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An empirical analysis of the dynamic relation among investment, earnings and dividends

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Abstract

Purpose – The purpose of this paper is to examine the dynamic relationships among investment, earnings and dividends for US firms. The sample period is 1950-2006.

Design/methodology/approach – The authors use a firm-level vector auto-regression (VAR) framework to examine the firm-level dynamics among investment, earnings and dividends. The firm-level VAR yields Granger causality results, impulse response functions, and variance decompositions characterizing the dynamics of these three variables at the firm level.

Findings – For the average firm in the sample, Miller and Modigliani dividend policy irrelevance is not supported, even in the long run; the shocks to dividends do have long-run consequences for investment and vice versa. Dividend changes are an ineffective signal of future earnings in both the short and long-term. The cost of an increased dividend is on average an immediate decrease of $3 in investment for every dollar increase in dividends and the effect is persistent up to six years after the increase in dividends.

Research limitations/implications – The firm-level VAR used in the study requires that sample firms have long histories of investment, earnings and dividend data. The study addresses the interaction between dividends and investment and therefore necessitates examining dividend-paying firms. By the nature of the research question, the sample firms will not be representative in all respects to the universe of firms. The most striking difference between the sample and the universe of firms is firm size. As such, the study's conclusions are most applicable to larger, stable, dividend-paying firms. The study is also limited to dividend payout. Alternative payout policies, such as share repurchases, are not considered in this work.

Practical implications – In theory, increases in dividends can signal higher future earnings; however, the evidence does not support this hypothesis. When capital markets are constrained or incomplete, increases in dividends come at a cost to investment. Firms should consider alternative methods of signaling future earnings that have less of an impact on investment. Investors should carefully evaluate the possible impact of an increase in dividends on investment and future earnings growth.

Originality/value – This study is the first to examine the dynamics of earnings, dividends and investment at a firm level and over such a long sample period. By including the dynamics of earnings, the authors emphasize the potential opportunity costs that increasing dividends has on investment when capital markets are imperfect. The dynamic system also allows the authors to consider long-run effects as well as immediate responses to system shocks.

Keywords Granger causality, Dividends, Variance decomposition, Investment, Impulse response

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I. Introduction

The question of whether dividend policy impacts firm value remains an important and highly debated question in corporate finance. Miller and Modigliani (1958, 1961) rigorously prove that under certain conditions, which one might call "frictionless financial markets", both capital structure and payout policy are irrelevant with respect to firm value. Fama and Miller (1972) further articulate a "separation principle" stating independence among a firm's financing, investment, and dividend decisions, implying that investment policy is the sole determinant of firm value. Past studies dating back to Lintner (1956) suggests that dividends and investment are related, but an exact relation is not specified. To date, the empirical relation between dividends and investment leave us with ambiguous and conflicting evidence. More recent work by DeAngelo and DeAngelo (2006, 2007) argues that dividend policy is also a first-order firm value determinant, on par with investment decisions. When capital markets are imperfect, theory suggests that firms may use dividends as a signal of future earnings to overcome asymmetric information. If the dividend is financed internally, it may come at the expense of current and future investment, and subsequently future growth in earnings. This dynamic feedback has not been examined in the literature and is the primary focus of our study.

Since many studies show that dividends and earnings are highly correlated in both the time series and cross-section, we posit that a simple three-equation vector auto-regression (VAR) model of dividends, investment and earnings can capture the time series dynamics of payout policy and investment. Our VAR framework allows us to gain a deeper understanding of the short-term and long-term dynamics among a firm's investment, earnings and dividends. In most previous studies, earnings were omitted from the analysis. In modeling investment and dividends, including the dynamics of earnings is important since it is earnings that are retained for investment or paid out as dividends. When capital is constrained, financing dividends with earnings imposes a zero-sum game between investment and dividends. In addition to incorporating the dynamics of earnings, our study, to our knowledge, is the first to provide valuable information relating the firm-level long-run dynamics of earnings, investment and dividends over time to shocks in each of the three variables.

We report Granger causality results as well as the variance decomposition and impulse response functions from the VAR. We find that dividend changes fail to act as a signal of future earnings. However, for the average firm in our sample, a $1 increase in dividends causes an initial $3.0048 decrease in investment the year following the dividend increase, and the shock is statistically persistent for the subsequent six years. Combined, these results bear to the costliness and value of dividends as a signal of future earnings and to the independence of dividends, investment and firm value. Dividends changes have long-run consequences for investment and vice versa, implying bi-directional interdependence, evidence against the separation principle.

The remainder paper is organized as follows. Section II provides a review of the literature on the relationship between dividends and investment, and Section III describes the VAR model. Section IV describes the data and sample. Section V presents our empirical results, and Section VI concludes.

II. Literature

The dividend and payout irrelevance policies of Miller and Modigliani (1958, 1961) and the separation principle of Fama and Miller (1972) follow directly from the assumption of perfect markets. Of course, the implications might be different under the assumption of imperfect and incomplete markets. Myers and Majluf (1984) suggest that capital market frictions will lead to a competition for funds, which may ultimately lead to firms being forced to choose between paying dividends and pursuing reinvestment. Thus, with finite funds, the firm must decide how to allocate between dividends and investment, and if paying the dividend is deemed important, it may be the case that some projects get passed over due to a lack of funds. Brav *et al.* (2005) provide survey evidence consistent with this possibility, as they find that firm managers are willing to pass up profitable projects in order to maintain the current dividend level when financial constraints force the manager to allocate between the two choices. In such a case, the separation principle is clearly violated, since the dividend decision is having a direct impact on the firm's investment policy. DeAngelo and DeAngelo (2006, 2007) further spark the debate by invalidating the classic Miller and Modigliani dividend irrelevance result and show that dividend decisions do impact firm value in frictionless markets, even if investment policy is held constant.

A number of studies (Fama and Babiak, 1968; Jensen *et al.*, 1992; Fama and French, 2002; DeAngelo *et al.*, 2004) show that dividends and earnings are highly correlated in both the time series and cross-section, but correlation does not imply causation. However, some earlier studies examined causation between dividends and investment. Dhrymes and Kurtz (1967), Grabowski and Mueller (1972) and Peterson and Benesh (1983) conclude that investment decisions affect dividend decisions and vice versa, thus finding causality in both directions. Higgins (1972) finds that investment is a significant factor in explaining dividends but dividends are not significant in explaining investment. Fama (1974), Smirlock and Marshall (1983) and Pruitt and Gitman (1991) conclude that investment decisions and dividend decisions are independent, a result consistent with the Miller and Modigliani (1961) theorem. McCabe (1979) specifically addresses the conflicting evidence of Dhrymes and Kurtz (1967), Higgins (1972) and Fama (1974) and concludes strong interdependence among dividends, investment and financing decisions. Louton and Domian (1995) provide some evidence of dividend decisions affecting investment, and Sarig (2004) finds that investment decisions appear to be independent of firm payout decisions when payout includes share repurchases.

In summary, the causation evidence is mixed, and furthermore, there appears to be a gap in the literature with respect to examining the longer-term dynamics of the relationship between investment and dividends.

III. VAR model

We estimate a separate three-variable, firm-level VAR for each of our 1,056 firms in percent changes in investment, earnings and dividends. Differencing renders the variables stationary but heteroskedastic; we scale these differences to formulate percent changes which render the data homoskedastic[1]. We first estimate the lag-length for each firm VAR by assuming a maximum length of 4 and successively reducing the lag until a likelihood ratio test indicates no statistical difference at the 5 percent level between $p + 1$ and p lags. Therefore, for each firm, we estimate:

$$\%\Delta INV_t = \sum_{i=1}^{p} \beta_{11}^{i} \%\Delta DIV_{t-1} + \sum_{i=1}^{p} \beta_{12}^{i} \%\Delta INV_{t-1} + \sum_{i=1}^{p} \beta_{13}^{i} \%\Delta NI_{t-1} + \varepsilon_{1t} \quad (1)$$

$$\%\Delta NI_t = \sum_{i=1}^{p} \beta_{21}^{i} \%\Delta DIV_{t-1} + \sum_{i=1}^{p} \beta_{22}^{i} \%\Delta INV_{t-1} + \sum_{i=1}^{p} \beta_{23}^{i} \%\Delta NI_{t-1} + \varepsilon_{2t} \quad (2)$$

$$\%\Delta DIV_t = \sum_{i=1}^{p} b_{31}^{i} \%\Delta DIV_{t-i} + \sum_{i=1}^{p} \beta_{32}^{i} \%\Delta INV_{t-i} + \sum_{i=1}^{p} \beta_{33}^{i} \%\Delta NI_{t-1} + \varepsilon_{3t} \quad (3)$$

where $\%\Delta DIV_t$, $\%\Delta INV_t$, and $\%\Delta NI_t$ are the percent changes in investment, earnings and dividends, respectively. Writing the VAR system in more compact form yields:

$$A_i(L)\%\Delta X_{it} = u_{it} \quad (4)$$

where $A_i(L)$ is the 3×3 lag polynomial unique to firm i and $\Delta\%X_{it}$ is the 3×1 vector $[\%\Delta INV_{it}, \%\Delta NI_{it}, \%\Delta DIV_{it}]$. We use the estimates of $A_i(L)$ and the residuals from equation (4) to conduct a standard impulse response and variance decomposition analysis for the VAR system. The impulse response function is not identified unless we impose additional structure onto the VAR. Unfortunately, there is no single agreed upon method for achieving such a structure and the different methods may lead to different results. A reasonable assumption would suggest that, in the long run, investment should determine earnings and earnings should determine dividends. In the short run, the direction of causality is indeterminate. We impose a long-run causal ordering from investment to earnings to dividends using the Blanchard and Quah (1989) structural decomposition.

The Blanchard-Quah decomposition starts with the variance/covariance matrix from equation (4), $E(u_{it}u'_{it}) = \Sigma$. The variance/covariance matrix can be decomposed such that $\Sigma = GG'$. With three variables, the Blanchard-Quah method requires nine elements of G to be determined. Three elements of G are determined from the variances of u_{it}, three are determined by the covariance elements of u_{it} and the remaining three are set so that the long run responses are constrained. Specifically, the coefficients on G are constrained so that the long-run responses of investment to earnings and dividends are set to zero. That is, the responses in the causal direction opposite to our assumed long-run relation are zero. This supplies two additional constraints. Finally, G is further constrained so that the long-run response of earnings to dividends is zero.

The Blanchard-Quah decomposition is ideally suited to impose a long-run causal order, but flexible enough to allow for short-run responses. We carry out the impulse responses and variance decompositions out to a twelve-step-ahead horizon (measured in years). After repeating the VAR estimates, we have 1,056 VAR systems, one for each sample firm, each with its own lag length and set of coefficients. We use these VARs to generate a unique set of impulse response functions and variance decompositions for each firm.

IV. Data

We collect annual data on a sample of firms from the Compustat database for the time period 1950-2006. We exclude utilities and financials, defined as firms with SIC codes outside the intervals 4900-4999 and 6000-6999, respectively. We require firms to have non-missing data for at least 20 consecutive years on gross property, plant and equipment (investment) and net income before extraordinary items (earnings), and dividends. Specifically, our screen requires that firms have a minimum of 20 consecutive years of data during the same set of years for all three variables. We follow the lead of previous work and utilize change in the gross property, plant and equipment variable as a proxy for annual investment. We choose to include only firms that pay dividends in every year to restrict our focus to the dynamics among the variables and minimize the potential of dividend omissions and initiations impacting our results. From the starting sample of 1,230 firms, we eliminate 174 firms whose VAR estimates result in explosive impulse responses. The final sample includes 34,360 firm-year observations on 1,056 unique firms.

Table I reports summary statistics on various firm characteristics for our 1,056 sample firms. To facilitate comparison, we also report summary statistics for the Compustat universe. To arrive at the entries in Table I, for each year over 1950-2006, we compute a median for each variable using only firms with non-missing data for both our sample and the Compustat universe and then report the mean and median of annual medians. As might be expected with a sample of firms with at least 20 years of operating history, including being a dividend payer in every year, our sample of firms are larger, are more profitable, carry slightly higher debt (based upon the median measure), are larger dividend payers, and historically trade at higher price-to-earnings ratios. Also, the higher ratio of retained earnings to total equity in our sample of firms relative to the Compustat universe indicates a higher propensity to pay dividend among our sample (DeAngelo *et al.*, 2006).

	Sample firms		Compustat universe	
	Mean	Median	Mean	Median
Assets	759.62	311.52	84.14	50.99
Market cap	562.4	160.33	66.03	47.02
Payout ratio	0.453	0.443	0.17	0.069
RE/TE	0.574	0.692	0.366	0.371
ROA	0.057	0.056	0.038	0.041
EBIT/assets	0.117	0.118	0.092	0.102
P/E	13.09	13.73	10.75	10.81
ROE	0.112	0.118	0.092	0.09
M/B	1.215	1.225	1.26	1.259
Debt/MV equity	0.701	0.696	0.742	0.656

Notes: This table reports summary statistics on select firm characteristics for sample firms; all data are from Compustat; the first two columns report summary statistics for the 1,056 sample firms; the last two columns report summary statistics for all firms in the Compustat universe; for each year over 1950-2006, we compute a median for each variable using only firms with non-missing data and then report the mean and median of annual medians; total assets and market cap are in millions of dollars; market cap is fiscal year end market value of equity; payout ratio is common dividends scaled by net income before extraordinary items; RE/TE is retained earnings divided by total (book) equity; ROE and ROA are net income before extraordinary items scaled by total assets and total (book) equity, respectively; EBIT/assets is net income before extraordinary items plus interest plus taxes, all scaled by total assets; P/E is fiscal year end price scaled by earnings per share excluding extraordinary items; M/B is total debt less deferred liabilities plus preferred stock plus market cap, all scaled by total assets; Debt/MV equity is total debt scaled by market cap

Table I.
Summary statistics

Of course, given the stringent data requirements for our sample of long-time dividend-paying firms, survivorship bias is clearly present in our data and some may consider this to be a weakness of our study. However, the data requirement allows for the unique study of dynamics among investment, earnings and dividends at the individual firm level over a long period of time. Consequently, the results of our study may generally not be applicable to younger companies that do not pay dividends.

V. Empirical results

We first report the results of Granger causality tests, which are readily available from the firm-level VARs. We then report the results of the variance decomposition and impulse responses, which describe the longer-term dynamics of between investment, earnings, and dividends.

A. Granger causality

Technically, Granger causality is a measure of the marginal contribution of a variable to the forecasting of some other variable. For each VAR system we apply an F-test for the exclusion of the lags on one variable from the VAR. For example, our test of whether dividends Granger cause investment is a test of whether $\sum_{i=1}^{p}\beta_{11}^{i}=0$ from equation (1):

$$\%\Delta INV_t=\sum_{i=1}^{p}\beta_{11}^{i}\%\Delta DIV_{t-1}+\sum_{i=1}^{p}\beta_{12}^{i}\%\Delta INV_{t-1}+\sum_{i=1}^{p}\beta_{13}^{i}\%\Delta NI_{t-1}+\varepsilon_{1t}$$

This methodology is standard in the literature. Unlike past studies, however, we are measuring the Granger causality between investment and dividends controlling for earnings. By including the dynamics of earnings, we are focusing on the decision to pay dividends rather than on the ability to pay dividends. By controlling for earnings, we are effectively addressing the recent finding by DeAngelo and DeAngelo (2006) that distinguishing between firms that are likely to pay dividends and those firms not likely to pay dividends is important when examining the propensity to pay dividends.

We find Granger causality (in some direction) between dividends and investment for only 30 percent of the sample firms. For 16 percent of the firms, knowledge of dividends is valuable in forecasting investment above and beyond knowledge of the momentum in investment and earnings. Interestingly, we also find for 17 percent of the firms, the Granger causality is in the opposite direction. For 3 percent of the firms, the causality runs in both directions[2].

In terms of the causal relationship between investment and earnings, controlling for dividends, we find Granger causality (in some direction) between investment and earnings for 30 percent of the sample firms. Interestingly, results indicate that knowledge of investment for next period's earnings forecast is statistically relevant for only 18 percent of the firms. We find that causality runs the opposite direction for 15 percent of the firms (earnings impacting subsequent investment), with 3 percent of the firms having causality between investment and earnings run in both directions.

We also examine the causal relationship between dividends and earnings, controlling for investment. Results indicate Granger causality (in some direction) between dividends and earnings for 36 percent of the sample firms. We find Granger causality in the direction of earnings causing dividends for 27 percent of the firms, and the causality runs in the opposite direction for 14 percent of the sample firms. Causality between earnings and dividends runs in both directions for 5 percent of the firms.

We report these firm-level Granger causality results to provide some general direction of the short-term dynamics between investment, earnings and dividends. However, the emphasis of our study is the dynamics among the three variables over longer horizons and how each variable responds to shocks in the other variables. We analyze these longer-term dynamics with the impulse responses and variance decompositions derived from the firm-level VARs.

B. Impulse responses

The impulse response function provides the estimated response of each variable in the VAR over time to a immediate pure shock to one of the variables in the system. A pure shock is defined as a shock to one of the variables that is uncorrelated with any of the shocks to the other variables in the system. The impulse response captures the dynamics of the system. For example, suppose we are interested in the response of dividends or earnings to a shock in investment. We assume a one standard deviation shock for ε_1 in equation (1), and then trace out the time path of the various shocks on the dividends, earnings and investment in the VAR system. Each of the variables in the VAR (investment, earnings and dividends) is measured in percent change so we normalize the pure shocks to be a 1 percent increase in a particular variable. This normalization of the pure shocks allows the responses (also in percentages) to be interpreted as elasticities.

We convert the elasticity responses into dollar responses by measuring the percent change from the average level of the variable over the firm-specific sample period. For example, if a 1 percent shock to investment leads to a 0.80 percent response in a particular firm's dividends, then the elasticity is 0.80. If the average level of annual investment for that firm over the sample period was \$200 million and average annual dividends were \$5 million, then we would say that a \$2 million (\$200 million × 1 percent) increase in investment leads to a \$40,000 (\$5 million × 0.80 percent) increase in dividends. On a per dollar basis, this implies a \$1 shock to investment leads to a \$0.02 increase in dividends. Given our twelve-step-ahead horizon, the impulse response for a particular firm to a pure shock in one variable is the estimated dollar change in each variable for the 12 years following the shock.

We would like to make general statements about the dynamic relations among investment, earnings and dividends in the aggregate. Consequently, we estimate the VAR in equation (4) for each of our 1,056 sample firms and subsequently generate the impulse responses for each of the 1,056 firms in our sample. This results in a 1,056 × 12 matrix of impulse responses, 1,056 in the cross-section and 12 in the time dimension (measured in years). We take the cross-sectional average of the responses for each of the 12 time periods. We then appeal to the central limit theorem to test whether the mean response is statistically different from zero. Again, it is important to note that we are estimating the VAR at the firm level and merely aggregating the individual firms' responses. We interpret the mean response as being representative of the average firm in our sample.

B.1 Impulse responses of dividends. Table II shows the aggregated response for six possible shocks of interest. Panel A shows the response of dividends to an increase in earnings. On average, dividends increase approximately \$0.025 the year following a \$1

	Steps ahead forecast											
	1	2	3	4	5	6	7	8	9	10	11	12
Panel A: aggregate response of dividends to a $1 increase in earnings (in dollars)												
Mean	0.0250	0.0417	0.0006	0.0018	−0.0001	0.0004	0.0002	0.0001	0.0005	0.0000	0.0002	0.0000
Variance	0.2301	0.1033	0.0127	0.0021	0.0013	0.0004	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Number of firms	952	952	952	952	952	952	952	952	952	952	952	952
SE of mean	0.0155	0.0104	0.0037	0.0015	0.0012	0.0006	0.0004	0.0003	0.0002	0.0002	0.0001	0.0001
t-statistic mean = 0	1.6059	4.0023	0.1700	1.2493	−0.0690	0.6357	0.5507	0.4944	2.2667	0.2278	1.6398	0.1867
Panel B: aggregate response of dividends to a $1 increase in investment (in dollars)												
Mean	0.0279	0.0203	0.0044	0.0030	0.0016	0.0012	0.0007	0.0005	0.0003	0.0002	0.0001	0.0001
Variance	0.0039	0.0047	0.0012	0.0003	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Number of firms	952	952	952	952	952	952	952	952	952	952	952	952
SE of mean	0.0020	0.0022	0.0012	0.0006	0.0004	0.0003	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
t-statistic mean = 0	13.7525	9.1757	3.9326	5.2178	4.4651	4.5080	3.8771	3.4879	2.8200	1.6060	1.4302	1.0178
Panel C: aggregate response of investment to a $1 increase in dividends (in dollars)												
Mean	−3.0048	1.5227	0.7221	0.4401	0.1302	0.0804	0.0239	0.0237	0.0226	0.0106	0.0074	0.0033
Variance	123.0341	87.5232	24.3414	4.8272	1.4999	0.4417	0.2120	0.0825	0.0362	0.0188	0.0090	0.0033
Number of firms	952	952	952	952	952	952	952	952	952	952	952	952
SE of mean	0.3595	0.3032	0.1599	0.0712	0.0397	0.0215	0.0149	0.0093	0.0062	0.0044	0.0031	0.0019
t-statistic mean = 0	−8.3582	5.0220	4.5159	6.1804	3.2802	3.7341	1.6035	2.5479	3.6598	2.3754	2.3917	1.7449
Panel D: aggregate response of investment to a $1 increase in earnings (in dollars)												
Mean	−0.1415	−0.1220	0.1506	0.0970	0.0357	−0.0090	−0.0104	−0.0044	0.0015	−0.0005	0.0015	0.0002
Variance	20.0512	55.3318	11.4921	7.0779	0.9173	0.1183	0.0705	0.0210	0.0083	0.0029	0.0012	0.0008
Number of firms	952	952	952	952	952	952	952	952	952	952	952	952
SE of mean	0.1451	0.2411	0.1099	0.0862	0.0310	0.0111	0.0086	0.0047	0.0029	0.0017	0.0011	0.0009
t-statistic mean = 0	−0.9752	−0.5061	1.3710	1.1249	1.1510	−0.8081	−1.2070	−0.9386	0.5060	−0.2803	1.2918	0.1635
Panel E: aggregate response of earnings to a $1 increase in investment (in dollars)												
Mean	0.2652	−0.0913	−0.0007	−0.0097	0.0057	−0.0002	0.0023	0.0004	0.0010	−0.0002	0.0002	−0.0001
Variance	2.6234	6.8450	0.6131	0.1496	0.0242	0.0083	0.0025	0.0011	0.0006	0.0003	0.0002	0.0002
Number of firms	952	952	952	952	952	952	952	952	952	952	952	952
SE of mean	0.0525	0.0848	0.0254	0.0125	0.0050	0.0030	0.0016	0.0011	0.0008	0.0006	0.0005	0.0004
t-statistic mean = 0	5.0514	−1.0769	−0.0291	−0.7758	1.1335	−0.0668	1.3925	0.3460	1.2164	−0.2865	0.4323	−0.0235

(continued)

Table II.

Table II.

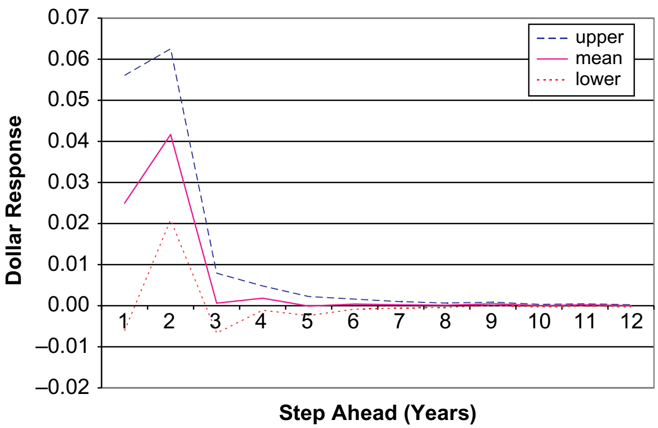
	Steps ahead forecast											
	1	2	3	4	5	6	7	8	9	10	11	12
Panel F: aggregate response of earnings to a $1 increase in dividends (in dollars)												
Mean	0.9838	−0.4322	−0.4668	−0.0607	0.0066	−0.0152	−0.0129	0.0106	−0.0021	−0.0022	0.0008	0.0016
Variance	453.6541	344.9027	354.1959	30.5811	8.0436	0.9720	0.2876	0.0862	0.0311	0.0144	0.0080	0.0036
Number of firms	952	952	952	952	952	952	952	952	952	952	952	952
SE of mean	0.6903	0.6019	0.6100	0.1792	0.0919	0.0320	0.0174	0.0095	0.0057	0.0039	0.0029	0.0019
t-statistic mean = 0	1.4252	−0.7180	−0.7653	−0.3386	−0.0715	−0.4769	−0.7426	1.1152	−0.3682	−0.5661	0.2685	0.8210

Notes: Panel A of this table reports the cross-sectional average response of dividends to an increase in earnings; we estimate a separate three-variable VAR in percent changes of investments, earnings and dividends for each of the 1,056 firms in our sample; for each firm in the sample, we first perform lag-length tests in order to find a reasonable specification for the VAR; we estimate the lag-length for each VAR by assuming a maximum length of 4 and successively reducing the lag length until a likelihood ratio test indicates no statistical difference at the 5 percent level between p + 1 and p lags; the entries are obtained by averaging the dividend impulse responses from the individual firm-level VARs, and only include the 952 firms within the 5th-95th percentile range of the responses; the firms in the upper and lower 5th percentiles of responses are excluded so that the response statistics are more representative of typical firms in the sample; Panel B of this table reports the cross-sectional average response of dividends to an increase in investment; we estimate a separate three-variable VAR in percent changes of investments, earnings and dividends for each of the 1,056 firms in our sample; for each firm in the sample, we first perform lag-length tests in order to find a reasonable specification for the VAR; we estimate the lag-length for each VAR by assuming a maximum length of 4 and successively reducing the lag length until a likelihood ratio test indicates no statistical difference at the 5 percent level between p + 1 and p lags; the entries are obtained by averaging the dividend impulse responses from the individual firm-level VARs, and only include the 952 firms within the 5th-95th percentile range of the responses; the firms in the upper and lower 5th percentiles of responses are excluded so that the response statistics are more representative of typical firms in the sample; Panel C of this table reports the cross-sectional average response of investment to an increase in dividends; we estimate a separate three-variable VAR in the percent changes of investments, earnings and dividends for each of the 1,056 firms in our sample; for each firm in the sample, we first perform lag-length tests in order to find a reasonable specification for the VAR; we estimate the lag-length for each VAR by assuming a maximum length of 4 and successively reducing the lag length until a likelihood ratio test indicates no statistical difference at the 5 percent level between p + 1 and p lags; the entries are obtained by averaging the dividend impulse responses from the individual firm-level VARs, and only include the 952 firms within the 5th-95th percentile range of the responses; the firms in the upper and lower 5th percentiles of responses are excluded so that the response statistics are more representative of typical firms in the sample; Panel D of this table reports the cross-sectional average response of investment to an increase in earnings; we estimate a separate three-variable VAR in percent changes of investments, earnings and dividends for each of the 1,056 firms in our sample; for each firm in the sample, we first perform lag-length tests in order to find a reasonable specification for the VAR; we estimate the lag-length for each VAR by assuming a maximum length of 4 and successively reducing the lag length until a likelihood ratio test indicates no statistical difference at the 5 percent level between p + 1 and p lags; the entries are obtained by averaging the dividend impulse responses from the individual firm-level VARs, and only include the 952 firms within the 5th-95th percentile range of the responses; the firms in the upper and lower 5th percentiles of responses are excluded so that the response statistics are more representative of typical firms in the sample; Panel E of this table reports the cross-sectional average response of earnings to an increase in investment; we estimate a separate three-variable VAR in percent changes of investments, earnings and dividends for each of the 1,056 firms in our sample; for each firm in the sample, we first perform lag-length tests in order to find a reasonable specification for the VAR; we estimate the lag-length for each VAR by assuming a maximum length of 4 and successively reducing the lag length until a likelihood ratio test indicates no statistical difference at the 5 percent level between p + 1 and p lags; the entries are obtained by averaging the dividend impulse responses from the individual firm-level VARs, and only include the 952 firms within the 5th-95th percentile range of the responses; the firms in the upper and lower 5th percentiles of responses are excluded so that the response statistics are more representative of typical firms in the sample; Panel F of this table reports the cross-sectional average response of earnings to an increase in dividends; we estimate a separate three-variable VAR in percent changes of investments, earnings and dividends for each of the 1,056 firms in our sample; for each firm in the sample, we first perform lag-length tests in order to find a reasonable specification for the VAR; we estimate the lag-length for each VAR by assuming a maximum length of 4 and successively reducing the lag length until a likelihood ratio test indicates no statistical difference at the 5 percent level between p + 1 and p lags; the entries are obtained by averaging the dividend impulse responses from the individual firm-level VARs, and only include the 952 firms within the 5th-95th percentile range of the responses; the firms in the upper and lower 5th percentiles of responses are excluded so that the response statistics are more representative of typical firms in the sample increase in earnings, which is followed up by a slightly larger average increase of $0.0417 the second year following the increase in earnings. Dividends continue to trend upward at a decreasing rate for a cumulative 12-year increase of approximately $0.07. However, only the second year response is statistically different than zero. The slow and general statistically insignificant response of dividends to the increase in earnings is consistent with the notion that firms make gradual adjustments in dividends in response to earnings so that dividends are a smoothed function of earnings. These average responses are provided in graphical form in Figure 1.

Panel B of Table II shows the response of dividends to a $1 increase in investment. Dividends increase on average by $0.0279 in the year immediately following an increase in investment and an average $0.0203 the second year following the increase in investment. Dividends continue to increase at a declining rate for the next ten years, and the average responses are all statistically different than zero out to the ninth year. The cumulative 12-year response to dividends for an increase of $1 in investment is $0.0602. A graphical summary of these average responses is shown in Figure 2. Clearly, shocks to investment have long-term consequences for changes in dividends.

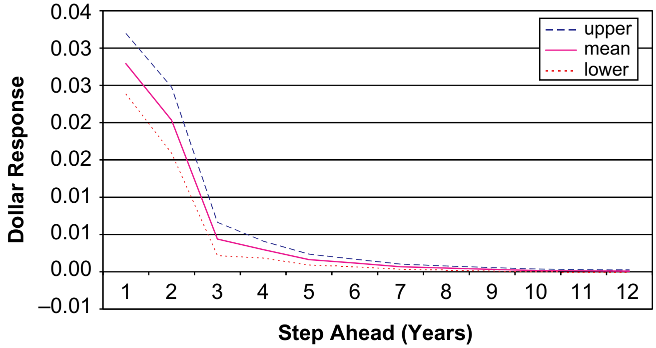
In summary, given that mature companies often have dividend policies that are smooth over time somewhat irrespective of earnings volatility, the results in Panel A that shocks to earnings have minimal statistical impact on future dividends is not surprising. However, the results in Panel B that future dividend changes in response to a shock to investment is quite surprising. Investors are often hopeful that increases in investment will lead to higher subsequent dividends.

B.2 Impulse responses of investment. Panel C of Table II is of particular interest to address the question of whether firms forego investment to pay dividends.



Notes: This figure corresponds to the data in Panel A of Table II; the upper and lower series correspond to the mean plus and minus two standard errors of the mean; the data include only the 952 firms within the 5th-95th percentile range of the responses; the firms in the upper and lower 5th percentiles of responses are excluded so that the graph is more representative of typical firms in the sample

Figure 1.
Impulse response of dividends to a $1 shock in earnings



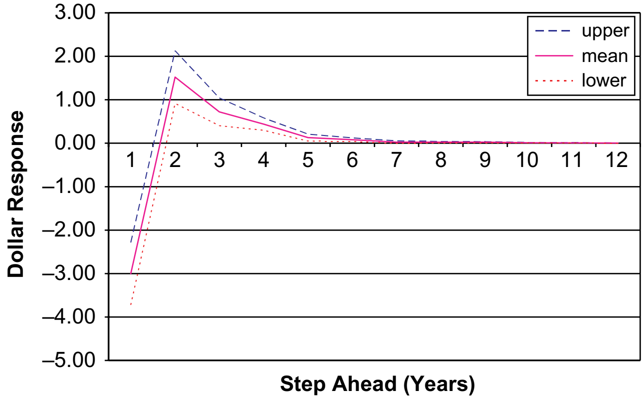
Notes: This figure corresponds to the data in Panel B of Table II; the upper and lower series correspond to the mean plus and minus two standard errors of the mean; the data include only the 952 firms within the 5th-95th percentile range of the responses; the firms in the upper and lower 5th percentiles of responses are excluded so that the graph is more representative of typical firms in the sample

Figure 2.
Impulse response of dividends to $1 shock in investment

The impulse response indicates that on average a $1 increase in dividends causes an initial $3.0048 decrease in investment the year following the dividend increase but investment spending actually increases by an average of $1.5227 in the second year and $0.7221 in the third year following the dividend increase. In fact, after the initial first year decrease, investment increases at a decreasing rate and remains positive on average out to the 12 year. The average cumulative 12-year response of investment to a $1 increase in dividends is a slight decrease of $0.0178. Figure 3 shows a graphical summary of these average responses. The average responses are all statistically and economically significant out to the sixth year. Clearly, shocks to dividends have long-term consequences for changes in investment. Interestingly, this result of investment directly impacting dividends in the short run is evidence against the separation principle. One can envision that a firm may be reluctant to cut dividends and thus to increase the dividend requires that investment decrease.

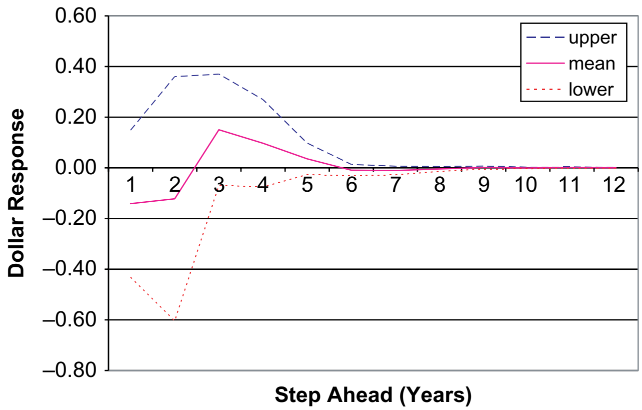
We report the average response dynamics of investment to a $1 increase in earnings in Panel D of Table II. The impulse response indicates that on average a $1 increase in earnings causes an initial $0.1415 decrease in investment the year following the dividend increase and also a $0.1220 decrease in the second year following the dollar increase in earnings. However, the responses of investment to earnings for all 12 years are not significantly different than zero, which suggests very little if any relation in the direction from earnings to investment. This is a bit surprising as one might expect that companies with increases in earnings might elect to increase subsequent investment. A graphical summary of these average responses is shown in Figure 4.

B.3 Impulse responses of earnings. Panel E of Table II reports average response dynamics of earnings to a $1 increase in investment. On average, a $1 increase in investment leads to an initial $0.2652 increase in earnings the year following the increase in investment, which is statistically different than zero. This initial increase in earnings in the first year is subsequently followed by slight decreases in earnings in



Notes: This figure corresponds to the data in Panel C of Table II; the upper and lower series correspond to the mean plus and minus two standard errors of the mean; the data include only the 952 firms within the 5th-95th percentile range of the responses; the firms in the upper and lower 5th percentiles of responses are excluded so that the graph is more representative of typical firms in the sample

Figure 3.
Impulse response of investment to $1 shock in dividends



Notes: This figure corresponds to the data in Panel D of Table II; the upper and lower series correspond to the mean plus and minus two standard errors of the mean; the data include only the 952 firms within the 5th-95th percentile range of the responses; the firms in the upper and lower 5th percentiles of responses are excluded so that the graph is more representative of typical firms in the sample

Figure 4.
Impulse response of investment to a $1 shock in earnings

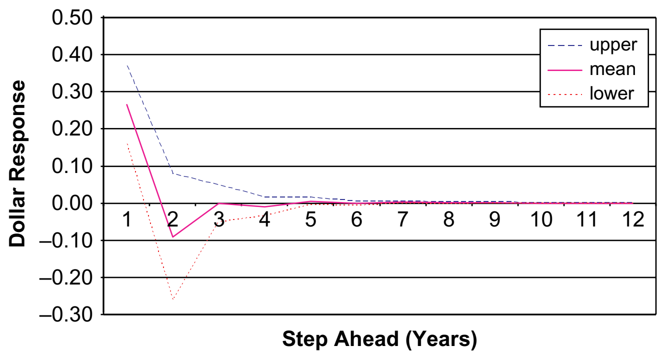
the next three years totaling $0.1018, albeit these responses are not statistically different than zero. In fact, all of the responses beyond the first year response are not statistically different than zero. This result is puzzling in the sense that one might expect that, on average, earnings to be positively affected by increases in investment, as the payoff to investment over time would likely lead to increased earnings. The average cumulative 12-year response of earnings to a $1 increase in investment is $0.1725. A graphical summary of these average responses is shown in Figure 5.

Lastly, we report average response dynamics of earnings to a $1 increase in dividends in Panel F of Table II. On average, a $1 increase in dividends leads to an initial $0.9838 increase in earnings the year following the dividend increase. This initial increase in earnings in the first year is subsequently followed by slight decreases in earnings in the next three years totaling $0.1018. Again, all of the responses to earnings to a dollar increase in dividends are not statistically different than zero. The average cumulative 12-year response of earnings to a $1 increase in investment is $0.1725. Figure 6 shows a graphical summary of these average responses. In summary, these results that dividend shocks do not appear to impact earnings is consistent with the separation principle.

C. Variance decompositions

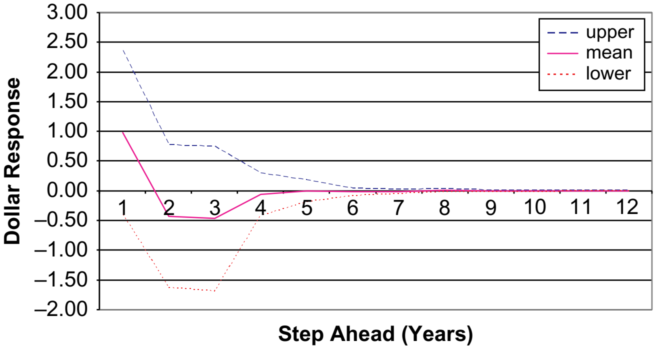
The impulse response function gives the impact on the system of a hypothetical shock to one of the variables in the system. The variance decomposition measures the historical contribution of each variable to the variance of each other variable in the system. The variance decompositions indicate how important each variable is in forecasting the behavior of the other variables. Used in conjunction with the impulse responses, we can judge not only the impact of a variable, but also its importance. The variance decompositions are provided in Tables III-V for dividends, investment and earnings, respectively.

From Panel A of Table III, we see that on average, 73 percent of the variance in dividends at a one-year horizon is coming from the pure shocks to dividends itself.



Notes: This figure corresponds to the data in Panel E of Table II; the upper and lower series correspond to the mean plus and minus two standard errors of the mean; the data include only the 952 firms within the 5th-95th percentile range of the responses; the firms in the upper and lower 5th percentiles of responses are excluded so that the graph is more representative of typical firms in the sample

Figure 5.
Impulse response of earnings to a $1 shock in investment



Notes: This figure corresponds to the data in Panel F of Table II; the upper and lower series correspond to the mean plus and minus two standard errors of the mean; the data include only the 952 firms within the 5th-95th percentile range of the responses; the firms in the upper and lower 5th percentiles of responses are excluded so that the graph is more representative of typical firms in the sample

Figure 6.
Impulse response of earnings to a $1 shock in dividends

More interesting is the contribution of variance in dividends from investment. Panel B of Table III indicates that, on average, 17 percent of the variance in dividends is coming from investment at a one-year horizon. However, over longer horizons, the variance of investment contributes on average near 25 percent of the variance to dividends. Therefore, for longer run horizon forecasts, the importance of investment for explaining variation in dividends is greater.

Table IV provides the variance decomposition of investment. From Panel A, on average, about 83 percent of the variance in investment is attributed to the direct shocks in investment itself. This is the case over both short and long run horizons. From Panels B and C, we see that in the long-run, on average, shocks to dividends and earnings contribute 8 and 10 percent to the variance of investment, respectively. While not shown in the table, for 25 percent of the firms in the sample, the variance in dividends contributes more than 10 percent to the variance in investment at a 12 year horizon. This result suggests that dividend decisions do have a long-term impact on investment policy for some firms, which is evidence against the separation principle.

The variance decomposition of earnings in Table V shows that, on average, dividends and investment contribute 13.94 percent and 6.72 percent to the variance of earnings, respectively, at a one-year horizon with the remaining 79.35 percent coming from earnings itself. However, in the long run, the contribution of investment to the variance in earnings is approximately 19 percent and the contribution of dividends is also slightly higher at 8 percent as shown in Panels B and C.

VI. Conclusion

In theory, when financial markets are frictionless, investment decisions are the sole determinants of firm value, while capital structure and payout policy are little more than window dressing (Miller and Modigliani, 1958, 1961). In practice, however, we know that capital structure and payout policy vary systematically across firms and

Table III.
Variance decomposition of dividends

Percentile	Steps ahead forecast (years) 1	2	3	4	5	6	7	8	9	10	11	12
Panel A: variance from dividends												
100	0.9994	0.9982	0.9982	0.9982	0.9982	0.9982	0.9982	0.9982	0.9982	0.9982	0.9724	0.9982
95	0.9909	0.9458	0.9420	0.9417	0.9417	0.9417	0.9417	0.9417	0.9417	0.9417	0.6614	0.9417
50	0.7969	0.6094	0.5902	0.5881	0.5877	0.5877	0.5876	0.5876	0.5875	0.5875	0.1898	0.5875
5	0.2381	0.1427	0.1335	0.1320	0.1317	0.1317	0.1317	0.1316	0.1310	0.1307	0.0097	0.1303
0	0.0018	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0003	0.0012
Mean	0.7263	0.5909	0.5765	0.5728	0.5715	0.5710	0.5707	0.5705	0.5705	0.5704	0.2441	0.5703
Panel B: variance from investment												
100	0.8851	0.9263	0.9479	0.9654	0.9706	0.9721	0.9724	0.9724	0.9724	0.9724	0.9724	0.9724
95	0.5727	0.6365	0.6471	0.6588	0.6612	0.6615	0.6614	0.6614	0.6614	0.6614	0.6614	0.6614
50	0.0928	0.1689	0.1852	0.1881	0.1891	0.1893	0.1898	0.1898	0.1898	0.1898	0.1898	0.1898
5	0.0004	0.0064	0.0094	0.0096	0.0096	0.0097	0.0097	0.0097	0.0097	0.0097	0.0097	0.0097
0	0.0000	0.0001	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Mean	0.1679	0.2272	0.2387	0.2417	0.2429	0.2434	0.2437	0.2439	0.2440	0.2440	0.2441	0.2441
Panel C: variance from earnings												
100	0.9793	0.9902	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847
95	0.4775	0.5912	0.5753	0.5725	0.5770	0.5765	0.5763	0.5762	0.5762	0.5762	0.5762	0.5762
50	0.0370	0.1094	0.1142	0.1165	0.1163	0.1153	0.1154	0.1153	0.1153	0.1153	0.1153	0.1153
5	0.0003	0.0043	0.0049	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
0	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Mean	0.1058	0.1819	0.1847	0.1855	0.1856	0.1856	0.1856	0.1856	0.1856	0.1856	0.1856	0.1856

Notes: Panel A provides an indication of the distribution of the variance decomposition of dividends that comes directly from shocks to dividends; the distribution is over the 952 firms within the 5th-95th percentile range; on average, 73 percent of the one-step (year) ahead variance in the forecast in dividends is from dividends itself; Panel B provides an indication of the distribution of the variance decomposition of dividends that comes indirectly from shocks to investment; the distribution is over the 952 firms within the 5th-95th percentile range; on average 17 percent of the one-step (year) ahead variance in the forecast in dividends is from shocks to investment; Panel C provides an indication of the distribution of the variance decomposition of dividends that comes indirectly from shocks to earnings; the distribution is over the 952 firms within the 5th-95th percentile range; on average 10 percent of the one-step (year) ahead variance in the forecast in dividends is from shocks to earnings

Table IV. Variance decomposition of investment

Percentile	1	2	3	4	5	6	7	8	9	10	11	12
						Steps ahead forecast						
Panel A: variance from investment												
100	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
95	0.9974	0.9958	0.9958	0.9958	0.9958	0.9959	0.9959	0.9959	0.9959	0.9959	0.9959	0.9959
50	0.9220	0.8919	0.8821	0.8832	0.8835	0.8831	0.8830	0.8829	0.8829	0.8829	0.8829	0.8829
5	0.3663	0.5012	0.4872	0.4846	0.4872	0.4876	0.4878	0.4891	0.4915	0.4915	0.4915	0.4915
0	0.0291	0.0695	0.0452	0.0450	0.0450	0.0449	0.0449	0.0449	0.0449	0.0449	0.0449	0.0449
Mean	0.8348	0.8326	0.8278	0.8274	0.8272	0.8272	0.8271	0.8271	0.8271	0.8271	0.8271	0.8271
Panel B: variance from earnings												
100	0.9317	0.9219	0.9503	0.9505	0.9505	0.9506	0.9506	0.9506	0.9506	0.9506	0.9506	0.9506
95	0.4485	0.3682	0.3713	0.3716	0.3719	0.3716	0.3716	0.3716	0.3716	0.3716	0.3716	0.3716
50	0.0231	0.0342	0.0382	0.0388	0.0388	0.0389	0.0389	0.0389	0.0389	0.0389	0.0389	0.0389
5	0.0002	0.0006	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Mean	0.0911	0.0912	0.0960	0.0964	0.0966	0.0967	0.0967	0.0967	0.0967	0.0967	0.0968	0.0968
Panel C: variance from dividends												
100	0.9120	0.6459	0.5634	0.5631	0.5624	0.5624	0.5624	0.5624	0.5624	0.5624	0.5624	0.5624
95	0.3542	0.3287	0.3275	0.3198	0.3181	0.3178	0.3178	0.3178	0.3178	0.3178	0.3178	0.3178
50	0.0187	0.0246	0.0260	0.0261	0.0262	0.0262	0.0263	0.0263	0.0264	0.0264	0.0264	0.0264
5	0.0001	0.0002	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Mean	0.0742	0.0762	0.0763	0.0762	0.0762	0.0762	0.0761	0.0761	0.0761	0.0761	0.0761	0.0761

Notes: Panel A provides an indication of the distribution of the variance decomposition of investment that comes directly from shocks to investment; the distribution is over the 952 firms within the 5th-95th percentile range; on average, 83 percent of the one-step (year) ahead variance in the forecast in investment is from investment itself; Panel B provides an indication of the distribution of the variance decomposition of investment that comes indirectly from shocks to earnings; the distribution is over the 952 firms within the 5th-95th percentile range; on average, 9 percent of the one-step (year) ahead variance in the forecast in investment is from shocks to earnings; Panel C provides an indication of the distribution of the variance decomposition of investment that comes indirectly from shocks to dividends; the distribution is over the 952 firms within the 5th-95th percentile range; on average, 7 percent of the one-step (year) ahead variance in the forecast in investment is from shocks to dividends

Table V.
Variance decomposition of earnings

Percentile	Steps ahead forecast 1	2	3	4	5	6	7	8	9	10	11	12
Panel A: variance from earnings												
100	0.9998	0.9995	0.9993	0.9993	0.9992	0.9992	0.9992	0.9992	0.9992	0.9992	0.9992	0.9992
95	0.9965	0.9822	0.9818	0.9816	0.9816	0.9816	0.9816	0.9816	0.9816	0.9816	0.9816	0.9816
50	0.8782	0.8028	0.7944	0.7909	0.7906	0.7898	0.7897	0.7895	0.7894	0.7893	0.7893	0.7893
5	0.2799	0.2843	0.2789	0.2772	0.2765	0.2765	0.2765	0.2765	0.2765	0.2765	0.2765	0.2765
0	0.0003	0.0256	0.0255	0.0256	0.0256	0.0256	0.0256	0.0256	0.0256	0.0256	0.0256	0.0256
Mean	0.7935	0.7384	0.7307	0.7284	0.7276	0.7273	0.7271	0.7270	0.7269	0.7269	0.7269	0.7269
Panel B: variance from investment												
100	0.9892	0.9743	0.9741	0.9740	0.9740	0.9740	0.9740	0.9740	0.9740	0.9740	0.9740	0.9740
95	0.5535	0.5740	0.5785	0.5777	0.5777	0.5777	0.5777	0.5777	0.5777	0.5777	0.5777	0.5777
50	0.0552	0.1112	0.1206	0.1222	0.1230	0.1230	0.1230	0.1234	0.1234	0.1234	0.1234	0.1234
5	0.0003	0.0068	0.0085	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087
0	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Mean	0.1394	0.1836	0.1896	0.1912	0.1919	0.1922	0.1924	0.1925	0.1926	0.1926	0.1926	0.1926
Panel C: variance from dividends												
100	0.9988	0.7139	0.7080	0.7127	0.7341	0.7470	0.7550	0.7602	0.7637	0.7661	0.7677	0.7688
95	0.3578	0.3948	0.3957	0.3952	0.3962	0.3964	0.3965	0.3965	0.3965	0.3965	0.3965	0.3965
50	0.0103	0.0205	0.0220	0.0224	0.0226	0.0226	0.0226	0.0225	0.0225	0.0225	0.0225	0.0225
5	0.0001	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Mean	0.0672	0.0780	0.0797	0.0804	0.0805	0.0805	0.0805	0.0805	0.0805	0.0805	0.0805	0.0805

Notes: Panel A provides an indication of the distribution of the variance decomposition of earnings that comes directly from shocks to earnings; the distribution is over the 952 firms within the 5th-95th percentile range; on average 79 percent of the one-step (year) ahead variance in the forecast in earnings is from earnings itself; Panel B provides an indication of the distribution of the variance decomposition of earnings that comes indirectly from shocks to investment; the distribution is over the 952 firms within the 5th-95th percentile range; on average, 14 percent of the one-step (year) ahead variance in the forecast in earnings is from shocks to investment; Panel C provides an indication of the distribution of the variance decomposition of earnings that comes indirectly from shocks to dividends; the distribution is over the 952 firms within the 5th-95th percentile range; on average, 7 percent of the one-step (year) ahead variance in the forecast in earnings is from shocks to dividends across time. In the presence of market frictions, such as credit constraints, the necessity to fund investment out of earnings ties dividend payout decisions to current and future investment funding. Consequently, investment and payout policies have the potential to become linked in both the short and long run via earnings.

We investigate the long-term dynamics among dividends, earnings and investment using a firm-level VAR. We use impulse response functions and variance decomposition to characterize the short-term and long-term dynamics among the variables. Consistent with intuition, we find that subsequent dividends reflect increases in current investment and earnings. For the average firm in our sample, dividends increase approximately \$0.025 the year following a \$1 increase in earnings, and \$0.0279 the year following a \$1 increase in investment.

In contrast to the dividend signaling literature, we find no support for the hypothesis that an increase in current dividends is followed by subsequent higher earnings. However, the increase in current dividends is associated with an initial \$3.0048 decrease in investment the year following the dividend increase. In addition, the dividend shock has a statistically significance effect on investment for the following six years. The response of future investment to a change in dividends provides evidence counter to the Miller and Modigliani (1961) dividend irrelevance proposition.

Taken together, our results indicate that for the subsample of large dividend paying firms, dividends, earnings and investment are linked in both the short and long run. Increases in dividends are not a reliable signal for future earnings and are "financed" through subsequent lower levels of investment. Firms should look for alternative methods to signal future earnings increases and investors should interpret an increase in dividends within the context in which it is financed. The research could be expanded to include additional payout policies such as repurchases as well as incorporating the role of cash holdings.

Notes

1. Using conventional log differences was not feasible due to some observations of the earnings variable being negative.
2. The percentages that we report sum to 36 percent; however, the 3 percent for which causality runs in both directions, there is double counting. Consequently, 30 percent of our firms uniquely exhibit some causality, while 70 percent do not.

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