

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 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.8.

\textsuperscript{31}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.
C. Agency

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 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), Daniel et al. (1997), and Freyberger et al. (2019)). 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)). 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

\footnote{Results for sample splits based on total volatility are similar; see Table A.10 in the Online Appendix.}
idiosyncratic volatility, and the difference is highly statistically significant. 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 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 is unlikely to explain our evidence on payout policy and subsequent changes in cash-flow volatility.

D. 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

33 Again, we find similar results when we split samples based on total volatility, see Table A.10 in the Online Appendix.
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.

### E. Effect over Time

Changes in the future riskiness of cash flows might occur over time and it is reasonable to assume that changes in the variance of cash-flow news build up with horizon. To examine this intuition, we study the change in the variance of cash-flow news over time using larger windows in Table A.9 of the Online Appendix. We see an impact a reduction in the variance of cash-flow news in the year around the dividend event for positive dividend changes. The reduction builds up over the following two years and levels off after four years. We observe a similar build up for dividend cuts and omissions.

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34 We thank our AFA discussant Yufeng Wu for this suggestion.
VII Conclusion

The notion that changes in payout policy convey information to the market is intuitive, and managers support it in surveys. The strong market reaction to announcements of payout changes further suggests payout 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 study whether the cash-flow volatility changes around dividend events. We use the Campbell (1991) return decomposition to estimate cash-flow volatility from data on stock returns. 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. At the same time, we do not find changes in dividends to be followed by changes in the first moment of cash flow, or by changes in total return volatility, or by changes in discount rate news.

To understand the mechanisms driving these findings, we develop a model which allows for both signaling and agency motives. Both motives have identical implications for the change in the variance of cash flow around dividend events but they make predictions of opposite signs regarding the interaction with the level of earnings. In the signaling model, a given dollar of dividends contains more information the smaller the current earnings because the cost of the signal are foregone investment opportunities. In the agency model, the market should react more strongly the higher the current earnings because low earnings already constrain the private benefits of managers. In the cross section, we find empirically the same dollar of dividend paid is followed by a larger reduction in cash-flow volatility for firms with smaller current earnings.
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, our method allows us to document novel empirical facts about the drivers of payout policy, as well as to reconsider some old ones. The main takeaway of our empirical analysis is that the riskiness of future cash flows is a central determinant of firms’ payout policies. We also show that the variance of cash-flow news is only weakly correlated with total return volatility and that the volatility of returns does not change around dividend events or has the “wrong” sign. Therefore, our results imply that total return volatility is not a good proxy for cash-flow volatility; and that having a robust method to measure cash-flow volatility is crucial.

Third, our results indicate that the often-heard reports of the demise of signaling models in corporate finance are probably premature. 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 other fields.

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. For example, Kogan et al. (2019) examine whether “unusually large” investment expenditures (i.e., “spikes”) are followed by lower cash-flow volatility, as implied by the exercise of real options, or by larger cash-flow volatility, as implied by agency theory. Our method may also be able to shed light on questions beyond finance. For example, a recent strand of research in economics 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.
References


Figure 1: Model Solution

This figure plots the solution of the signaling model of Section VB. The red line depicts the equilibrium downward sloping relationship between dividends, $D_1$, and cash flow volatility, $\sigma^2$. The worst firm type with the highest variance, $\sigma^2_{max}$, sets dividends $D_1^*$ as in the first-best, full-information case.
Table 1: Descriptive Statistics

This table reports descriptive statistics. $\Delta \text{Var}(\eta_{cf})/\text{mean}(\eta_{cf})$ 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.

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<td>Nobs Median Mean Std</td>
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<td>2,461 0.06 0.07 0.83</td>
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<td>2,461 0.00 0.00 0.02</td>
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<tr>
<td>Market Cap</td>
<td>2,441 0.45 4.34 19.23</td>
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<td>1,233 0.15 1.88 11.24</td>
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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 II. \( r_t \) denotes the excess log stock return, \( \theta \) is the log book-to-market ratio, and \( \text{roe} \) is the log return-on-equity. The sample period from 1964 till 2013.

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<th>( r )</th>
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<td>0.10</td>
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<td>(2.02)</td>
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<td>(28.85)</td>
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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 II. 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 ($\Delta \text{Var}(\eta_{cf})$), 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 ($\Delta \text{Var}(\eta_{cf})/\text{mean}(\text{Var}(\eta_{cf}))$). Our sample period is 1964 till 2013.

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<td>Panel D. $\Delta$ Scaled Variance Cash-flow News: $\Delta \text{Var}(\eta_{cf})/\text{mean}(\text{Var}(\eta_{cf}))$</td>
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<td>2,461</td>
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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 II. Panel A estimates one VAR for the whole sample period and then uses the estimate for $\Gamma$ 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 $\Gamma$, 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.

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<td><strong>Panel C. Extended Sample</strong></td>
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<td>5,942</td>
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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 II. 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.

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

<table>
<thead>
<tr>
<th></th>
<th>$\Delta Div &gt; 0$</th>
<th>Initiation</th>
<th>Pooled</th>
<th>$\Delta Div &lt; 0$</th>
<th>Omission</th>
<th>Pooled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>($\Delta$)</td>
<td></td>
<td>($\Delta$)</td>
<td></td>
<td></td>
<td>($\Delta$)</td>
</tr>
<tr>
<td>(1)</td>
<td>-14.81%</td>
<td>-25.72%</td>
<td>-17.80%</td>
<td>7.25%</td>
<td>5.36%</td>
<td>6.68%</td>
</tr>
<tr>
<td>(2)</td>
<td>(-9.57)</td>
<td>(-5.90)</td>
<td>(-9.89)</td>
<td>(4.32)</td>
<td>(2.27)</td>
<td>(4.87)</td>
</tr>
<tr>
<td>Nobs</td>
<td>2,401</td>
<td>906</td>
<td>3,307</td>
<td>2,419</td>
<td>1,051</td>
<td>3,470</td>
</tr>
</tbody>
</table>

49
Table 7: 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 (\(\Delta \frac{\text{Var}(\eta_{cf})}{\text{mean(Var}(\eta_{cf}))}\)) using the methodology of Vuolteenaho (2002) which we describe in Section II 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.

<table>
<thead>
<tr>
<th></th>
<th>(\Delta Div &gt; 0)</th>
<th>(\Delta Div &lt; 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large Increase (1)</td>
<td>Small Increase (2)</td>
</tr>
<tr>
<td>(\text{Panel A. } \Delta \text{ Scaled Variance Cash-flow News: } \Delta \frac{\text{Var}(\eta_{cf})}{\text{mean(Var}(\eta_{cf}))})</td>
<td>(-19.02%) (-8.28)</td>
<td>(-10.56%) (-5.18)</td>
</tr>
<tr>
<td>(\text{Nobs})</td>
<td>1,243</td>
<td>1,198</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>(\text{Panel B. Cumulative Returns})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(\text{Large Increase})</td>
</tr>
<tr>
<td></td>
<td>(0.76%) (5.68)</td>
</tr>
<tr>
<td>(\text{Nobs})</td>
<td>1,243</td>
</tr>
</tbody>
</table>
This table reports estimates from the following specification:

$$
\Delta \text{Var}(\eta_{cf_{it}}) = \alpha + \beta_1 \cdot \Delta D_{it} + \beta_2 \cdot \text{eps}_{it} + \beta_3 \cdot \Delta D_{it} \cdot \text{eps}_{it} + \delta \cdot X_{it} + \varepsilon_{it}.
$$

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 II of firm $i$ at event $t$, $\Delta \text{Var}(\eta_{cf_{it}})$, on the dividend change, $\Delta D_{it}$, earnings per share, $\text{eps}_{it}$, 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.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta Div$</td>
<td>-0.26</td>
<td>-0.24</td>
<td>-0.37</td>
<td>-0.35</td>
<td>-0.15</td>
<td>-0.14</td>
<td>-0.25</td>
<td>-0.23</td>
</tr>
<tr>
<td></td>
<td>(-5.55)</td>
<td>(-5.31)</td>
<td>(-5.94)</td>
<td>(-6.06)</td>
<td>(-4.92)</td>
<td>(-4.66)</td>
<td>(-5.01)</td>
<td>(-5.00)</td>
</tr>
<tr>
<td>$\text{eps}$</td>
<td>-0.17</td>
<td>-0.12</td>
<td>-0.17</td>
<td>-0.14</td>
<td>-0.10</td>
<td>-0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-1.56)</td>
<td>(-1.87)</td>
<td>(-2.71)</td>
<td>(-1.41)</td>
<td>(-1.75)</td>
<td>(-1.76)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta Div \times \text{eps}$</td>
<td>0.24</td>
<td>0.21</td>
<td>0.19</td>
<td>0.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.12)</td>
<td>(3.19)</td>
<td>(2.64)</td>
<td>(2.51)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\eta^i$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(1.37)</td>
<td>(1.20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Book-to-market</td>
<td>28.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>132.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.33)</td>
<td>(2.41)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.35</td>
<td>-0.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(-2.54)</td>
<td>(-1.13)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td>0.11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(3.06)</td>
<td>(1.10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.03</td>
<td>0.12</td>
<td>0.08</td>
<td>-0.86</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.45)</td>
<td>(1.22)</td>
<td>(1.01)</td>
<td>(-2.75)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*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%

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 ($\frac{\Delta \text{Var}(\eta_{cf})}{\text{mean}(\text{Var}(\eta_{cf}))}$) using the methodology of Vuolteenaho (2002) which we describe in Section II 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.

<table>
<thead>
<tr>
<th></th>
<th>Baseline (1)</th>
<th>Large Repurchase (2)</th>
<th>Small Repurchase (3)</th>
<th>$\Delta$ (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel A. $\Delta$ Scaled Variance Cash-flow News: $\frac{\Delta \text{Var}(\eta_{cf})}{\text{mean}(\text{Var}(\eta_{cf}))}$</td>
<td>$-14.79%$</td>
<td>$-18.05%$</td>
<td>$-11.54%$</td>
<td>$-5.39%$</td>
</tr>
<tr>
<td></td>
<td>$(-6.51)$</td>
<td>$(-5.65)$</td>
<td>$(-3.56)$</td>
<td>$(-13.19)$</td>
</tr>
<tr>
<td>Nobs</td>
<td>2,662</td>
<td>1,331</td>
<td>1,331</td>
<td></td>
</tr>
</tbody>
</table>

Panel B. Cumulative Returns

<table>
<thead>
<tr>
<th></th>
<th>1.91%</th>
<th>2.62%</th>
<th>1.19%</th>
<th>1.41%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$(12.11)$</td>
<td>$(10.15)$</td>
<td>$(6.68)$</td>
<td>$(36.01)$</td>
</tr>
<tr>
<td>Nobs</td>
<td>2,662</td>
<td>1,331</td>
<td>1,331</td>
<td></td>
</tr>
</tbody>
</table>
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 \((\Delta \text{Var}(\eta_{cf})/\text{mean(Var}(\eta_{cf})))\) using the methodology of Vuolteenaho (2002) which we describe in Section II in Panel A and announcement returns in Panel B. The table splits 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 & 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.

<table>
<thead>
<tr>
<th>Panel A. (\Delta) Scaled Variance Cash-flow News: (\Delta \text{Var}(\eta_{cf})/\text{mean(Var}(\eta_{cf}))))</th>
<th>(\Delta) Div &gt; 0</th>
<th>(\Delta) Div &lt; 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Vol</td>
<td>Small Vol</td>
<td>(\Delta)</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>(-17.27%)</td>
<td>(-12.89%)</td>
<td>(-4.73%)</td>
</tr>
<tr>
<td>((-6.98)</td>
<td>((-6.66)</td>
<td>((-12.57)</td>
</tr>
<tr>
<td>Nobs</td>
<td>1,102</td>
<td>1,339</td>
</tr>
</tbody>
</table>

| Panel B. Announcement Returns |
|---|---|---|---|
| Large Vol | Small Vol | \(\Delta\) | Large Vol | Small Vol | \(\Delta\) |
| (1) | (2) | (3) | (4) | (5) | (6) |
| \(0.79\%\) | \(0.65\%\) | \(0.16\%\) | \(-0.83\%\) | \(-0.57\%\) | \(-0.27\%\) |
| \(4.78\) | \(6.47\) | \(6.58\) | \(-4.34\) | \(-4.55\) | \(-11.09\) |
| 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 (\(\Delta \frac{\text{Var}(\eta_{cf})}{\text{mean}(\text{Var}(\eta_{cf}))}\)) using the methodology of Vuolteenaho (2002) which we describe in Section II 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.

<table>
<thead>
<tr>
<th>(\Delta \text{Div} &gt; 0)</th>
<th>(\Delta \text{Div} &lt; 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High BM</td>
<td>Low BM</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>(-14.89%)</td>
<td>(-14.84%)</td>
</tr>
<tr>
<td>((-6.74))</td>
<td>((-6.91))</td>
</tr>
</tbody>
</table>

Panel A. \(\Delta\) Scaled Variance Cash-flow News: \(\Delta \frac{\text{Var}(\eta_{cf})}{\text{mean}(\text{Var}(\eta_{cf}))}\)

<table>
<thead>
<tr>
<th>Nobs</th>
<th>1,245</th>
<th>1,216</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nobs</td>
<td>1,245</td>
<td>1,216</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(\Delta \text{Div} &gt; 0)</th>
<th>(\Delta \text{Div} &lt; 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High BM</td>
<td>Low BM</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>(0.75%)</td>
<td>(0.62%)</td>
</tr>
<tr>
<td>((6.97))</td>
<td>((6.13))</td>
</tr>
</tbody>
</table>

Panel B. Announcement Returns

<table>
<thead>
<tr>
<th>Nobs</th>
<th>1,219</th>
<th>1,222</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nobs</td>
<td>1,245</td>
<td>1,216</td>
</tr>
</tbody>
</table>
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 \( \frac{\Delta \text{Var}(\eta_{cf})}{\text{mean}(\text{Var}(\eta_{cf}))} \) using the methodology of Vuolteenaho (2002) which we describe in Section II 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 firm’s 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.

<table>
<thead>
<tr>
<th>Panel A. Δ Scaled Variance Cash-flow News: ( \Delta \frac{\text{Var}(\eta_{cf})}{\text{mean}(\text{Var}(\eta_{cf}))} )</th>
<th>Large Vol (1)</th>
<th>Small Vol (2)</th>
<th>Δ (3)</th>
<th>High BM (4)</th>
<th>Low BM (5)</th>
<th>Δ (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>−21.61%</td>
<td>−10.20%</td>
<td>−12.58%</td>
<td></td>
<td>−21.05%</td>
<td>−14.78%</td>
<td>−3.81%</td>
</tr>
<tr>
<td>(−4.24)</td>
<td>(−3.20)</td>
<td>(−6.18)</td>
<td></td>
<td>(−4.81)</td>
<td>(−3.05)</td>
<td>(−1.58)</td>
</tr>
<tr>
<td>Nobs 1,286</td>
<td>1,376</td>
<td>1,140</td>
<td>1,097</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B. Cumulative Returns</th>
<th>Large Vol (1)</th>
<th>Small Vol (2)</th>
<th>Δ (3)</th>
<th>High BM (4)</th>
<th>Low BM (5)</th>
<th>Δ (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.55%</td>
<td>1.30%</td>
<td>1.29%</td>
<td></td>
<td>1.76%</td>
<td>2.10%</td>
<td>−0.29%</td>
</tr>
<tr>
<td>(9.19)</td>
<td>(8.28)</td>
<td>(13.02)</td>
<td></td>
<td>(7.34)</td>
<td>(7.73)</td>
<td>(−1.38)</td>
</tr>
<tr>
<td>Nobs 1,286</td>
<td>1,376</td>
<td>1,140</td>
<td>1,097</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Online Appendix:
Signaling Safety

Roni Michaely, Stefano Rossi, and Michael Weber

Not for Publication
I Theoretical Appendices

In this Section we present our theoretical proofs. Appendix A solves the signaling model of Section VB. Appendix B analyzes the general case of our baseline setting of Section VA. Appendix C examines the our signaling model of Section VB 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 D 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 E verifies that the assumptions of Theorem 1 of Esö and Schummer (2009) hold for our signaling model, which implies that the Riley outcome is the unique equilibrium that survives the ”credible deviations” refinement (Esö and Schummer (2009); see also Cho and Sobel (1990) and Ramey (1996)). Appendix F states Theorem 1, Theorem 2 and Corollary of Mailath (1987). Appendix G states Theorem 1 of Esö and Schummer (2009). Appendix H presents an example with the log production function. Appendix I proves the main comparative statics results.

A. Solving the Signaling Model

Assume we can associate to each level of variance $\sigma^2$ 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

$$V^s(-\sigma^2(D_1), D_1) = D_1 + f(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1)),$n=1$$

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

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, $\sigma^2_{\text{max}}$, will choose the same optimal dividend $D_1$ as it would in the full-information case, so that

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

\[
\sigma^2(D_1^*) = \sigma^2_{\text{max}}.
\]

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, $\sigma^2_{\text{max}}$, sets dividends $D_1^*$ 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,

\[-V_{\sigma^2}^h(\sigma^2, D_1) \frac{\partial \sigma^2}{\partial D_1} < 0.\]

Because \(V_{\sigma^2}^h(\sigma^2, D_1) = \frac{a}{2} f''(\omega_1 + Y - D_1 - \frac{a}{2} \sigma^2) < 0\), 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 \(D_1^*\) 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.

**B. Baseline Setting: General Case**

Recall the manager’s maximization problem is,

\[
\max_{D_1} \quad D_1 + \mathbb{E}[Y_2]
\]

\[s.t.\]

\[Y_2 = f(I_1) + \nu\]

\[D_1 \leq \omega_1\]
We can rewrite $D_1 + \mathbb{E}(Y_2)$ as

\[
D_1 + \mathbb{E}(Y_2) = D_1 + \mathbb{E}(f(I_1) + \nu) \\
= D_1 + \mathbb{E}(f(\omega_1 + Y_1 - D_1)) \quad \text{(since } \mathbb{E}(\nu) = 0) \\
= D_1 + \mathbb{E}(f(\omega_1 + Y + \nu - D_1)) \quad \text{(since } \mathbb{E}(Y_1) = f(I_0) = Y) 
\]

Let $f(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2) = \mathbb{E}[f(\omega_1 + Y + \nu - D_1)]$. 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),

\[
f(\omega_1 + Y + \nu - D_1) = f(\omega_1 + Y - D_1) + f'(\omega_1 + Y - D_1)\nu + \frac{f''(\omega_1 + Y - D_1)}{2}\nu^2
\]

Taking expectation in both sides, obtain

\[
\mathbb{E}[f(\omega_1 + Y + \nu - D_1)] \approx f(\omega_1 + Y - D_1) + f'(\omega_1 + Y - D_1)\mathbb{E}(\nu) + \frac{f''(\omega_1 + Y - D_1)}{2}\mathbb{E}(\nu^2) \\
= f(\omega_1 + Y - D_1) + \frac{f''(\omega_1 + Y - D_1)}{2}\mathbb{E}(\nu^2) \quad \text{(since } \mathbb{E}(\nu) = 0) \\
= f(\omega_1 + Y - D_1) + \frac{f''(\omega_1 + Y - D_1)}{2\sigma^2}
\]

Comparing Taylor expansions of LHS and RHS, we obtain $\frac{\partial f(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2)}{\partial Y} = -\frac{f''(\omega_1 + Y - D_1)}{f'(\omega_1 + Y - D_1)}$. 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**
\[
\frac{\partial \sigma^2}{\partial D_1} < 0 \text{ if }
\]

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

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

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

Recalling the F.O.C.,

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

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

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

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

\[= \frac{2}{\sigma^2} \frac{f''(\omega_1 + Y - D_1 - a(Y, D_1)\frac{\sigma^2}{2})}{f'(\omega_1 + Y - D_1 - a(Y, D_1)\frac{\sigma^2}{2})^2} \]

\[= \frac{2}{\sigma^2} \frac{f''(\omega_1 + Y - D_1 - a(Y, D_1)\frac{\sigma^2}{2})}{f'(\omega_1 + Y - D_1 - a(Y, D_1)\frac{\sigma^2}{2})^3}
\]

Thus, if \( f''(Y, D_1) - \frac{f'}{2} \frac{\partial a(Y, D_1)}{\partial D_1} < 0 \) (i.e., \( f''(Y, D_1) - \frac{f'}{2} \frac{\partial a(Y, D_1)}{\partial D_1} < 0 \)),

\[
\frac{\partial \sigma^2}{\partial D_1} < -\frac{f''}{f'} \frac{\sigma^2 f''}{2f'} + \frac{f''}{f'} \frac{\partial a(Y, D_1)}{\partial D_1} \Rightarrow \frac{\partial \sigma^2}{\partial D_1} < 0
\]

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

**Prediction 2**

The sign of \( \frac{\partial^2 \sigma^2}{\partial D_1 \partial Y} \) 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,

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

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

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

where

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

and

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

\[
\frac{\partial a}{\partial D_1} = \frac{f''(\omega_1 + Y - D_1)f'(\omega_1 + Y - D_1) - 2f''(\omega_1 + Y - D_1)}{f''(\omega_1 + Y - D_1)} = -\frac{\partial a}{\partial Y}
\]

\[
\frac{\partial^2 a}{\partial D_1 \partial Y} = -\frac{\partial^2 a}{\partial D_1^2} = \frac{\hat{f}^{mm} \hat{f}^3 - \hat{f}^{m} \hat{f}^m \hat{f}^{m} - 2 \hat{f}^{m} \hat{f}^{m} \hat{f}^{m} - 2 \hat{f}^{m} \hat{f}^{m} \hat{f}^{m}}{\hat{f}^m}
\]

where \( \hat{f}'' = f''(\omega_1 + Y - D_1) \), \( \hat{f}'' = f''(\omega_1 + Y - D_1) \), \( \hat{f}'' = f''(\omega_1 + Y - D_1) \) and \( \hat{f}' = f'(\omega_1 + Y - D_1) \).
\[
\frac{\partial^3 a}{\partial D_1^2 \partial Y} = -\frac{\partial^3 a}{\partial D_1^3} \\
= \frac{\hat{j}^{mn} \hat{j}^{i2} - \hat{j}^{i} \hat{j}^{mr2} - 2 \hat{j}^{i} \hat{j}^{u} \hat{j}^{m} - 2 \hat{j}^{r2} \hat{j}^{mr2} - 2 \hat{j}^{r2} \hat{j}^{u} \hat{j}^{m} - 4 \hat{j}^{m} + 10 \hat{j}^{r} \hat{j}^{mr2} \hat{j}^{m}}{f^{i3}}
\]

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

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

\[
\begin{align*}
  f'(x) &= -(-ke^{-kx}) = ke^{-kx} \\
  f''(x) &= -k^2e^{-kx}
\end{align*}
\]

In this case, \( a = \frac{-f''(\omega_1 + Y - D)}{f'(\omega_1 + Y - D)} = k \) 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).
\[
\frac{\partial \sigma^2}{\partial D_1} < 0
\]

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

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

Because \( a = k > 0 \). ■

Prediction 2 (Special Case).
\[
\frac{\partial^2 \sigma^2}{\partial D_1 \partial Y} = 0
\]

Proof. \[
\frac{\partial^2 \sigma^2}{\partial D_1 \partial Y} = \frac{\partial}{\partial D_1} \frac{\partial \sigma^2}{\partial Y} = \frac{\partial}{\partial Y} \left( \frac{-2}{a} \right) = 0 \]

■
C. 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

\[ W = k \cdot V^s + (1 - k) \cdot V^h \]

\[ V^s = D_1 + f \left( \omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1) \right) \]

\[ V^h = D_1 + f \left( \omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2 \right) \]

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, \( \sigma^2 \), 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. \( \frac{\partial W}{\partial \sigma^2} > 0 \)

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

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

A6. \( W(-\sigma^2; D_1, V^h(-\sigma^2, D_1)) \) 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 \( \frac{\partial}{\partial(-\sigma^2)} \left( \frac{-\frac{\partial W}{\partial D_1}}{\frac{\partial W}{\partial \sigma^2}} \right) < 0 \).

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

\[ \frac{\partial W}{\partial \sigma^2} = k. \]

Hence:

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

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

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

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

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

D. 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 \([\sigma_{\min}^2, \sigma_{\max}^2] \subset \mathbb{R}\) and the set of possible actions is \( \mathbb{R} \). Let \( \tau^{-1}(D_1) = \sigma^2(D_1) \) where \( \tau : [\sigma_{\min}^2, \sigma_{\max}^2] \to \mathbb{R} \) is the proposed equilibrium one-to-one strategy.

Recall that

\[
W = k \cdot V^s + (1 - k) \cdot V^h \\
V^s = D_1 + f \left( \omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1) \right) \\
V^h = D_1 + f \left( \omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2 \right)
\]
so the expected payoff function is

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

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

\[(IC)\quad \tau(\sigma^2) \in \arg\max_{D_1 \in \tau([\sigma_{\min}^2, \sigma_{\max}^2])} W(-\sigma^2, -\tau^{-1}(D_1), D_1), \forall \sigma^2 \in [\sigma_{\min}^2, \sigma_{\max}^2]\]

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

\[(1)\quad W(-\sigma^2, -\sigma^2(D_1), D_1) \text{ is } C^2 \text{ on } [\sigma_{\min}^2, \sigma_{\max}^2]^2 \times \mathbb{R} \text{ (smoothness) }\]

\[(2)\quad W_2 \text{ never equals zero, and so is either positive or negative (belief monotonicity) }\]

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

\[(4)\quad W_3(-\sigma^2, -\sigma^2, D_1) = 0 \text{ has a unique solution in } D_1, \text{ denoted } \phi(\sigma^2),\]

which maximizes \(W(-\sigma^2, -\sigma^2, D_1), \text{ and } W_{33}(-\sigma^2, -\sigma^2, \phi(\sigma^2)) < 0 \text{ ("strict" quasi-concavity) }\]

\[(5)\quad \text{there exists } k > 0 \text{ such that for all } (-\sigma^2, D_1) \in [\sigma_{\min}^2, \sigma_{\max}^2] \times \mathbb{R},\]

\[W_{33}(-\sigma^2, -\sigma^2, D_1) \geq 0 \Rightarrow W_3(-\sigma^2, -\sigma^2, D_1) > k \text{ (boundedness) }\]

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

\[(6)\quad \tau(\sigma_{\min}^2) = \phi(\sigma_{\max}^2), \text{ where } \sigma_{\min}^2 = \sigma_{\max}^2 \text{ if } W_2 > 0 \text{ and } \sigma_{\min}^2 \text{ if } W_2 < 0 \text{ (initial value) }\]

\[(7)\quad \frac{W_3(-\sigma^2, -\sigma^2(D_1), D_1)}{W_2(-\sigma^2, -\sigma^2(D_1), D_1)} \text{ is a strictly monotonic function of } -\sigma^2 \text{ (single crossing). }\]

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

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

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

since \(f'(\cdot) > 0.\)
Condition (3) is satisfied because \( W_{13} < 0 \) is always negative and will never equal zero.

\[
W_{13} = \frac{\partial W}{\partial (-\sigma^2)} \frac{\partial (-\sigma^2)}{\partial D_1} = \frac{(1-k) \cdot a}{2} \frac{f'(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2)}{\partial D_1} = \frac{-(1-k) \cdot a}{2} f''(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2) > 0
\]

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

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

\[
W_3(-\sigma^2, -\sigma^2, D_1) = 0 \iff 1 - f'(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2) = 0
\]

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

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

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

\[
W_{33}(-\sigma^2, -\sigma^2, D_1) = \frac{\partial W_3}{\partial D_1} = \frac{1 - f'(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2)}{\partial D_1} = f''(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2) < 0
\]

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

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

\[ \iff \]

\[ f''(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2) \geq 0 \]

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

\[ W_3 = 1 - f'(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2) \neq 1 - f'(\omega_1 + Y - D_1^* - \frac{a}{2} \cdot \sigma^2) = 0 \quad (A.4) \]

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

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. \( \tau(\sigma_{\text{max}}^2) = \phi(\sigma_{\text{max}}^2) \).

Condition (7) holds because
\[
W_3(-\sigma^2, -\sigma^2(D_1), D_1) = 1 - k \cdot f'(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)) \\
+ \frac{k \cdot a}{2} f'(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)) \frac{\partial(-\sigma^2(D_1))}{\partial D_1} \\
-(1-k) \cdot f'(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2) \\
W_2(-\sigma^2, -\sigma^2(D_1), D_1) = \frac{\partial W}{\partial(-\sigma^2(D_1))} \\
= \frac{k \cdot a}{2} f'(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)) \\
\frac{\partial W_3(-\sigma^2, -\sigma^2(D_1), D_1)}{\partial W_2(-\sigma^2, -\sigma^2(D_1), D_1)} \frac{\partial(-\sigma^2)}{\partial\sigma^2} = -\frac{a}{2} \cdot 2(1-k) f''(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)) \\
- \frac{k \cdot a}{2} f'(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)) \\
= -1 - \frac{k}{k} \cdot f''(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2(D_1)) > 0
\]

Thus \(W_3(-\sigma^2, -\sigma^2(D_1), D_1)/W_2(-\sigma^2, -\sigma^2(D_1), D_1)\) 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.

**E. 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 \(\sigma^2\) (type) decides to pay \(D_1\) (signal). The investors (receivers) in the market buy the share of the firm at price \(V^*(D_1)\) 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.** \(W(-\sigma^2, D_1, V^*(D_1))\) is strictly increasing in \(V^*(D_1)\) 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 \( \sigma^2 \) 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,
\[
\frac{\partial V^h}{\partial (-\sigma^2)} = \frac{a}{2} f'(\omega_1 + Y - D_1 - \frac{a}{2} \sigma^2) > 0.
\]

**A4.** Assume the game satisfies the central assumption in Spenceian 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,

\[ W(-\sigma^2, D_1, V^h(D_1)) = V^h(D_1) = D_1 + f\left(\omega_1 + Y - D_1 - \frac{a}{2} \cdot \sigma^2\right). \]

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.

**F. 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, \(\tau\) is an optimal strategy for the informed agent, so that \(\tau(\alpha)\) maximizes the expected payoff. So, for \(\tau\) to be a separating equilibrium strategy it must be one-to-one and satisfy incentive compatibility (IC):

\[(IC) \quad \tau(\alpha) \in \arg\max_{y \in \tau([m, M])} U(\alpha, \tau^{-1}(y), y), \forall \alpha \in [m, M]\]

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

\[(SIC) \quad \tau(\alpha) = \arg\max_{y \in \tau([m, M])} U(\alpha, \tau^{-1}(y), y) \forall \alpha \in [m, M].\]
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 $(\alpha, y) \in [m, M] \times \mathbb{R}$ $U_{33}(\alpha, \alpha, y) \geq 0 \Rightarrow |U_3(\alpha, \alpha, y)| > k$ (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 $\alpha$ (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 $\tau$ has at most one discontinuity on $[m, M]$, and where it is continuous on $(m, M)$, it is differentiable and satisfies $\frac{d\tau}{d\alpha} = -\frac{U_2(\alpha, \alpha, \tau)}{U_3(\alpha, \alpha, \tau)}$.

Furthermore, if $\tau$ is discontinuous at a point, $\alpha'$ say, then $\tau$ is strictly increasing on one of $[m, \alpha')$ or $(\alpha', M]$ and strictly decreasing on the other, and the jump at $\alpha'$ 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 $\tau$ is satisfied. Then $\tau$ 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 $\tau$ is continuous on $[m, M]$ and $\frac{d\tau}{d\alpha}$ 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 $\tau$ satisfies incentive compatibility, then $\tau = \tilde{\tau}$.
This Section states results in Esö and Schummer (2009) that are used above.

Define the Sender-Receiver game which is denoted by the tuple \((\Theta, \pi, u_S, u_R)\). The Sender has private information that is summarized by his type \(\theta \in \Theta = \{\theta_1, \theta_2, \ldots, \theta_n\} \subset \mathbb{R}\), where \(\theta_1 < \theta_2 < \cdots < \theta_n\). The commonly known prior probability that the Sender’s type is \(\theta\) is \(\pi(\theta)\). Upon realizing his type, the Sender chooses a message \(m \in \mathbb{R}_+\). A strategy for the Sender is a function \(M: \Theta \rightarrow \mathbb{R}_+\). 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 \(\mu: \mathbb{R}_+ \rightarrow \Delta(\Theta)\), where \(\Delta(\Theta)\) refers to the set of probability distributions on \(\Theta\). 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 \(BR(\tilde{\pi}, m) \equiv \arg\max_{a \in \mathbb{R}} E[u_R(\theta, m, a) | \tilde{\pi}]\).

Formalizing Credible Deviations

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

\[
C = \{\theta \in \Theta : u^*_S(\theta) < \min_{a \in BR(C, m)} u_S(\theta, m, a)\} \quad \text{(A.5)}
\]

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 \((\theta, m)\). 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 \( \theta \) 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 \( \theta \) 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 \( \theta \).

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 \( \theta \) and \( m \), let \( \hat{a}(\theta, m) \) be the action to satisfy,
\[
  u_S(\theta, m, \hat{a}(\theta, m)) = u^*_S(\theta)
\]
if such an action exists, and denote \( \hat{a}(\theta, m) = \infty \) otherwise. This action by the Receiver would give Sender-type \( \theta \) his equilibrium payoff after sending \( m \). If such an action exists, it is unique by monotonicity.

**Lemma 3** If an equilibrium \((M, A, \mu)\) 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.

**H. 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)
\[
1 - f'(\omega_1 + Y - D_1 - \frac{a}{2} \sigma^2(D_1)) - \frac{ka}{2} \cdot f'(\omega_1 + Y - D_1 - \frac{a}{2} \sigma^2(D_1)) \cdot \frac{\partial^2(D_1)}{\partial D_1} = 0 \quad \text{(A.7)}
\]
becomes
\[
\frac{\partial \sigma^2(D_1)}{\partial D_1} = \frac{2(\omega_1 + Y - D_1 - 1 - \frac{a}{2}\sigma^2)}{k \cdot a}.
\]

(A.8)

Together with the boundary condition which says the worst type chooses the dividend such that \(\sigma^2(D^*_1) = \sigma^2_{max}\), we get the solution to this problem,
\[
\sigma^2(D_1) = \frac{2(\omega_1 - Y - 1 - \frac{a}{2}\sigma^2)D_1 - D_1^2 + a \cdot k \cdot \sigma^2_{max} + D^*_1^2 - 2(\omega_1 + Y - 1 - \frac{a}{2}\sigma^2)D^*_1}{k \cdot a}
\]

(A.9)

where \(D_1 \geq D^*_1\).

I. 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

\[-V^2_{s2}(\sigma^2, D_1) \frac{\partial \sigma^2}{\partial D_1} < 0 \tag{A.10}\]

With \(V^2_{s2}(\sigma^2, D_1) = \frac{a}{2}f''(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2) < 0\), 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
\[
\frac{\partial \sigma^2(D_1)}{\partial D_1} = \frac{1 - f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2)}{\frac{ka}{2} \cdot f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1))}
\] (A.12)

Then
\[
\frac{\partial^2 \sigma^2(D_1)}{\partial D_1 \partial Y} = \frac{\partial \left( \frac{1 - f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2)}{\frac{ka}{2} \cdot f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1))} \right)}{\partial Y} = -\frac{2f''(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1))}{k \cdot a \cdot \left[ f'(\omega_1 + Y - D_1 - \frac{a}{2}\sigma^2(D_1)) \right]^2} > 0
\]
because \(f'' < 0\).
Table A.1: Descriptive Statistics Matching

This table reports descriptive statistics for the event firms and the observationally-similar firms matched on propensity scores. BM is the book-to-market-ratio, Size is the log market cap, Lev is financial leverage and age is the time since the firm has been on CRSP. Our sample period is 1964 till 2013.

<table>
<thead>
<tr>
<th></th>
<th>Event Firms</th>
<th>Matched Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nobs  Median</td>
<td>Mean</td>
</tr>
<tr>
<td>BM</td>
<td>6,777 0.70</td>
<td>0.92 0.79</td>
</tr>
<tr>
<td>Size</td>
<td>6,777 19.66</td>
<td>19.74 1.93</td>
</tr>
<tr>
<td>Leverage</td>
<td>6,777 0.41</td>
<td>0.43 0.27</td>
</tr>
<tr>
<td>Age</td>
<td>6,777 12.75</td>
<td>15.96 9.93</td>
</tr>
</tbody>
</table>
Table A.2: Correlation between Variance of Cash Flow News and Stock Return Volatility

This table reports correlations of the variance of cash-flow news using the methodology of Vuolteenaho (2002) which we describe in Section II and stock-return volatility which we calculate using five years of daily data around dividend events. The sample period from 1964 till 2013.

<table>
<thead>
<tr>
<th></th>
<th>Before (1)</th>
<th>After (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiations</td>
<td>17.82%</td>
<td>21.54%</td>
</tr>
<tr>
<td>Dividend Increases</td>
<td>22.38%</td>
<td>21.31%</td>
</tr>
<tr>
<td>Omissions</td>
<td>20.62%</td>
<td>21.29%</td>
</tr>
<tr>
<td>Dividend Decreases</td>
<td>21.56%</td>
<td>21.34%</td>
</tr>
</tbody>
</table>
Table A.3: Scaled Change in Stock Return Volatility Around Dividend Events

This table reports changes in annualized stock return volatility around dividend events using using five years of daily data before and after the dividend event. Panel A reports the average change in annualized stock return volatility and Panel B reports the average change in annualized stock return volatility scaled by the average stock return volatility before the event. Our sample period is 1964 till 2013.

<table>
<thead>
<tr>
<th></th>
<th>ΔDiv &gt; 0</th>
<th>Initiation</th>
<th>Pooled</th>
<th>ΔDiv &lt; 0</th>
<th>Omission</th>
<th>Pooled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td>Panel A. Δ Annualized Return Variance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.42%</td>
<td>18.16%</td>
<td>18.31%</td>
<td>-6.42%</td>
<td>5.43%</td>
<td>-4.24%</td>
<td></td>
</tr>
<tr>
<td>(8.39)</td>
<td>(5.24)</td>
<td>(9.82)</td>
<td>(-2.77)</td>
<td>(0.93)</td>
<td>(-1.95)</td>
<td></td>
</tr>
</tbody>
</table>

| Panel B. Δ Scaled Annualized Return Variance |           |            |        |          |          |        |
| 3.76%           | 3.70%    | 3.73%      | -1.31% | 1.11%    | -0.86%   |        |
| (8.39)           | (5.24)   | (9.82)     | (-2.77)|(0.93)    | (-1.95)  |        |

| Nobs            | 2,441    | 1,069      | 3,510  | 2,461    | 1,233    | 3,694  |
Table A.4: Announcement Returns

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

<table>
<thead>
<tr>
<th></th>
<th>ΔDiv &gt; 0</th>
<th>Initiation</th>
<th>Pooled</th>
<th>ΔDiv &lt; 0</th>
<th>Omission</th>
<th>Pooled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td></td>
<td>0.72%</td>
<td>2.37%</td>
<td>1.22%</td>
<td>-0.70%</td>
<td>-8.68%</td>
<td>-3.38%</td>
</tr>
<tr>
<td></td>
<td>(7.69)</td>
<td>(11.00)</td>
<td>(13.11)</td>
<td>(-6.11)</td>
<td>(-29.77)</td>
<td>(-24.37)</td>
</tr>
<tr>
<td>Nobs</td>
<td>2,441</td>
<td>1,069</td>
<td>3,510</td>
<td>2,461</td>
<td>1,233</td>
<td>3,694</td>
</tr>
</tbody>
</table>
Table A.5: Regression of Changes in Variance of Cash-Flow News Around Dividend Events: Initial Variance

This table reports estimates from the following specification:

$$\Delta \text{Var}(\eta_{cf_{it}}) = \alpha + \beta_1 \cdot \Delta D_{it} + \beta_2 \cdot \text{eps}_{it} + \beta_3 \cdot \Delta D_{it} \cdot \text{eps}_{it} + \delta \cdot X_{it} + \epsilon_{it}.$$  

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 II of firm i at event t, $\Delta \text{Var}(\eta_{cf_{it}})$, on the dividend change, $\Delta D_{it}$, earnings per share, $\text{eps}_{it}$, 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.

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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%
Table A.6: Regression of Changes in Variance of Cash-Flow News Around Dividend Events

This table reports estimates from the following specification:

\[
\Delta \text{Var}(\eta \cdot f_{it}) = \alpha + \beta_1 \cdot \Delta D_{it} + \beta_2 \cdot \text{eps}_{it} + \beta_3 \cdot \Delta D_{it} \cdot \text{eps}_{it} + \delta \cdot X_{it} + \varepsilon_{it}.
\]

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 II of firm \(i\) at event \(t\), \(\Delta \text{Var}(\eta \cdot f_{it})\), on the dividend change, \(\Delta D_{it}\), earnings per share, \(\text{eps}_{it}\), 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.

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</table>

Year FE | Industry FE |
--- | --- |
X | X |
X | X |
X | X |
X | X |

R2               | 2.06% | 2.89% | 3.89% | 5.24% | 30.60% | 31.15% | 31.80% | 32.27% |
Table A.7: Regression of Changes in Variance of Cash-Flow News Around Dividend Events

This table reports estimates from the following specification:

\[
\Delta \text{Var}(\eta_{cfi}) = \alpha + \beta_1 \cdot \Delta D_{it} + \beta_2 \cdot CF_{it} + \beta_3 \cdot \Delta D_{it} \cdot CF_{it} + \delta \cdot X_{it} + \varepsilon_{it}.
\]

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 II of firm i at event t, \( \Delta \text{Var}(\eta_{cfi}) \), on the dividend change, \( \Delta D_{it} \), 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.

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Table A.8: 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 \( \frac{\Delta \text{Var}(\eta_{cf})}{\text{mean}(\text{Var}(\eta_{cf}))} \) using the methodology of Vuolteenaho (2002) which we describe in Section II 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.

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<td>−17.05%</td>
<td>−3.07%</td>
<td>3.04%</td>
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<td>−0.62%</td>
<td>−0.82%</td>
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Table A.9: Scaled Change in Variance of Cash-Flow News Around Dividend Events: Build-Up  

This table reports changes in cash-flow news around dividend events using the methodology of Vuolteenaho (2002) which we describe in Section II. We study the build-up of the change in the variance of cash-flow news after the dividend event over time when we expand the event window. Our sample period is 1964 till 2013.

| (\text{Var}(\eta_{cft+1} - \text{Var}(\eta_{cft-1}))/\text{mean}(\text{Var}(\eta_{cft-5}))) | \Delta \text{Div} > 0 & \text{Initiation} & \text{Pooled} & \Delta \text{Div} < 0 & \text{Omission} & \text{Pooled} |
|-------------------------------------------------|----------------|---------------|-------------|---------------|-------------|-------------|
| (\text{Var}(\eta_{cft+2} - \text{Var}(\eta_{cft-2}))/\text{mean}(\text{Var}(\eta_{cft-5}))) | \text{Nobs} 2,441 & 1,069 & 3,510 & 2,461 & 1,233 & 3,694 |
| (\text{Var}(\eta_{cft+3} - \text{Var}(\eta_{cft-3}))/\text{mean}(\text{Var}(\eta_{cft-5}))) | \text{Nobs} 2,441 & 1,069 & 3,510 & 2,461 & 1,233 & 3,694 |
| (\text{Var}(\eta_{cft+4} - \text{Var}(\eta_{cft-4}))/\text{mean}(\text{Var}(\eta_{cft-5}))) | \text{Nobs} 2,441 & 1,069 & 3,510 & 2,461 & 1,233 & 3,694 |
| (\text{Var}(\eta_{cft+5} - \text{Var}(\eta_{cft-5}))/\text{mean}(\text{Var}(\eta_{cft-5}))) | \text{Nobs} 2,441 & 1,069 & 3,510 & 2,461 & 1,233 & 3,694 |
Table A.10: 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 ($\frac{\Delta \text{Var}(\eta_{cf})}{\text{mean} \text{Var}(\eta_{cf})}$) using the methodology of Vuolteenaho (2002) which we describe in Section II 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.

<table>
<thead>
<tr>
<th>$\Delta \text{Div} &gt; 0$</th>
<th>$\Delta \text{Div} &lt; 0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Vol</td>
<td>Small Vol</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Panel A. $\Delta$ Scaled Variance Cash-flow News: $\frac{\Delta \text{Var}(\eta_{cf})}{\text{mean} \text{Var}(\eta_{cf})}$</td>
<td></td>
</tr>
<tr>
<td>$-16.49%$</td>
<td>$-13.13%$</td>
</tr>
<tr>
<td>$(-7.23)$</td>
<td>$(-6.39)$</td>
</tr>
<tr>
<td>Nobs</td>
<td>1,262</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\Delta \text{Div} &gt; 0$</th>
<th>$\Delta \text{Div} &lt; 0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Vol</td>
<td>Small Vol</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Panel B. Announcement Returns</td>
<td></td>
</tr>
<tr>
<td>$0.93%$</td>
<td>$0.48%$</td>
</tr>
<tr>
<td>$(5.97)$</td>
<td>$(5.10)$</td>
</tr>
<tr>
<td>Nobs</td>
<td>1,262</td>
</tr>
</tbody>
</table>