ESSAYS ON A RATIONAL EXPECTATIONS MODEL OF DIVIDEND POLICY

AND STOCK RETURNS

A Dissertation

by

CHANGWOO NAM

DOCTOR OF PHILOSOPHY

August 2011

Major Subject: Economics

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ABSTRACT

Essays on A Rational Expectations Model of Dividend Policy and Stock Returns.

(August 2011)

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We propose an asset pricing model in a production economy where cash flows are determined by firms' optimal dividend and investment decisions. Extensive and intensive decision margins in dividend payout are modeled with cash holding and investment adjustment costs. The model implies that delays in dividend distribution of young and growing firms play instrumental roles in explaining various asset pricing anomalies. Quantitative results show that model-implied dividend policies and investments are consistent with data, and the cross sections of stock returns are well explained by the interactions between productivity shocks and the lumpy dividend policies. Additionally, the model produces countercyclical variations in the market risk premium.

In addition, we empirically investigate the relevance of firm characteristics and aggregate productivity shocks in determining dividend payment propensity, thereby asset prices. It is found that excess returns for dividend payers over nonpayers are significantly linked to business cycles. Relative future returns are fairly predicted by the spread of lagged propensities to pay dividends. Furthermore, the empirical results document that each future return of payers and nonpayers increases in propensities to pay out cash to shareholders. These results are consistent to our rational expectations model of dividend policy, and contradictory to the catering theory of dividends.

To my parents and my wife

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I am happy to have this opportunity to express my gratitude to those who helped to make this dissertation possible. Without these people's love, support and dedication, I might not have been able to finish this long and demanding journey of doctoral studies.

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I would like to thank my parents, Sangkil Nam and Sungja Lee. They have always supported me. My parents-in-law, Chunsik Lee and Mijung Kim, have encouraged me with their best wishes. Finally, I want to thank my wife, Hyunju Lee. She has always been there to cheer me up and to stand by me through the good times and the bad. I love you.

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CHAPTER I

INTRODUCTION

It is well known that corporate decisions made by firm managers matter in explaining the cross-sectional properties of stock returns. Especially, if decisions on investment and dividend payout can affect cash flows of firms, these have direct implications on the equity prices of firms, since the cash flow processes of firms are one of the two main pillars determining stock prices. The other pillar, stochastic discount factor, is closely related to the changes of market investor's wealth given their attitudes toward risk and uncertainty. Since the distributed cash flows of firms will constitute the current and future wealths of market investors, corporate financial decisions related to investments and dividends can have important links to variations in asset prices via channels of both firms' cash flows and investors' discount factors. This paper studies the implications of corporate dividend policies on stock returns in a general equilibrium framework.

We develop a dynamic general equilibrium model of asset prices with many firms whose dividend processes are endogenously determined by firms' optimal dividend policies and investment behaviors. In so doing, both extensive and intensive decision margins in dividend payout are modeled. Corporate managers will maximize the present value of current and future cash flows net of dividends and the costs involved with investment and cash holding. Cash holding is assumed costly to reflect the agency cost or the conflict of interests between shareholders and firm managers. Easterbrook (1984) and Jensen (1986) are the classic studies suggesting that firm

This dissertation follows the style of *Econometrica*.

managers pursue self-interests, and increase cash holdings for various reasons. In this case, they argue that dividends can help shareholders to reduce the associated agency costs. Recently, Nikolov and Whited (2009) estimate a dynamic model of firm investment and cash accumulation to find that agency problems affect corporate cash holding decisions. They model three specific mechanisms that misalign managerial and shareholder incentives: managerial bonuses on current profits, limited managerial ownership of the firm, and a managerial preference for firm size. Our setup can be viewed as an attempt to incorporate these findings in the corporate finance into a general equilibrium framework.

The model features rich firm dynamics and generates several cross-sectional implications of asset returns and firm characteristics. Regarding the firm dynamics, both analytic and quantitative results show that younger firms with small capital tend to invest more in capital, and they withhold paying dividends. These firms initiate dividend payouts mainly to reduce the increasing cash holding and investment costs, as capital is accumulated. It turns out that this extensive decision margin on firm cash flow depends on firm characteristics associated with productivity shocks.[1] Thus, this model endogenizes not only the amount but also the timing of cash flows distributed from firms to shareholders. Note that the latter is reminiscent of duration-based explanations of the value premium examined by Lettau and Wachter (2007) and Santos and Veronesi (2010). These papers view that growth stocks pay later, while value firms pay now. Alas, if there exist long-run risks (persistent shocks in economic growth, for instance) in an economy and the discount factor co-varies with

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[1]These theoretical findings are consistent with the firm life cycle theory of dividends. For more details, see Mueller (1972), Grullon, Michealy, and Swaminathan (2002), DeAngelo, DeAngelo, and Skinner (2004), DeAngelo, DeAngelo, and Stulz (2006). On the firm characteristics for the propensity to pay dividends, see Fama and French (2001) and Denis and Osobov (2008).

stock prices, counterfactual growth premiums can occur. To overcome this, Lettau and Wachter (2007) assume that shocks to the discount factor do not co-vary with cash flows shocks, and Santos and Veronesi (2010) assume that cash flows are highly volatile. The former is difficult to justify in an equilibrium, while the latter needs an abnormal amount of cash flow fluctuations. In our model, young and growing firms typically do not pay dividends, and therefore covariations with the discount factor are close to zero. Meanwhile mature firms with larger amounts of capital pay dividends, and tend to have less room for growth. Thus, their short-run cash flows become risky and accordingly priced. In this vein, our paper provides a novel explanation of the value premium which extends and generalizes the insight from the durations of assets based on firms' cash flows.[2]

With this model in hand, we analyze the behaviors of stock returns generated from the simulated cash flows of firms. According to our quantitative results, the expected returns on value and size sorted portfolios are consistent with the historical data (e.g., Fama and French (2007) and Chen, Petkova, and Zhang (2008)). In addition, the simulated expected returns on decile portfolios sorted by book-to-market equity ratio and size present features of value and size premia in the empirical facts (Fama and French (1992)). Interestingly, pooling new decile portfolios sorted by fitted propensity to pay dividends, the simulated expected returns on them consistently increase in the likelihood of dividend payout. This implies that the factors affecting dividend policy largely overlap with the characteristics used to form pricing factors. Finally, the simulated market risk premiums and volatilities of aggregate dividend and asset returns reveal endogenously countercyclical variations, again in line with empirical evidence.

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[2]The size premium can also arise due to the delay in dividend payout and the profitability of firms in this model.

Our work also belongs to another line of literature on the asset pricing model, which extends Lucas (1978) to have many trees (dividends). Cochrane, Longstaff, and Santa-Clara (2008) solve a model with two Lucas trees. They show that expected returns, excess returns, and return volatility as functions of dividend share vary through time, and returns are predictable from price-dividend ratios. Martin (2009) further extends Cochrane, Longstaff, and Santa-Clara (2008) with many trees. Menzly, Santos, and Veronesi (2004) propose a general equilibrium model with multiple securities in which investors' risk preferences, and expectations of dividend growth are time-varying with external habit formation. Santos and Veronesi (2010) show that substantial heterogeneity in firm's cash-flow risk yields both a value premium as well as most of the stylized facts about the cross-section of stock returns, but it generates a "cash-flow risk puzzle". All these papers assume exogenous processes for dividend processes. Therefore, these papers are restrictive in linking firm characteristics to asset prices. In this context, our paper can be viewed as a general equilibrium justification of Lucas models with multiple trees.

In addition, we empirically investigate the relevance of firm characteristics and aggregate productivity shocks in determining dividend payment propensity and stock returns, and we analyze the implications of serial correlations of stock returns. Our rational expectations model of dividend policy shows that differences in dividend policies result from firm characteristics including the level of firm maturity and variations in aggregate productivity shocks, and dividend policy, especially in extensive margin can affect stock returns via shifting cash flows of firms. We further show that this channel can explain some major asset pricing anomalies such as the value and size premia. Therefore, without resorting to the existence of irrational investors such as the catering theory of dividends (Baker and Wurgler (2004b)), it is possible to link stock returns and propensity to pay dividends. Especially, we have shown that the

propensity to pay dividend (PPD, hereafter) is positively related to the future stock returns since the cash flow risk is definitely linked to the probability of dividend payment in the next period and the cumulated cash flow risks in discount risk effect (long-term dividend growth rate) must be associated to conditional PPDs. Therefore, once we can appropriately find the proxy (fitted PPD by logit regression, Fama and French (2001)) for the probability of dividend payment or payout, then it is possible to scrutinize the predictability of relative returns of dividend-payers' stocks and nonpayers' stocks, payout stocks and nonpayout stocks (including stock repurchase).

The important issue is the comparison of rational expectations model and behavioral asset pricing model. Baker and Wurgler (2004b) posit that the decision on paying dividends is made by prevailing investor demand for dividend payers. In other words, investors prefer dividend-paying firms because they ignore some cost of excess dividends to long-run growth of firms and rational firm mangers respond to this excess demand up to some costs. This makes dividend premium exist and related to dividend payment decisions. This so-called catering theory of dividend payment emphasizes the roles of stock mispricing in explaining the relationship between dividend policy and stock returns. The casual intuition suggests that the dividend premium and initiation effects are positively related to excess demand for payers. However, they find that the difference in future returns of payers and nonpayers is negatively related to this demand in empirical analysis because overpricing stocks by excess supply of dividends makes payers' future returns relatively low. But, by our rational expectations model of dividend policy, the relative returns of payers and nonpayers are explained by PPDs dependent on business cycles, not by mispricing stocks. Especially, we show that these relative returns are countercyclical due to the time-varying differences between rational investors' risk premiums for dividend payers and nonpayers, or payouts and non-payouts. In addition, the empirical results document that each future return

of payers and nonpayers is positively correlated to propensities of paying out cash. These results are consistent to our rational model of payout policies, but contradict the catering theory of dividend because according to their security overpricing, future returns should have been negatively linked to propensities and measures of dividend payment.

CHAPTER II

TO PAY OR NOT TO PAY: A DIVIDEND-BASED EXPLANATION OF ASSET
PRICING ANOMALIES

A. Introduction

Do corporate decisions made by firm managers matter in explaining the cross-sectional
properties of stock returns? Especially, if decisions on investment and dividend payout
can affect cash flows of firms, these have direct implications on the equity prices of
firms, since the cash flow processes of firms are one of the two main pillars determining
stock prices. The other pillar, stochastic discount factor, is closely related to the
changes of market investor's wealth given their attitudes toward risk and uncertainty.
Since the distributed cash flows of firms will constitute the current and future wealths
of market investors, corporate financial decisions related to investments and dividends
can have important links to variations in asset prices via channels of both firms' cash
flows and investors' discount factors. This paper studies the implications of corporate
dividend policies on stock returns in a general equilibrium framework.

There are several studies that attempt to connect the investment and production
behaviors of firms to stock returns (e.g., Cochrane (1996), Gomes, Kogan, and Zhang
(2003), Zhang (2005), Li, Livdan, and Zhang (2009), and Livdan, Sapriza, and Zhang
(2009)). However, the existing literature pays little attention to dividend policy,
and the authors assume that dividends are given as residual cash flow. Simple as
it may be, the assumption of this residual dividend policy is not consistent with
empirical evidence. Figure 1 plots earnings per share and dividends per share of
several firms. Dividends appear to be managed with the following patterns: First,
there are periods of no dividend payments which make earnings much more volatile,

and second, dividends and earnings share a common trend over time, though the latter more volatile, other than the period of zero dividends.[1] Thus, modeling whether and when to pay dividends seems relevant in describing dividend policy.

Empirical studies report that highly related are the extensive/intensive margins of dividend payout and key firm characteristics frequently used in empirical asset pricing studies. Fama and French (2001) find that four characteristics have effects on the decision to pay dividends: profitability, investment opportunities, market-to-book ratio, and size. Larger and more profitable firms are more likely to pay dividends, and paying dividends is less likely for firms with more investments. Grullon, Michealy, and Swaminathan (2002) report that the firm profitability declines after a dividend increase and rises after a dividend decrease. DeAngelo, DeAngelo, and Stulz (2006) present evidence that the probability that a firm pays dividends is significantly related to the mix of earned capital and contributed capital in its capital structure. Firms with a greater proportion of earned capital are more likely to be dividend payers. Bulan, Subramanian, and Tanlu (2007) use duration analysis to study the timing of dividend initiations in a firm's life cycle, and document that firms initiate dividends after reaching the maturity phase in their life cycles. Putting together, initiators are the firms that have grown larger and have fewer growth opportunities than do non-payers at the same stage in their life cycles.

Based on these observations, we develop a dynamic general equilibrium model of asset prices with many firms whose dividend processes are endogenously determined by firms' optimal dividend policies and investment behaviors. In so doing, both extensive and intensive decision margins in dividend payout are modeled. Corporate

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[1]It is well known that, at the aggregate level, dividend payments tend to be smooth relative to earnings, suggesting that corporate managers manage dividends (Lease, John, Kalay, Lowenstein, and Sarig (1999)).

managers will maximize the present value of current and future cash flows net of dividends and the costs involved with investment and cash holding. Cash holding is assumed costly to reflect the agency cost or the conflict of interests between shareholders and firm managers. Easterbrook (1984) and Jensen (1986) are the classic studies suggesting that firm managers pursue self-interests, and increase cash holdings for various reasons. In this case, they argue that dividends can help shareholders to reduce the associated agency costs. Recently, Nikolov and Whited (2009) estimate a dynamic model of firm investment and cash accumulation to find that agency problems affect corporate cash holding decisions. They model three specific mechanisms that misalign managerial and shareholder incentives: managerial bonuses on current profits, limited managerial ownership of the firm, and a managerial preference for firm size. Our setup can be viewed as an attempt to incorporate these findings in the corporate finance into a general equilibrium framework.

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based explanations of the value premium examined by Lettau and Wachter (2007) and Santos and Veronesi (2010). These papers view that growth stocks pay later, while value firms pay now. Alas, if there exist long-run risks (persistent shocks in economic growth, for instance) in an economy and the discount factor co-varies with stock prices, counterfactual growth premiums can occur. To overcome this, Lettau and Wachter (2007) assume that shocks to the discount factor do not co-vary with cash flows shocks, and Santos and Veronesi (2010) assume that cash flows are highly volatile. The former is difficult to justify in an equilibrium, while the latter needs an abnormal amount of cash flow fluctuations. In our model, young and growing firms typically do not pay dividends, and therefore covariations with the discount factor are close to zero. Meanwhile mature firms with larger amounts of capital pay dividends, and tend to have less room for growth. Thus, their short-run cash flows become risky and accordingly priced. In this vein, our paper provides a novel explanation of the value premium which extends and generalizes the insight from the durations of assets based on firms' cash flows.[3]

With this model in hand, we analyze the behaviors of stock returns generated from the simulated cash flows of firms. According to our quantitative results, the expected returns on value and size sorted portfolios are consistent with the historical data (e.g., Fama and French (2007) and Chen, Petkova, and Zhang (2008)). In addition, the simulated expected returns on decile portfolios sorted by book-to-market equity ratio and size present features of value and size premia in the empirical facts (Fama and French (1992)). Interestingly, pooling new decile portfolios sorted by fitted propensity to pay dividends, the simulated expected returns on them consistently increase in the likelihood of dividend payout. This implies that the factors affecting

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dividend policy largely overlap with the characteristics used to form pricing factors. Finally, the simulated market risk premiums and volatilities of aggregate dividend and asset returns reveal endogenously countercyclical variations, again in line with empirical evidence.

This paper is related to growing literature that links the cross-sectional properties of stock returns to firm characteristics. Gomes, Kogan, and Zhang (2003) construct a dynamic general equilibrium production economy to explicitly link expected stock returns to firm characteristics such as the firm size and the book-to-market equity ratio. Zhang (2005) shows that the value premium occurs from the asymmetric cost of reversibility and the countercyclical price of risk, and assets in place are riskier than growth options especially in bad times when the price of risk is high. Li, Livdan, and Zhang (2009) use a simple q-theory model, and ask if it can explain external financing anomalies, both qualitatively and quantitatively. Livdan, Sapriza, and Zhang (2009) analyze the effect of financial constraints on risk and expected returns by extending the investment-based asset pricing framework to incorporate retained earnings, debt, costly equity, and collateral constraints on debt capacity. However, this paper differs from all these studies in that our model explains the cross section of stock returns using endogenous dividend policies as well as production and investment. As mentioned earlier, models missing this feature can have counterfactual implications on the relationships between stock returns and firm characteristics.

Our work also belongs to another line of literature on the asset pricing model, which extends Lucas (1978) to have many trees (dividends). Cochrane, Longstaff, and Santa-Clara (2008) solve a model with two Lucas trees. They show that expected returns, excess returns, and return volatility as functions of dividend share vary through time, and returns are predictable from price-dividend ratios. Martin (2009) further extends Cochrane, Longstaff, and Santa-Clara (2008) with many

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The outline for the rest of this chapter is as follows: The recursive competitive equilibrium with dynamic problems is described in Section B, and our theoretical findings about the firm characteristics and the cross-section of stock returns are explored in Section C. Section D outlines the quantitative analysis of cross-sectional stock returns including the baseline calibration, and discusses the consistency of our findings related to similar literature. Finally, Section E concludes.

B. Model

1. Individual Firm Dynamics

This section sets up the dynamic and stochastic problem of firms. The economy is composed of a continuum of competitive firms that produce a homogeneous product. Firms are subject to an aggregate productivity shock (x_t) and a firm-specific productivity shock (z_{it})[4]. The aggregate shock, x_t, develops according to a first-order autoregressive stationary and monotone Markov transition function, denoted

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[4]This convention is based on recent macro-finance literature: Zhang (2005), Li, Livdan, and Zhang (2009), and Livdan, Sapriza, and Zhang (2009).

by $dQ_x\left(x_{t+1}|x_t\right),$

$$x_{t+1} = \mu_x\left(1 - \rho_x\right) + \rho_x x_t + \epsilon_{xt+1},$$

in which ϵ_x follows truncated $\mathcal{N}\left(0, \sigma_x^2\right)$, and x_t serves as the driving force of economic fluctuations and systematic risks. x_t has the finite support as $\left[\underline{x}, \bar{x}\right].$ Similarly, the firm specific productivity shocks, $\{z_{it}\}_{i\in[0,1]}$ with $dQ_z\left(z_{it+1}|z_{it}\right)$ are uncorrelated across firms, and follow

$$z_{it+1} = \rho_z z_{it} + \epsilon_{it+1},$$

in which ϵ_i follows truncated $\mathcal{N}\left(0, \sigma_z^2\right)$, and ϵ_{xt+1} is independent of ϵ_{it+1} for all i. z_{it} has the finite support as $\left[\underline{z}, \bar{z}\right].$

The production function is given by

$$y_{it} = e^{z_{it}+x_t}K_{it}^{\theta},$$

in which K_{it} is the capital of firm i at time t, and has the compact support of $\left[\underline{K}, \bar{K}\right].$ The assumption on capital implies that firms have limited investment opportunities as firms accumulate capital close to the upper bound. The production function exhibits decreasing returns to scale: the curvature parameter satisfies $0 < \theta < 1$. The operating profit is, then, defined as,

$$\Pi\left(K_{it}, x_t, z_{it}\right) = e^{z_{it}+x_t}K_{it}^{\theta} - f,$$

in which f is the nonnegative fixed production cost, which is paid in every period[5].

With this production technology in hand, we now describe the firm's decision process below. In the beginning of period t, firm i observes current aggregate and firm-specific shocks. Then, it decides whether to pay dividends to shareholders ($a_{it} = $

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[5]For mathematical simplicity, we assume that f is zero in driving our theoretical results.

1 : paying dividends, $a_{it} = 0$: not-paying dividends). In particular, the dividend payment (D_{it}) is determined by a fixed payout ratio $0 < \delta < 1$ as

$$(2.1) \qquad\qquad D_{it} = a_{it}\delta\Pi\left(K_{it}, x_t, z_{it}\right) = a_{it}\delta e^{z_{it}+x_t}K_{it}^{\theta}.$$

To motivate our choice of dividend policy dictated by (2.1), we plot Figure 1. As mentioned earlier, Figure 1 illustrates the existence of zero dividend periods for individual firms. Although we do not tabulate here, a significant number of firms do not pay dividends at any given point of time. Thus, we believe that it is pertinent to include the discrete decision of dividend distribution. In addition, this figure suggests that dividend and corporate earnings follow a common trend, excluding the period of no dividend, which makes (2.1) a reasonable approximation of reality. We further investigate this issue in Figure 2. Panel (A) in Figure 2 displays the aggregate payout ratios in the U.S. stock market during 1950 and 2009. Although there exist some variations, the payout ratio is stable around 0.5. To see if the variations result from the usual suspects such as profitability and investments, we run rolling regressions of the aggregate payout ratio onto those variables. We find that both variables are mostly not different from zero, and the negative sign of the profitability is inconsistent with the related theory.

After the decision of paying dividends, the firm manager of firm i chooses the optimal investment I_{it}^a to maximize the present value of future cash streams under the operating profit less dividends. This cash accumulation decision is motivated from the empirical findings in the corporate finance literature[6]. Related, firms often need to hold a significant amount of funds (cash and marketable securities) to allow for future

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[6]For instance, Nikolov and Whited (2009) argues that although numerous empirical researchers have studied the effects of agency conflicts on cash holding, this topic remains of interest because no single prominent conclusion has emerged from these exercises.

acquisitions and to cover its considerable legal and business risks (Harford (1999)).[7]

It is also well known that there exists an agency conflict between managers and equity

providers, and increasing cash holdings further intensify this type of agency problem.[8]

That is, increasing the cash holdings of firms is a costly business. Incorporating this

stylized fact, we set up a firm's dynamic decision problem with a non-convex agency

cost function in the following way.

$$(2.2) \qquad V_i\left(S_{it}\right) = \max_{\{a_{it}=0, a_{it}=1\}} V_i^{a_{it}}\left(S_{it}\right) \text{ for all } \left(K_{it}, x_t, z_{it}\right) \equiv S_{it} \in \mathcal{S},$$

$$V_i^{a_{it}}\left(S_{it}\right) = \max_{I_{it}^a} \left\{v_{it}^a - \Xi\left(v_{it}^a, K_{it}, x_t, z_{it}\right) + \beta\mathbb{E}_t\left[V_i\left(S_{it+1}\right) | S_{it}\right]\right\},$$

in which $V^{a_{it}=0}$ is the present value of future cash streams reserved when it does not

pay dividends, $V^{a_{it}=1}$ is the present value of future cash flows held by a firm paying

dividends, v_{it}^a is the current cash held and used by the firm manager before the cost of

reserving the cash, $\Xi\left(v_{it}^a, K_{it}, x_t, z_{it}\right)$ is the cash holding cost, $\mathcal{S}$ is a compact product

space of state variables, and $\mathbb{E}_t$ is the expectation operator at time t.[9] Thus, the firm

i maximizes the present value of the net cash flows into the corporate cash holdings,

defined as $v_{it}^{a_{it}} - \Xi(v_{it}^{a_{it}}, K_{it}, x_t, z_{it})$ with the decision of paying or not paying dividends

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[7]From the perspective of corporate governance, Harford (1999) states that cash is an important tool for firms operating in imperfect capital markets. However, firms often build up much more cash than they need to meet expected financing requirement, which also provides another rational on why managers accumulate cash reserves, and it is subject to a source of agency cost. Harford, Mansi, and Maxwell (2008) find that firms with weaker corporate governance structures actually have smaller cash reserves, and weakly controlled managers tend to spend cash quickly on acquisitions and capital expenditures.

[8]Readers are referred to Jensen and Meckling (1976), Jensen (1986), Easterbrook (1984) for more on this issue.

[9]The superscript a is sometimes suppressed, when it is not confusing, for the purpose of expositional ease. For instance, when we integrate over i, we will simply use v_{it} instead of v_{it}^a.

each period as well as an investment decision.[10] Furthermore, we define v_{it}^a as

$$v_{it}^a \equiv \Pi\left(K_{it}, z_{it}, x_t\right) - D_{it} - \Phi\left(I_{it}^a, K_{it}\right),$$

and

$$\Phi\left(I, K\right) \equiv \frac{\phi}{2}\left(\frac{I}{K}\right)^2 K + I,$$

in which Φ is a quadratic investment adjustment cost with a constant $\phi > 0$.

Regarding the cash holding cost, $\Xi\left(v_{it}^{a_{it}}, K_{it}, x_t, z_{it}\right)$, we assume the following quadratic form:

$$\Xi\left(v, K, x, z\right) \equiv \frac{\xi_1 e^{\xi_2(x+z)}}{2}\left(\frac{v}{K}\right)^2 K,$$

in which $\xi_1, \xi_2 > 0$ are constant parameters. This reflects the idea that shareholders would expect more dividends to be paid in good times, and increasing the cash holdings of firms becomes more costly. The law of motion for capital is expressed as

$$K_{it+1} = I_{it}^a + \left(1 - \bar{\delta}\right)K_{it},$$

in which $\bar{\delta}$ is a constant depreciation rate of capital stocks. This setup allows that capital in the next period may depend upon dividend policy, especially around the time of initiating dividend payment, since whether a firm pays a proportion of cash flow from the profit as dividend to a shareholder determines the amount of investment given the investment opportunity set.

Recall that firm managers are subject to costs due to the agency problem mentioned above. This not only has a direct implication on the payout policy of firms, but also affects firms' capital accumulation paths over time. Furthermore, note that the total cost defined as $\Phi + \Xi$ is state-dependent, depending on the firms' choices

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[10]We can define a felicity function for firm manager, F such that her periodic utility is $F(v_{it}^a - \Xi\left(v_{it}^a, K_{it}, x_t, z_{it}\right))$, where $F' > 0$, and $F'' \leq 0$. In this context, our setup assumes that firm managers are risk-neutral.

of extensive margins on the dividend payout. Specifically, even if each of Φ and Ξ is a convex function, total cost function is non-convex in investment. Figure 3 displays this feature. Notice that the level of investment corresponding to the minimum cost of non dividend payment, $(\Phi^0 + \Xi^0)$ is bigger than that of the minimum cost when paying dividend, $(\Phi^1 + \Xi^1)$. This property results from the fact that dividend payment effectively reduces the range of possible investments by lowering down cash flow in hand. In addition, the total cost function shifts to the right as capital increases. Once a firm has enough cash in hand and fewer marginal profitable investment options, it has the incentive to pay dividends to reduce the cash holding cost as well as the investment adjustment cost.

The recursive problem of firm (2.2) is well defined, and the existence of a solution can be easily established, summarized in the following proposition.

Proposition II.1. *There exists a solution to the functional equation* (2.2).

Proof. We refer to Theorem 9.6 in Stokey and Lucas (1989).

Now we characterize the firm dynamics implied by our model. In light of optimal dividend policy, the probability of paying dividends is described as

$$\mathbb{P}\left\{a = 1|S\right\} = 1$$

if and only if $V^1 > V^0$ given the state vector $S \in \mathcal{S}$. In this context, the propensity to pay dividends (PPD, hereinafter) following Fama and French (2001) is defined as,

$$(2.3) \qquad \mathbb{P}\left\{a_{t+u} = 1|S_t\right\} \equiv \int_{\mathcal{S}} a_{t+u} dQ\left(S_{t+u}|S_t\right),$$

in which dQ is the transition density of S. This PPD measure is reminiscent of a hazard function in that a firm usually does not pay dividends at its initiation, yet it tends to pay dividends as it matures. In addition, (2.3) states that capital, aggregate

shock, and firm-specific shock (i.e., the elements of S_t) determine optimal dividend policy, and can be related to the size and the profitability of firms. Although we will investigate this issue in detail through numerical analysis, we show some theoretical predictions consistent with the empirical findings by Fama and French (2001) below. For the purpose of illustration, we make a simplifying assumption that there are some dividend payers and non-payers who will not change their types for this and next sections.[11]

Assumption II.2. There exist compact sets $\mathcal{S}^0$ and $\mathcal{S}^1$ such that for bounded positive integer sets $\{u^0\}$ and $\{u^1\}$,

$$\mathcal{S}\left(u^0\right) \equiv \left\{S_t \in \mathcal{S} \mid \mathbb{P}\left\{a_{t+s} = 0 | S_t\right\} = 1, \ \forall 0 \le s \le u^0\right\}, \ \text{and} \ \bigcup_{\{u^0\}} \mathcal{S}\left(u^0\right) = \mathcal{S}^0,$$

and

$$\mathcal{S}\left(u^1\right) \equiv \left\{S_t \in \mathcal{S} \mid \mathbb{P}\left\{a_{t+s} = 1 | S_t\right\} = 1, \ \forall 0 \le s \le u^1\right\}, \ \text{and} \ \bigcup_{\{u^1\}} \mathcal{S}\left(u^1\right) = \mathcal{S}^1.$$

Assumption II.2 describes that if a firm's state vector is located in $\mathcal{S}^0$, then it currently does not pay dividends and it has no propensity to pay dividends to shareholders in a near future. But, in $\mathcal{S}^1$, a firm is paying a proportion of operating profit as dividends for some periods. Then, we show the following.

Proposition II.3. *Suppose that $\phi = 1$ in the investment adjustment cost function for simplicity, for $S \in \mathcal{S}^0$ and $\frac{\Pi}{3} < I^0 \le \Pi$. Under the technical Assumption IV.1 in Appendix A,*

$$\frac{\partial I^0\left(S\right)}{\partial K} > 0, \ \frac{\partial I^0\left(S\right)}{\partial x} > 0, \ and \ \frac{\partial I^0\left(S\right)}{\partial z} > 0,$$

in which I^0 is the optimal investment when a firm does not pay dividends.

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[11]This exogeneity is not used in our main quantitative section.

Proof. See Appendix A.

According to Proposition II.3, the optimal investment increases in capital, aggregate shock, and firm-specific shock, when a firm does not pay dividends. If a firm starts to pay out, we find that this relationship becomes non-monotonic and is unable to show. The complexity comes from the shift in conditional likelihood of initiating dividend payment as either productivity shock or level of capital varies. For instance, if the aggregate productivity shock x_t increases, then investment increases when there is no dividend payment. But, the increases in firm profitability can also increase the value of firm with or without dividend payment. Note that increases in productivity can give more pressure to the firm manager toward paying dividends via the agency cost channel. Then, the conditional probability of dividend payment can increase as x or z goes up. This is illustrated in Figure 4. As x increases, the level of capital that triggers dividend payment shifts leftward, implying that dividend is going to be distributed at an earlier stage of firm maturity.

We expect that the optimal investment experiences a one-time reduction as dividend starts getting paid, followed by a gradual increase of investment in capital. This conjecture is confirmed in our numerical and empirical analysis (Section 2).

2. Preferences and Asset Prices

We assume that there is a representative household in this economy. The household holds a continuum of stocks from a set of firms. This setting is borrowed from Lucas tree model (Lucas (1978), Cochrane, Longstaff, and Santa-Clara (2008), and Martin (2009)). The preference of this household is given by

$$\mathbb{E}_t \left[\sum_{u=0}^{\infty} \beta^u \frac{C_{t+u}^{1-\gamma}}{1-\gamma} \right],$$

in which $\beta \in (0,1)$, and $\gamma > 1$. The budget constraint of the representative household is written as

$$(2.4) \qquad C_t + \int P_{it}\varphi_{it+1}di = \int \varphi_{it}\left(P_{it} + D_{it}\right)di,$$

where φ_{it} is an outstanding share of stock i publicly traded from firm i in the stock market, P_{it} is the price of asset of firm i at time t, and D_{it} is the dividend from firm i at time t. We assume that φ_{it} for all i and t is equal to one, hence

$$(2.5) \qquad C_t = \int D_{it}di.$$

This is a Lucas tree model with multiple assets. But, it is important to note that the dividend processes of firms, $\{(D_i)_t\}_{i\in[0,1]}$ are endogenously determined by the firm problem we developed previously, in lieu of using exogenous processes for endowments. In addition, our setup incorporates financial frictions as well as real frictions, allowing interactions between the two main pillars in corporate decision making.

Given the simplicity of the household setup, we can readily compute the fundamental asset pricing equation through the Euler equation of the representative household as

$$(2.6) \qquad P_{it} = \mathbb{E}_t\left[\sum_{u=1}^{\infty} M_{t,t+u}D_{it+u}\right],$$

in which $M_{t,t+u}$ is the stochastic pricing kernel such that,

$$M_{t,t+u} = \beta^u \left(\frac{C_{t+u}}{C_t}\right)^{-\gamma} = \beta^u \left(\frac{\int D_{it+u}di}{\int D_{it}di}\right)^{-\gamma}.$$

Cochrane, Longstaff, and Santa-Clara (2008) show that the volatility of consumption growth is endogenously related to a non-linear function of dividend shares (D_{it}/C_t), which leads to time-variations in risk premium. Our model shares this feature, and

endogenizes the dividend processes of individual firms, and aggregate dividend to explicitly link economic factors to asset returns, without relying on some ad-hoc statistical processes.

Recently, there are several papers studying asset returns via variables related to the investment and production sides of firms (See Zhang (2005), Li, Livdan, and Zhang (2009), and Livdan, Sapriza, and Zhang (2009)). However, we depart from this literature by emphasizing the role of endogenous dividend policy to explain the cross-sectional behaviors of asset returns. In addition, they assume a version of stochastic risk aversion to generate time-varying risk premium unlike this model in which the risk premium is endogenously countercyclical.

Expected returns, market sizes, book-to-market equity ratios and some sort of risks are functions of three state variables K_{it}, z_{it} and x_t. The risk and expected return of firm i satisfy

$$\mathbb{E}_t\left[R_{it+1}\right] = R_{ft} + \beta_{it}\lambda_{Mt} \text{ or } \mathbb{E}_t\left[r_{it+1}\right] - r_{ft} = \beta_{it}\lambda_{Mt}.$$

The *quantity of risk* is given by

$$\beta_{it} \equiv -\frac{\mathbb{C}ov_t\left[M_{t,t+1}, R_{it+1}\right]}{\mathbb{V}ar_t\left[M_{t,t+1}\right]},$$

the *price of risk* is given by

$$\lambda_{Mt} \equiv \frac{\mathbb{V}ar_t\left[M_{t,t+1}\right]}{\mathbb{E}_t\left[M_{t,t+1}\right]}.$$

and the maximum conditional *Sharpe* ratio is given by

$$\left|\frac{\mathbb{E}_t\left[R_{t+1}\right] - R_{ft}}{\sigma_t\left[R_{t+1}\right]}\right| \leq \frac{\sigma_t\left[M_{t,t+1}\right]}{\mathbb{E}_t\left[M_{t,t+1}\right]},$$

in which R is assumed to be located on the mean-standard deviation frontier (Cochrane (2005)). The market size is P_{it} since we already assume that a supplied outstanding

share of stock i, φ_{it} is one. Then, *book-to-market equity ratio* is defined as

$$\frac{BE_{it}}{ME_{it}} \equiv \frac{K_{it}}{P_{it}}.$$

3. Equilibrium

By developing a recursive competitive equilibrium model, we characterize the aggregate behaviors of the economy. We assume that aggregate demand is automatically cleared at the aggregate output. Asset prices (P_{it}) are real prices normalized by the output price, and we can suppress the output price. Let μ_t denote the measure over the capital stocks and idiosyncratic shocks for all the firms at time t and let $\Psi(\mu_t, x_t, x_{t+1})$ be the law of motion for the firm distribution μ_t. Then $\Psi(\mu_t, x_t, x_{t+1})$ can be stated formally as

(2.7) $$\mu_{t+1}(\mathcal{S}; x_{t+1}) = T(\mathcal{S}, (K_t, z_t); x_t)\, \mu_t(K_t, z_t; x_t),$$

in which the operator T is defined as

(2.8) $$T(\mathcal{S}, K_t, z_t; x_t) \equiv \int \int 1_{\left\{I_t + \left(1 - \bar{\delta}\right) K_t, z_{t+1} \in \mathcal{S}\right\}} dQ_z(z_{t+1}|z_t)\, dQ_x(x_{t+1}|x_t),$$

in which $1_{\{\cdot\}}$ is the indicator function. The operator T determines the law of motion of the firm distribution μ_t.

The total economic output can be written as

$$Y_t \equiv \int y(K_t, z_t; x_t)\, d\mu_t(K_t, z_t),$$

in equation (2.9). The resource constraint for this economy is given by

(2.9) $$Y_t = \int (D_{it} + v_{it} + \Phi_{it})\, di.$$

Definition II.4. A recursive competitive equilibrium is characterized by (*a*) an op-

timal investment rule $I^*(S_t)$, an optimal dividend policy $D^*(S_t)$ as well as a value function $V^*(S_t)$ for each firm, (b) an optimal consumption $C^*(\mu_t, x_t)$ for a representative household given asset prices $P(S_t)$, and (c) a law of motion of firm distribution Ψ^* such that:

1. $I^*(S_t)$ and $D^*(S_t)$, hence $v^*(S_t)$ solve the value-maximization problem (2.2) for each firm,

2. $C^*(\mu_t, x_t)$ solves the household utility-maximization problem,

3. $P(S_t)$ is determined in (2.6),

4. Consistency: (2.9) holds for the consistency of the production of all firms in the industry with the aggregate output Y_t. (2.7) and (2.8) hold for the consistency of the law of motion of firm distribution Ψ^* with firms' optimal decisions.

5. Market clearing condition: from (2.5) and (2.9),

$$Y_t = C_t + \int (v_{it} + \Phi_{it}) \, di,$$

and $\varphi_{it} = 1$ for all i and t.

Proposition II.5. *There exists a unique recursive general equilibrium.*

Proof. See Appendix A.

C.   Cross Sections of Stock Returns

Since our model incorporates key aspects of corporate decision making on capital accumulation and dividend payout which, in turn, determine the wealth of investors in equilibrium, the model offers a theoretical laboratory to analyze the stylized facts from the empirical asset pricing studies, such as (Fama and French (1992)). In particular,

we focus on the value and size premia. The first step is to illustrate the theoretical possibility via simple examples, paving the way to the quantitative analysis.

1. The Value Premium

The expected excess return is decomposed into a term indicating the discount risk effect and the other term representing the cash flow risk effect following (Santos and Veronesi (2010)) as

$$(2.10) \qquad \mathbb{E}_t \left[R_{it+1} \right] - R_{ft} = \left(\beta_{it}^{\text{cf}} + \beta_{it}^{\text{disc}} \right) \lambda_{Mt},$$

in which

$$\beta_{it}^{\text{cf}} = -\frac{\mathbb{C}ov_t \left[M_{t,t+1}, \frac{D_{it+1}}{P_{it}} \right]}{\mathbb{V}ar_t \left[M_{t,t+1} \right]},$$

$$\beta_{it}^{\text{disc}} = -\frac{\mathbb{C}ov_t \left[M_{t,t+1}, \frac{P_{it+1}}{P_{it}} \right]}{\mathbb{V}ar_t \left[M_{t,t+1} \right]}.$$

Alternatively, the expected stock return can be explained in two parts, the expected rate of capital gain (expected long-term dividend growth rate) and the expected dividend price ratio (Fama and French (2002), and Chen, Petkova, and Zhang (2008)) such that,

$$(2.11) \qquad \mathbb{E}_t \left[R_{it+1} \right] = \frac{\mathbb{E}_t \left[P_{it+1} \right]}{P_{it}} + \frac{\mathbb{E}_t \left[D_{it+1} \right]}{P_{it}}.$$

Now we show that the value premium can result from both the discount risk and cash flow risk under some conditions.

Proposition II.6. *Suppose that there are only two assets in the economy with $K_{1t} < K_{2t}$, $P_{1t} = P_{2t}$ with the Assumptions II.2 and IV.2. Further, we assume that*

$$(K_{1t}, x_t, z_{1t}) \in \mathcal{S}^0 \text{ and } (K_{2t}, x_t, z_{2t}) \in \mathcal{S}^1.$$

Then, the following relationships hold.

$$\beta_{1t}^{cf} < \beta_{2t}^{cf}, \; \beta_{1t}^{disc} < \beta_{2t}^{disc},$$

hence,

$$\mathbb{E}_t \left[R_{1t+1} \right] < \mathbb{E}_t \left[R_{2t+1} \right].$$

Proof. See Appendix A.

The firm 1 with small capital is a growth stock compared to the firm 2 with larger capital, a value firm by construction. Then the proposition states that the value premium prevails, as long as the growth firm has not been paying the dividend ($\mathcal{S}^0$), while the value firm pays ($\mathcal{S}^1$). It is worth mentioning that both the premiums from the cash flow and discount risks are higher for the value firm. Admittedly the assumptions used in this proposition are rather strong, which we do not impose in our quantitative analysis. However, this permits us to gain insight on the roles of lumpy dividend policy and the life cycle of firms in producing the value premium.

In this example, the cash flow beta (β_t^{cf}) of the value firm is higher than that of the growth firm, because the latter will not distribute its cash to a shareholder for a while, and the resulting conditional covariations will be zero. Thus, as long as it is a reasonable assumption that non-dividend paying firms are the growth firms, which will be shown in the next section, equity holders of those firms are exposed to lower cash flow risks, since they are unlikely to pay dividends in a near future.

Interestingly, this intuition carries over in evaluating the discount effect as well. According to the proposition, the equity of the firm 2 (value firm) will involve the higher risk than that of the firm 1 (growth firm) for betting on long-term dividend growths ($\beta_{1t}^{\text{disc}} < \beta_{2t}^{\text{disc}}$). At first glance, this result seems counterintuitive, because growth firms are assets with high durations, implying that the more sensitive are

their prices to changes in the discount factor. It is well known that this leads to counterfactual growth premiums. Lettau and Wachter (2007) assume that the discount rate shock is uncorrelated with the aggregate dividend growth to turn this channel off, while Santos and Veronesi (2010) increase idiosyncratic cash flow risks to counter the effect. Although the same channel still exists in the model, there is another discount effect from the short-run fluctuations in our case: Stocks currently paying dividends (value firms) can be exposed to more discount risk than those not paying dividends (growth firms) which has zero covariations with changes in the discount rate until they start paying. If this dominates the effect of high duration, the value firm involves higher risks from the shocks to discount rate.

More concretely, under the assumptions in Proposition II.6, we have the following relation

$$(2.12) \quad \beta_2^{\text{disc}} - \beta_1^{\text{disc}} \propto -\sum_{u=1}^{u^0-1} \mathbb{C}ov_t\left[M_{t,t+1}, (\mathbb{E}_{t+1} - \mathbb{E}_t)\left(\left(\frac{D_{2t+u+1}}{D_{2t+1}}\right)^{-\gamma} D_{2t+u+1}\right)\right],$$

where

$$(2.13) \quad \mathbb{C}ov_t\left[M_{t,t+1}, (\mathbb{E}_{t+1} - \mathbb{E}_t)\left[\left(\frac{D_{2t+u+1}}{D_{2t+1}}\right)^{-\gamma} D_{2t+u+1}\right]\right] < 0$$

for $u = 0, 1, \cdots u^0$. The term (2.13) exhibits the discount risk effect of the value firm (firm 2) during a period in which the growth firm does not pay dividends. If the differences in future dividends are relatively small by the time both firms pay dividends (Assumption IV.2), value premium can prevail because of the differences in dividend policy in the next upcoming periods. Assumption IV.2 is a quantitative concern, which we closely examine in the next section. Notice from (2.12) that the value premium increases in u^0 that measures how long the firm 1 will delay dividend payment, i.e., persistence in dividend policy. As the growth firm delays paying dividends for a longer period, the value premium is likely to be higher. In sum, a firm's

decisions on whether to pay dividend and its duration matter to generate the value premium in our model. Of course, the assumption on the equal market value of the two firms ($P_1 = P_2$) completely ties the firm's book value (K) with the book-to-market equity ratio (K/P). However, the following proposition shows that if firms with larger (smaller) book values (K) are those who (do not) pay dividends, their book-to-market equity ratios are consistent with the rank order of book values.

Proposition II.7. *Suppose that there are only two assets without firm-specific shocks in the economy with $K_{1t} < K_{2t}$, the Assumption II.2, and some parametric restrictions. If $(K_{1t}, x_t) \in \mathcal{S}^0$ and $(K_{2t}, x_t) \in \mathcal{S}^1$ additionally hold, then*

$$\frac{K_{1t}}{P_{1t}} < \frac{K_{2t}}{P_{2t}}.$$

Proof. See Appendix A.

The existing models such as Gomes, Kogan, and Zhang (2003) and Zhang (2005) have the property that a growth firm pays more dividend than a value firm, which is counterfactual. On the contrary, the above proposition suggests that, even without firm-specific shocks, the firm paying dividends (firm 2) is more likely to be a value stock compared to the firm 1 who is not paying dividends. Because the firm 1 has relatively higher marginal profitability and a larger opportunity set, its value of growth options given capital is greater than that of firm 2, inferred from the firm dynamics.

2. The Size Premium

This section explores the possibility of the size premium via dividend policy using a simple Gordon model. We assume that there exist only two firms with $K_{1t} < K_{2t}$ indexed by 1 and 2 in the economy. We further assume that $D_{1t} = \delta K_{1t}^{\theta}$ and $D_{2t} = \delta K_{2t}^{\theta}$, if dividends are distributed. Similar to the previous examples, for simplicity,

we assume that the firm 1 decides not to pay dividends until $t + u^0 + 1$, and the firm 2 pays dividends now. In addition, firms continue to pay dividends once it started. Finally, to control for the value premium, two firms are assumed to have the same book-to-market equity ratio, i.e.,

$$\frac{K_{1t}}{P_{1t}} = \frac{K_{2t}}{P_{2t}}.$$

The firm 1 (2), by construction, is a small (large) firm in this simple example.

Stock prices of the firms are then written as

$$P_{1t} = \sum_{u=u^0+1}^{\infty} \delta K_{1t}^{\theta} \left(\frac{1 + \Delta P_1/P_1}{1 + r} \right)^u = \frac{(1 + \Delta P_1/P_1)^{u^0+1} \delta K_{1t}^{\theta}}{(1 + r)^{u^0} (r - \Delta P_1/P_1)},$$

$$P_{2t} = \sum_{u=1}^{\infty} \delta K_{2t}^{\theta} \left(\frac{1 + \Delta P_2/P_2}{1 + r} \right)^u = \frac{(1 + \Delta P_2/P_2) \delta K_{2t}^{\theta}}{(r - \Delta P_2/P_2)},$$

in which $\Delta P_1/P_1$ and $\Delta P_2/P_2$ are long-term dividend growth rates in Gordon model, and r is a constant opportunity cost of capital in the financial market. $\Delta P_1/P_1$ and $\Delta P_2/P_2$ are less than r to have finite stock prices. We then solve for the difference of two long-term dividend growth rates under the assumption of equal book-to-market equity ratios to show that

$$\frac{\Delta P_1}{P_1} - \frac{\Delta P_2}{P_2} \propto \left(\frac{K_{2t}}{K_{1t}} \right)^{\frac{\theta-1}{u^0}}.$$

$(K_{2t}/K_{1t})^{\theta-1}$ is the ratio of marginal profitability of firm 2 to marginal profitability of firm 1, which must be less than 1 according to the assumption. The difference between two long-term dividend growth rates has the positive relation to u^0, which presents the firm 1's dividend policy. This property implies that in the stock market, the expected long-term dividend growth rate of the firm 1 is higher than the firm 2, even though the firm 1 has the same book-to-market equity ratio as the firm 2. While the firm 1 starts to pay dividends later, the condition of equal book-to-market

equity ratios makes its long-term dividend growth rate expected to be higher. Plus, if the firm 1 has the smaller capital, it will invest more in capital, postpone further the initiation time of dividend payout by due to the increases in its marginal profitability. Consequently, the expected capital gain of firm 1 must be higher than before. If the firm 2's expected dividend price ratio is sufficiently low, then the firm 1's expected stock return must be higher than the firm 2, implying the small firm's size premium. One caveat of this explanation is the lack of risk adjustment, and further quantitative analysis is desired.

To summarize, time-varying, persistent, and stochastic extensive margins in dividend policy have potentials to explain cross-sectional variations in stock returns. However, as emphasized in the beginning of this section, dividend policy is a highly endogenous process depending on the fundamental and firm specific shocks. To delve into this issue, we now turn our attention back to the full model, and quantitatively analyze it.

D.   Quantitative Analysis

1.   Calibration

We calibrate 12 parameters $\left(\bar{\delta}, \rho_x, \sigma_x, \rho_z, \sigma_z, \phi, \delta, \beta, \mu_x, \theta, \xi_1, \xi_2 \right)$ both in monthly and quarterly frequencies to facilitate the comparison of our results with those from the empirical literature. The monthly model is denoted as Model $\mathcal{M}$, and the quarterly model, as Model $\mathcal{Q}$. The first parameter set $\left(\bar{\delta}, \rho_x, \sigma_x, \rho_z, \sigma_z, \phi, \delta, \beta \right)$ is calibrated outside the models, and the second parameter set $(\mu_x, \theta, \xi_1, \xi_2)$ is calibrated inside the models following the idea of generalized method of moments. Table I reports the parameter values that we use to solve and simulate the models.

The monthly depreciation rate $\bar{\delta}$ is 1%, which implies an annual rate of 12%

(Abel and Eberly (2002)). The persistence of the aggregate productivity process (ρ_x) is 0.95 and its conditional volatility (σ_x) is 0.007, which are quarterly values. 0.983 and 0.0023 are the monthly values of those parameters, ρ_x and σ_x, respectively. These values are consistent with Cooley and Prescott (1995). For the persistence (ρ_z) and conditional volatility (σ_z) of the firm-specific productivity shock, we set $\rho_z = 0.97$ and $\sigma_z = 0.10$ for monthly frequency. These values are chosen from the related literature (e.g., Zhang (2005), Li, Livdan, and Zhang (2009), and Livdan, Sapriza, and Zhang (2009)) to generate a plausible amount of dispersion in the cross-sectional distribution of firms. We set $\rho_z = 0.912$ and $\sigma_z = 0.30$ for quarterly frequency. The average payout ratio (δ) is calibrated to be 60%, borrowed from the average value of aggregate payout ratios from 1981 to 2007 in CRSP/COMPUSTAT merged data. We choose the time preference parameter, $\beta = 0.998$ on monthly and $\beta = 0.994$ on quarterly.

Regarding the second set of parameters $(\mu_x, \theta, \xi_1, \xi_2)$, we calibrate those parameters using the following procedure.[12]

1. Set initial values for group $\Lambda^0 = (\mu_x^0, \theta^0, \xi_1^0, \xi_2^0)$.

2. Solve the value function $V(S_{it})$ such that,

   (a) Each grid on the compact set $\mathcal{S}$ represents each firm in the market.

   (b) By backward induction, solve the $V^0(S_{it})$ and $V^1(S_{it})$ on each iteration, and pick the bigger value.

3. From the converged value function $V(S_{it})$, we have the operating profit function (profitability) and endogenous policy functions (investment-capital ratio,

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[12]The convexity parameter of investment adjustment cost (ϕ) is normalized to one to conserve the number of parameters used in our numerical study.

disinvestment-capital ratio, and dividend policy) such that,

$$Z_{it} = \left(\frac{\Pi\left(S_{it}\right)}{K_{it}}, \frac{I_+\left(S_{it}\right)}{K_{it}}, \frac{I_-\left(S_{it}\right)}{K_{it}}, a_{it}; \Lambda \right)',$$

in which, I_+ is the net investment and I_- is the net disinvestment.

4. Define the generalized moments of policy functions as,

$$\frac{1}{n} \sum_{i=1}^{n} Z_{it} - \mathbb{E}\left[Z_{it}\right] = \bar{\mathcal{Z}}\left(\Lambda\right) - \mathcal{Z},$$

in which n is $n_K \times n_x \times n_z$, ($n_K$: number of grids on $\mathcal{S}_K$, n_x: number of states of x, and n_z: number of states of z).

5. By iterating the process from step 1 to step 4, we solve the minimization problem for the parameters as follows,

$$\hat{\Lambda} = \arg\min_{\Lambda} \left(\bar{\mathcal{Z}}\left(\Lambda\right) - \mathcal{Z} \right)' W \left(\bar{\mathcal{Z}}\left(\Lambda\right) - \mathcal{Z} \right),$$

in which W is a weight matrix, and we use identity matrix in this study.

Our method is not the same as the conventional simulated method of moments since we do not generate random numbers to compute the moments of endogenous policy functions. Rather, generated moments are the average numbers of target values from points on all grids of the compact state space while iterating value functions regarding the values of Z. The average monthly profitability defined as the operating profit to the capital ratio (Π/K) is 1.25%, the value of the average monthly net investment ratio (I_+/K) is 1.25%, for the net disinvestment (I_-/K), 0.17% is the average value on monthly frequency. These values are reported by Abel and Eberly (2002). The average proportion of firms in CRSP that paid dividends in a period from 1926 to 1999 is 49%. This number is borrowed from Fama and French (2001). The calibrated parameters are $\Lambda = (-2.0, 0.68, 323, 0.084)$ for Model $\mathcal{M}$ and

$(-1.71, 0.65, 458, 0.044)$ for Model Model $\mathcal{Q}$. The curvature parameter in the production function (θ) is monthly 0.68 and quarterly 0.65, close to the values suggested by Livdan, Sapriza, and Zhang (2009) or the average values estimated by Cooper and Ejarque (2001), Cooper and Ejarque (2003), Hennessy and Whited (2005), and Hennessy and Whited (2007). The long-run average level of aggregate productivity (μ_x) is -2.0 for Model $\mathcal{M}$ and -1.71 for Model $\mathcal{Q}$, which are higher than other free cash flow asset pricing models (e.g., Zhang (2005), Li, Livdan, and Zhang (2009), and Livdan, Sapriza, and Zhang (2009)). The difference may come from the way this parameter is retrieved. They calibrate μ_x and time-varying γ exogenously by fitting the first and second moments of risk-free rate data. Meanwhile, we use only firm characteristics data to calibrate it. Convexity parameter of the cash holding cost (ξ_1) and procyclical parameter of cash holding cost (ξ_2) are 323, 458, and 0.084, 0.044 on monthly and quarterly frequencies, respectively.

2. Investment, Dividend Policy, and Cash Holdings

Panel (A)'s in Figures 5-8 display optimal investment behaviors as a function of capital and productivity shocks (K, x, z). First, we observe that optimal investments increase until capital stock (K) reaches level at which dividend payouts begin. When this occurs, investment drops off by about the half of where it used to be. As discussed, x and z determine the amount of investments, and they have positive relationships with investment.

Panel (B)'s in Figures 5-8 show that the investment-capital ratios (I/K) given x and z decrease as capital stock increases, because of diminishing returns to scale of capital. This is consistent with the view that young firms are more likely to invest their resources in capital compared to mature firms. What is new in our model is that a firm will execute a one-time discrete reduction of investment in its life cycle, as it

grows. The discrete shift in investment results from the lumpy behavior of dividend policy, as we discussed earlier, because dividend payment substitutes for the amount of investment. However, we want to emphasize that this does not necessarily imply that investment and dividend payout will feature negative correlation, since adjustment is costly for both investment and dividend and therefore, frequent changes of these variables are unlikely to prevail. Only a few observations show conditionally negative correlations, and the unconditional correlation between investment and dividend does not need to be negative, because it can depend more on firm profitability, level of capital, and related, firm age.

Firms with the smaller amount of capital invest more, and the investment decreases rather abruptly as capital is accumulated. Panel (C)'s in Figures 5-8 show the optimal dividend policies. Zero dividend equity ratios mean that firms are not paying dividends, and positive numbers show that the firms pay dividends. Firms with higher x and z are more likely to initiate their dividend payouts earlier, since those firms will accumulate capital faster, hence they tend to mature earlier than other firms. Recall that our model has the cash holding cost motivated in part by the agency cost resulting from the tension between equity holders and the firm manager. Thus, accumulated capital will lead to larger operating incomes which trigger dividend payout.

It is natural to think that the propensity to pay dividends (PPD), $\mathbb{P}\{a = 1|S\}$ and firm-characteristics such as profitability, investment, and the market value of capital are associated with each other. Figures 5-8 suggest that our model indeed replicates the stylized facts in Fama and French (2001) as mentioned earlier: Asset prices generated by the model are consistent with the firm characteristics.

Panel (D)'s in Figures 5-8 plot the value functions of firm dynamics (2.2) which are the present values of cash flows into cash holdings. These figures show that as K,

x, and z increase, a young firm's present value of cash flows increases, but the value of a mature firm which pays dividends decreases. For a young firm, the increases in x and z make its managerial cost increase due to the procyclical cash holding cost, and force the young firm to invest more cash in capital. Then, this procyclical effect expedites the young firm's initiation of dividend payouts earlier than when it has lower x and z. For a mature firm, although it also shares this procyclicality channel, it will face a relatively limited investment opportunity set due to its large capital. Thus, the mature firms are bound to solve a more constrained optimization to minimize the total managerial cost. This renders the mature firms to incur higher cash holding cost than when it was young. This also makes them to pay more dividends to reduce the cash holding cost. Thus, the present values of cash flows for the mature firms will become smaller than those of younger firms, and decrease in x and z, ceteris paribus.

3. Analyzing Stock Returns

Now, to analyze the expected market return and cross sections of expected stock returns, we simulate 200 artificial panels, each of which has 2703 firms on each state x. Model $\mathcal{M}$ simulates average 2100 months to generate one panel, and Model $\mathcal{Q}$ simulates average 1200 quarters on each panel. The cash flows are discounted by the computed pricing kernels and summed up to P_{it}^j in each panel j, where $j = 1, ...200$, until all P_{it}^j's converge, following the pricing formula (2.6). Then, the final stock price of firm i at time t, P_{it}, is computed by the average value of $\{P_{it}^j\}_{j=1}^{200}$. Finally, the expected stock returns are computed using Markov transition matrices of x and z approximated by the method in Adda and Cooper (2003). We calculate the expected value-weighted stock returns on each state, x, and consider them as the market portfolio returns, or the wealth portfolio returns. In addition, the risk-free rate is computed by the reciprocal of the average value of $M_{t,t+1}$ using the simulated

data.

a. Aggregate Market Values

Table II reports the unconditional moments of market variables such as equity premium, risk-free rate, price-dividend ratio, book-to-market equity ratio, aggregate dividend growth, and the volatilities of those variables as well. The U.S. historical data are collected from various sources. The average equity premium ranges from 4% to 8% according to the related literature. The volatility of market return is 19.4%, according to Guvenen (2009), computed using Standard and Poor's 500 index during the period of 1890-1991. The empirical Sharpe ratio is 0.50, which is from Cochrane (2005). The fitted model generates reasonable values for the expected equity premiums compared to the data. Model $\mathcal{M}$ with $\gamma = 3$ and Model $\mathcal{Q}$ with $\gamma = 3.5$ have the volatilities of stock market returns of 20.1% and 20.9%, which is close to 19.4%. The cross-sectional volatility of individual stock returns is from 25% to 32% reported by Zhang (2005). Model $\mathcal{M}$ reports higher volatilities than this, but Model $\mathcal{Q}$ reports somewhat lower values. The actual rates of capital gain and dividend price ratio are 2.1% and 4.70% from Fama and French (2002) covering from 1872 to 2000. This means that the dividend price ratio is about 123% larger than the capital gain in constituting the market equity return. The dividend price to capital gain ratios $(D_{t+1}/\Delta P_{t+1})$ from all models are around 2.5, which is close to the empirical value. Turning to the risk-free rate, annualized U.S. risk-free rate is 1.8% with volatility of 3.0% according to Zhang (2005). The corresponding risk-free rates in Model $\mathcal{M}$ are relatively higher than data. The historical standard deviation of risk-free rate is more volatile compared to the simulated values in Model $\mathcal{M}$. Model $\mathcal{Q}$ creates more volatile risk-free rates than Model $\mathcal{M}$. However, there are several other studies reporting that the risk-free rate has much lower volatility, and therefore, we believe

that our result on the risk-free rate is reasonable.

Regarding the Sharpe ratio, the simulated Sharpe ratios have a wide range from 0.23 to 0.59 in Model $\mathcal{M}$, and the range from 0.27 to 0.54 in Model $\mathcal{Q}$. When relative risk aversion is between 3 and 4, our results are consistent with the empirical counterpart. Model $\mathcal{M}$ generates aggregate dividend growths around 2.40%, with the aggregate dividend growth volatilities at about 11.4%. Model $\mathcal{Q}$ generates somewhat higher aggregate dividend growth volatilities of around 13%, which is close to the data, 13.4%, reported by Guvenen (2009), and the aggregate dividend growths are around 2.56%, which is fairly close to the empirical value, 2.5%. The average book-to-market equity ratio (BE/ME) is 0.67 and its standard deviation is 0.23 according to Zhang (2005). Model $\mathcal{Q}$ represents values of 0.62 and 0.24 respectively, which are again fairly close to the data. We also compute $(BE/ME)^{\text{payer}} / (BE/ME)^{\text{non-payer}}$ which is the ratio of average book-to-market equity ratios of dividend payers and non-payers. The empirical value is 1.32, computed using the CRSP/COMPUSTAT merged data. This value states that high book-to-market firms are more likely to pay dividends (Smith and Watts (1992) and Baker and Wurgler (2004b)), and it is consistent with our theory for the value premium. All of our simulated values are greater than 1, and Model $\mathcal{Q}$ has values close to the data. For the average price-dividend ratio, as relative risk aversion increases, models yield lower rates of price dividend ratios, but higher volatilities of them. Results suggest that our model explains the data reasonably well with relative risk aversion around 3.

Thus, the model replicates the moments of key financial market variables in both monthly and quarterly versions. Note that all the parameters are fitted by matching the moments of variables related to firm characteristics, not financial variables. The model can capture the level and volatility of the historic equity premium, while keeping plausible values for the first two moments of the risk-free rates. However, we must

mention that our model does not resolve the equity premium puzzle. Since our model uses the equilibrium condition that the aggregate consumption is entirely financed by the sum of dividend shares, the aggregate consumption volatility coincides with that of aggregate dividend. This makes consumption growth highly volatile compared to empirical evidence. To break this tight link between consumption and dividend, one can include labor income or other types of capital or source of income not directly traded in the market. Alternatively, modifying the preference function to generate a sufficient volatility size of the stochastic discount factor would be desired, following Santos and Veronesi (2010).

b. Conditional Risk Premiums and Betas

Cochrane, Longstaff, and Santa-Clara (2008) and Martin (2009) extend Lucas (1978) to set the aggregate endowment process as the sum of multiple trees exogenously given, and show that the implied aggregate dividend (or consumption) volatility is time-varying, and dependent on the dividend share. The intuition behind this result is that the idiosyncratic shocks of each dividend process (tree) will induce dividend shares to fluctuate via the binding equilibrium condition that consumption equals the sum of these dividends. Then, the conditional moments of the aggregate consumption and dividend growth will vary over time, as the relative contribution of each tree to the aggregate process changes over time.

The model also has the feature of multiple dividend processes with the binding equilibrium condition, and therefore, time-varying and stochastic volatilities of the aggregate dividend can prevail as dividend shares vary. However, this does not provide much economic insight regarding the nature of this time-variability because dividend processes are exogenously given. In contrast, endogenous evolution of dividend processes, especially from the infrequent adjustments, arises in the model and this has

additional implications on the time-series behaviors of the conditional moments on the related stochastic discount factor.

We illustrate the point using a simple version of our model developed in the previous section. Suppose that there exist only two firms indexed by 1 and 2 in the economy, and these firms have only an aggregate shock, x_t without firm-specific shocks, and zero depreciation rate. In addition, K_{1t} is assumed to be less than K_{2t} $(K_{1t} < K_{2t} \ll \bar{K})$. Then, the proposition 2.1.3 and the equilibrium condition state that the second firm must pay the dividend, while the first firm may or may not pay the dividend. That is, the condition $(a_1, a_2) \in \{(0,1), (1,1)\}$ holds in equilibrium and $(a_1, a_2) = (1,1)$ occurs only when x is sufficiently high. Therefore, we can view $(a_1, a_2) = (0,1)$ as the recession in this simple example. It is easy to show that the conditional mean and variance of the aggregate dividend growth vary over time.

$$\mathbb{E}_t \left[\left(\frac{D_{1t+1} + D_{2t+1}}{D_{1t} + D_{2t}} \right) \right] = \frac{e^{(1-\rho_x)(\mu_x - x_t)} \left\{ (K_{1t} + I_{1t})^\theta \, \mathbb{E}_t \left[e^{\epsilon_{xt+1}} a_{1t+1} \right] + (K_{2t} + I_{2t})^\theta \, e^{\frac{\sigma_x^2}{2}} \right\}}{a_{1t} K_{1t}^\theta + K_{2t}^\theta},$$

$$\mathbb{V}ar \left[\left(\frac{D_{1t+1} + D_{2t+1}}{D_{1t} + D_{2t}} \right) \right] = \frac{e^{2\mu_x(1-\rho_x) + 2(\rho-1)x_t} (K_{1t} + I_{1t})^{2\theta}}{(a_{1t} K_{1t}^\theta + K_{2t}^\theta)^2} \mathbb{V}ar \left[e^{\epsilon_{xt+1}} a_{1t+1} \right].$$

This implies that the maximum conditional Sharpe ratio varies over time given the definition of the stochastic discount factor. How do they change in response to changes in business condition?

Figures 9 and 10 plot the countercyclical business cycle patterns of risk premiums, Sharpe ratios, and the quantities of risks (β) for the full version of the model. The expected stochastic discount factor in Panel (A) $\mathbb{E}_t [M_{t,t+1}]$, increases in the aggregate shock by intertemporal substitution, which means that the shareholder's marginal utility for the future is low in good times and high in bad times. So, the risk-free rate is lower in good times, but higher in bad times, meaning that investors in good

times are likely to save more than in bad times from the argument of consumption smoothing. Panels (B) and (C) numerically show that the volatility of the stochastic pricing kernel and the maximum conditional Sharpe ratio have the countercyclical pattern.

Panels (A) to (C) in Figure 10 depict that conditional expected market returns in Models $\mathcal{M}$ and $\mathcal{Q}$ have countercyclical variations over time, while Panels (B) and (D) in Figure 10 demonstrate the same relationship via the quantities of risk (β_M) in Models $\mathcal{M}$ and $\mathcal{Q}$.

c. Cross-Sectional Analysis of Stock Returns

 Factor Portfolios and Size-BE/ME Portfolios   To examine the value and size premia, we follow the Fama-French method: Pool the factor portfolios, SMB (small minus big) and VMG (value minus growth, previously HML), and the six value-weighted size$-BE/ME$ portfolios (Fama and French (2006)). Firms below the median size are defined as small (S) and those above are big (B). We assign firms to growth (G), neutral (N), and value (V) groups if their BE/ME is in the bottom 30%, middle 40%, or top 30% of simulated firms. The six portfolios, small and big growth (SG and BG), small and big neutral (SN and BN), and small and big value (SV and BV) are the intersections of these sorts. SMB is the simulated expected return on the three small-size stock portfolios minus the expected returns on the three big-size stock portfolios such that,

$$\text{SMB} = \frac{\text{SG} + \text{SN} + \text{SV}}{3} - \frac{\text{BG} + \text{BN} + \text{BV}}{3},$$

and

$$\text{VMG} = \frac{\text{SV} + \text{BV}}{2} - \frac{\text{SG} + \text{BG}}{2},$$

in which the value-growth factor, VMG is the difference between the expected returns on the two value portfolios and the two growth portfolios. The empirical values in Table III are from Fama and French (2007), and Chen, Petkova, and Zhang (2008). Fama and French (2007) analyze the financial market data from 1927 to 2006, and Chen, Petkova, and Zhang (2008) deal with the data from 1945 to 2005. In both studies, value and size premia prevail, and the average value premium is about twice bigger than the average size premium, and the capital gain effect outperforms the dividend price effect on both value and size premiums. On a more disaggregated level with six portfolios, Fama and French (2007) report that the expected capital gain (long-term dividend growth) has stronger effect than the expected dividend price, while Chen, Petkova, and Zhang (2008) show that the latter has stronger effect when they use the return with and without dividends. When they use annuity formula to measure long-term dividend growth, they find that the expected long-run dividend growth effect is bigger than the expected dividend-price effect in smaller stocks, and the latter is bigger in larger stocks.

Our model produces results broadly consistent with data and Model $\mathcal{Q}$ shows better performances. In case of Model $\mathcal{M}$, Table III says that VMGs have the range from 14.3% to 19.9%, and SMBs have the range from 3.85% to 12.6%. Although these numbers are bigger than the empirical data, the dividend price effect is relatively smaller than the long-term dividend growth effect, which is consistent with the empirical pattern described above. In addition, on small stock portfolios (SG, SN, SV), the simulated capital gain effects are bigger than the simulated dividend price effects, while the opposite is true for bigger stocks (BG, BN, BV), consistent with Fama and French (2007), and Chen, Petkova, and Zhang (2008). Quarterly version of our model (Model $\mathcal{Q}$) is similar to Model $\mathcal{M}$, but these fit the data better. One caveat is that the model generates negative returns for big growth (BG) firms in monthly

models. One can observe that the negativity of the equity returns from big growth firms comes from the expected capital gain effect ($\Delta P/P$). We suspect that this is partly due to the fact that our setup has a stochastic discount factor formed by a simple power utility function, given that this problem appears to be mitigated as risk aversion increases.

To demonstrate the countercyclical time-variation in VMG and value spread[13], we plot VMGs and value spreads at quarterly frequency with $\gamma = 3.5$ in Figure 11. Zhang (2005) argues that the exogenous countercyclical price of risk and the value firm's inflexibility of reversibility make the value premium and value spread countercyclical. Meanwhile, we focus on the extensive margins of dividend policy and investment behaviors and these frictions in financial and real sectors lead to countercyclical value premiums and value spreads as well as other cross-sectional variations in stock returns.

We now pool decile portfolios sorted by the BE/ME and the size following the Fama-French method (Fama and French (1992)). The individual stocks are grouped into 10 portfolios sorted by book-to-market equity ratios and market values. The annualized expected portfolio returns are calculated as the equal-weighted portfolio returns. Additionally, we generate new 10 portfolios sorted by $\hat{a}_{it}$ values, which are fitted propensities to pay dividends such that,

$$\hat{\mathbb{P}}\{a_{it} = 1|S_{it}\} \equiv \hat{a}_{it} = \hat{\alpha}_a + \hat{b}_{a1}\ln ME_{it} + \hat{b}_{a2}BE/ME_{it} + \hat{b}_{a3}I_{it}/K_{it} + \hat{b}_{a4}\Pi_{it}/K_{it},$$

in which $\hat{\alpha}_a = -1.42$, $\hat{b}_{a1} = 0.30$, $\hat{b}_{a2} = 0.73$, $\hat{b}_{a3} = -12.4$, and $\hat{b}_{a4} = 10.7$ on average

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[13]The value spreads are computed by the difference between the log BE/ME of the value portfolio and the log BE/ME of the growth portfolio (Cohen, Polk, and Vuolteenaho (2003)).

values.[14] Each coefficient is significant, and they represent the effects of the size, the book-to-market equity ratio, the investment, and the profitability, respectively. The signs of all coefficients are consistent with the empirical results in Fama and French (2001), and Denis and Osobov (2008).

Figure 12 based on Models $\mathcal{M}$ and $\mathcal{Q}$ shows that the value premium prevails even with a finer grid of value portfolios (Panels (A) and (D)). The value premiums projected by our model outperform the simulated data of Gomes, Kogan, and Zhang (2003) and Zhang (2005). The graphs show the robustness of our model for the value premium at each frequency. Panels (B) and (E) present that the size portfolios have the size premium correspondent to the empirical facts. Especially, the expected size premiums on the first and second decile portfolios are coherent to the movement of the empirical data due to non-existence of dividend price effect. However, the size premiums on other portfolios disappear as CRRA increases. The 10 portfolios sorted by PPD ($\hat{a}_{it}$) have risk premiums consistently increasing in PPD (Panels (C) and (F) in Figure 12). BE/ME and PPD are theoretically associated with each other since PPD represents the probability of occurrence of cash flow into shareholders, and the book-to-market equity is positively related to the cash flow risk as stated in Proposition II.6. Thus, these Panels (C) and (F) demonstrate that the propensity to pay dividends captures the risk factor on cross-sectional behaviors of individual stock returns.

E.   Conclusion

This paper considers an important dimension of corporate decision, dividend policy, to construct a general equilibrium model of production and investment with many firms

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[14]ln ME_{it} denotes the log market size that is generated by ln P_{it} in our model.

to analyze stock returns. This model not only links firm characteristics such as size and book-to-market equity ratio to stock returns, but also explains the relationships of these variables with the propensity to pay dividends and the profitability of firms. We focus on the extensive margin of dividend policy such that dividend policy can be highly persistent with occasional discrete shifts. According to the model, firms pay no dividend if they are either young and growing or showing very poor performances. On the other hand, dividend-paying firms are the mature firms with relatively high book-to-market equity ratios or showing very good performances. The existence of persistently zero dividend payouts makes cash flow risks smaller due to the lack of covariations of these risks with the stochastic discount factor. This can generate the value and size premia, because of the diverse patterns of dividend payment for those respective firms. Quantitative results show that the model can explain the cross sections of stock returns by interactions between dividend payouts and other firm variables, which cries out for more rigorous studies. Modeling more corporate financial features, such as stock repurchases and capital structure, is a natural next step to further analyze this aspect.

Finally, the potential lumpiness in individual cash flows has a few interesting implications for the time-series behaviors of aggregate variables as well. Specifically, the model, despite simple preferences used for the stochastic discount factor, generates countercyclical variations in market risk premiums and time-varying volatilities of aggregate dividend and asset returns. More realistic stochastic discount factors and the inclusion of labor or non-tradable goods market will be useful additions to better understand this feature. We leave these to future works.

CHAPTER III

DIVIDEND PAYMENT PROPENSITY, BUSINESS CYCLES AND STOCK RETURNS

A. Introduction

In this chapter, we empirically investigate the relevance of firm characteristics and aggregate productivity shocks in determining dividend payment propensity and stock returns, and we analyze the implications of serial correlations of stock returns. Chapter II shows that differences in dividend policies result from firm characteristics, including the level of firm maturity and variations in aggregate productivity shocks, and dividend policy, especially in extensive margin, can affect stock returns via shifting cash flows of firms. We further show that this channel can explain some major asset pricing anomalies such as the value and size premia. Therefore, without resorting to the existence of irrational investors such as the catering theory of dividends (Baker and Wurgler (2004b)), it is possible to link stock returns and propensity to pay dividends. Especially, we have shown that the propensity to pay dividend (PPD, hereafter) is positively related to the future stock returns (Proposition II.6 in Chapter II) since the cash flow risk is definitely linked to the probability of dividend payment in the next period and the cumulated cash flow risks in discount risk effect (long-term dividend growth rate) must be associated to conditional PPDs. Therefore, once we can appropriately find the proxy (fitted PPD by logit regression, Fama and French (2001)) for the probability of dividend payment or payout, then it is possible to scrutinize the predictability of relative returns of dividend-payers' stocks and non-

payers' stocks, payout stocks and nonpayout stocks (including stock repurchase[1]). In addition, the countercyclicality of these relative returns are confirmed based on our rational expectations model of dividend policy in Chapter II.

The important issue is the comparison of rational expectations model and behavioral asset pricing model. Baker and Wurgler (2004b) posit that the decision on paying dividends is made by prevailing investor demand for dividend payers. In other words, investors prefer dividend-paying firms because they ignore some cost of excess dividends to long-run growth of firms and rational firm mangers respond to this excess demand up to some costs. This makes dividend premium exist and related to dividend payment decisions. This so-called catering theory of dividend payment emphasizes the roles of stock mispricing in explaining the relationship between dividend policy and stock returns. The casual intuition suggests that the dividend premium and initiation effects are positively related to excess demand for payers. However, they find that the difference in future returns of payers and nonpayers is negatively related to this demand in empirical analysis because overpricing stocks by excess supply of dividends makes payers' future returns relatively low. But, by our rational expectations model of dividend policy, the relative returns of payers and nonpayers are explained by PPDs dependent on business cycles, not by mispricing stocks. Especially, we show that these relative returns are countercyclical due to the time-varying differences between rational investors' risk premiums for dividend payers and nonpayers, or payouts and non-payouts. In addition, the empirical results document that each future return of payers and nonpayers is positively correlated to propensities of paying out cash. These results are consistent to our rational model of payout policies, but contradict

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[1]Skinner (2008) shows that repurchases are increasingly used in place of dividends, even for firms that continue to pay dividends. However, the propensity to repurchase stock is still below the propensity to pay dividends in our empirical analysis.

the catering theory of dividend because according to their security overpricing, future returns should have been negatively linked to propensities and measures of dividend payment.

The outline for the rest of this chapter is as follows: The set of testable hypotheses is described in Section B. We introduce data variables for empirical analysis and interpret the empirical results in Section C. Finally, Section D concludes.

B. Testable Hypotheses

In this section, we describe the testable hypotheses to support our rational expectations model against the dynamics in disequilibrium, which defends that investor demand for dividends fluctuates faster than firms can or do adapt.

Testable Hypothesis III.1. *The propensity to pay out cash to shareholders (including dividend payment and stock repurchase) are related to firm characteristics: profitability, investment, market-to-book ratio and firm size, and the aggregate productivity shock.*

In Chapter II, we theoretically explain that the propensity to pay dividend are linked to firm characteristics: profitability, investment, and firm size. Fama and French (2001) already show that more profitable, older and bigger firms are more likely to pay dividends, but younger firms with more investment opportunity sets are less likely to be payers. In this chapter, propensities of cash payouts including dividend payment and stock repurchase are tested in cross-sectional logit regression models, also those propensities would be tested for relation to the business cycles.

Testable Hypothesis III.2. *The market risk premium, value premium, and future excess return for payers over nonpayers are countercyclically linked to the aggregate productivity shock.*

Zhang (2005) already explains that the asymmetric cost for the reversibility prevents value firms disinvesting relative to growth firms. It means that value firms are bonded to more unproductive capital in bad times, and the value spread and value premium are higher in these times. However, in our model, value firms paying dividends are more exposed to current systematic risks by investors' rational expectations. This means that they expect value firms to be riskier in bad times because growth firms do not have effects on short-term consumption growth rate but rather on long-term consumption growth. Therefore, the countercyclicality of market risk premium and value premium should be tested in empirical analysis.

Additionally, Zhang (2005) is not able to explain the relationship between dividend premium (premium for dividend payers) and value spread because in his model, the growth stocks pay more dividends than value stocks. This result is inconsistent with the empirical findings. On the contrary, Chapter II explicitly documents that dividend payers are more likely to be value stocks than growth stocks. In other words, the value spread (value premium) can be a negative proxy for demand (premium) on dividend payers, and it explains why the increase in dividend premium (minus value spread) induces the decrease in difference between future returns of payers (value stocks) and nonpayers (growth stocks). Thus, the countercyclicality of excess return for dividend payers are intuitively reasonable since the value spread or dividend premium is supposed to be linked to business cycles.

Testable Hypothesis III.3. *The future excess returns for payers over nonpayers are predicted by the spread between PPDs of payers and nonpayers. Propensities to pay out cash are positively correlated to each future stock return of firms that pay out cash to shareholder and firms that do not.*

Baker and Wurgler (2004a) show that fluctuations in the propensity to pay divi-

dends and catering incentives for dividend payers are closely linked, and fluctuations in PPD and dividend premiums are negatively correlated to payers-minus-nonpayers strategy. Furthermore, they insist that these results are explained by managers' decisions as rational responses to security mispricing. However, by our rational expectations model of dividend, PPDs are related to business cycles since profitability and investment must be linked to the aggregate productivity shocks. In addition, propensities of payers and nonpayers are positively related to the future stock returns (Proposition II.6 in Chapter II) since the cash flow risk is definitely linked to the probability of dividend payment in the next period and the cumulated cash flow risks in discount risk effect (long-term dividend growth rate) must be associated to conditional PPDs. Therefore, we should investigate relationships of separate stock returns of dividend payers and nonpayers with PPD and dividend payment variables from Baker and Wurgler (2004b). Once future stock returns of payers or nonpayers are positively linked to the propensity to pay dividends and dividend payment variables, the catering theory of dividends can be rejected empirically since overpricing the stocks should induce the decreases in future stock returns by investors' adjustments based on Baker and Wurgler (2004b). Thus, we can confirm that time-varying risk premiums make relative returns of payers and nonpayers countercyclically time-varying.

C. Empirical Analysis

1. Data Variables for Empirical Analysis

To find the business cycles, we compute Solow residuals (total factor productivity, hereafter referred to as TFP) from

$$Y_t = e^{x_t} K_t^{\theta} H_t^{1-\theta},$$

such that

$$(3.1) \quad \Delta x_t \equiv x_t - x_{t-1} = \ln Y_t - \ln Y_{t-1} - \theta \left(\ln K_t - \ln K_{t-1} \right) - (1-\theta) \left(\ln H_t - \ln H_{t-1} \right),$$

in which Y_t is real GNP, K_t is GNP: consumption of fixed capital which is deflated by GNP deflator, H_t is annual average weekly hours of production and nonsupervisory employees: manufacturing. θ (the capital share) is 0.3 (Cooley and Prescott (1995)). Thus, the business cycles are extracted from (3.1).[2]

Following Fama and French (2001), we estimate propensities to pay dividends using firm characteristics: profitability (Π_{it}/A_{it} : Π_{it} is EBITDA (earnings before interest, taxes, depreciation and amortization) and A_{it} is assets - total), investment (I_{it}/A_{it} : I_{it} is CAPX (capital expenditures) minus SPPE (sale of property)), market-to-book ratio (M_{it}/A_{it}), and size (percent in stock market, PME_{it}) such that

$$(3.2) \quad \mathbb{P}\left\{ Payer_{it} = 1 \right\} = \text{logit}\left(a_1 + b_1 \frac{\Pi_{it}}{A_{it}} + c_1 \frac{I_{it}}{A_{it}} + d_1 \frac{M_{it}}{A_{it}} + e_1 PME_{it} \right) + u_{it}.$$

Those characteristics are computed from CRSP/COMPUSTAT merged data. We fit average propensities to pay dividends such that

$$\mathbb{P}\left\{ \widehat{Payer_t = 1} | Payer_t = 1 \right\} \equiv \hat{a}_t^D = \frac{1}{n_t^D} \sum_{i=1}^{n_t^D} \hat{a}_{it}^D,$$

$$\mathbb{P}\left\{ \widehat{Payer_t = 1} | Payer_t = 0 \right\} \equiv \hat{a}_t^{ND} = \frac{1}{n_t^{ND}} \sum_{i=1}^{n_t^{ND}} \hat{a}_{it}^N,$$

$$\text{and } \hat{a}_{Dt} = \frac{1}{n_t} \sum_{i=1}^{n_t} \hat{a}_{it},$$

in which n_t^D is the number of firms that pay dividend at t, and the difference between

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[2]In all figures, the shadow area shows the recession periods defined by NBER.

average propensities of dividend payers and nonpayers is

$$DS_t^{D-ND} \equiv \hat{a}_t^D - \hat{a}_t^{ND},$$

which is the supply factor for dividends such as the measurements of dividend payment in Baker and Wurgler (2004b).

For total payouts: dividend payment or stock repurchase, the propensity to pay out cash to shareholders using firm characteristics can be estimated such that

$$(3.3) \quad \mathbb{P}\left\{TotalPay_{it} = 1\right\} = \text{logit}\left(a_2 + b_2 \frac{\Pi_{it}}{A_{it}} + c_2 \frac{I_{it}}{A_{it}} + d_2 \frac{M_{it}}{A_{it}} + e_2 PME_{it}\right) + u_{it},$$

then,

$$\mathbb{P}\left\{\widehat{TotalPay_t = 1}|TotalPay_t = 1\right\} \equiv \hat{a}_t^P = \frac{1}{n_t^P}\sum_{i=1}^{n_t^P}\hat{a}_{it}^P,$$

$$\mathbb{P}\left\{\widehat{TotalPay_t = 1}|TotalPay_t = 0\right\} \equiv \hat{a}_t^{NP} = \frac{1}{n_t^{NP}}\sum_{i=1}^{n_t^{NP}}\hat{a}_{it}^{NP},$$

$$\hat{a}_{Pt} = \frac{1}{n_t}\sum_{i=1}^{n_t}\hat{a}_{it} \text{ and } TP_t^{P-NP} \equiv \hat{a}_t^P - \hat{a}_t^{NP},$$

in which n_t^P is the number of firms that pay out cash at t, and this is a supply factor of total payouts: dividend payments and stock repurchases. Additionally, we estimate the propensity to repurchase the stock (purchases of common and preferred stock minus sales of common and preferred stock) as cash payout such that

$$(3.4) \quad \mathbb{P}\left\{StockRp_{it} = 1\right\} = \text{logit}\left(a_3 + b_3 \frac{\Pi_{it}}{A_{it}} + c_3 \frac{I_{it}}{A_{it}} + d_3 \frac{M_{it}}{A_{it}} + e_3 PME_{it}\right) + u_{it},$$

and

$$\mathbb{P}\left\{StockRp_t \stackrel{\frown}{=} 1 | StockRp_t = 1\right\} \equiv \hat{a}_t^R = \frac{1}{n_t^R} \sum_{i=1}^{n_t^R} \hat{a}_{it}^R,$$

$$\mathbb{P}\left\{StockRp_t \stackrel{\frown}{=} 1 | StockRp_t = 0\right\} \equiv \hat{a}_t^{NR} = \frac{1}{n_t^{NR}} \sum_{i=1}^{n_t^{NR}} \hat{a}_{it}^{NR},$$

$$\hat{a}_{Rt} = \frac{1}{n_t} \sum_{i=1}^{n_t} \hat{a}_{it} \text{ and } SR_t^{R-NR} \equiv \hat{a}_t^R - \hat{a}_t^{NR},$$

in which n_t^R is the number of firms that repurchase stocks at t. As you see Figure 14, all PPDs have the non-linear time trends. Thus, we use PPDs detrended by H-P filter as supply factors for dividends.

Baker and Wurgler (2004b) propose that the decision on paying dividends is made by prevailing investor demand for dividend payers. In other words, managers cater to investors by paying dividends according to their stock price premium on payers. They develop four measures as the dividend premium, investor demand for payers. In this paper, we use one of them, equal-weighted dividend premium, which is the difference between the logs of the dividend payers' and nonpayers' average market-to-book ratios[3] such that

(3.5)
$$P_t^{D-N} \equiv \ln\left(\left[\frac{M_t}{A_t}\right]^D\right) - \ln\left(\left[\frac{M_t}{A_t}\right]^{ND}\right),$$

where M is the firm's market value and A is the firm's book value.

We propose the difference between the logs of nonpayers' and dividend payers' average book-to-market equity ratios as the investors demand for dividend payers since the investors are more likely to consider the relative variations in market values

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[3]Once we use the value-weighted average procesure for variables, they are more likely to be nonstationary. Thus, unless we note, variables are equally weighted for stationarity.

of equities between dividend payers and nonpayers.

$$(3.6) \qquad BM_t^{N-D} \equiv \ln\left(\left[\frac{BE_t}{ME_t}\right]^{ND}\right) - \ln\left(\left[\frac{BE_t}{ME_t}\right]^{D}\right),$$

which would be supposed to have the same movement with P_t^{D-N}. BE is the book value of equity and ME is the market value of equity. In addition, we use the minus value spread (growth-minus-value) as the alternative proxy for demand on payers such that

$$(3.7) \qquad VS_t^{G-V} \equiv \ln\left(\left[\frac{BE_t}{ME_t}\right]^{G}\right) - \ln\left(\left[\frac{BE_t}{ME_t}\right]^{V}\right),$$

which is also supposed to have the same movement with P_t^{D-N}.

These variables, P_t^{D-N}, BM_t^{N-D}, and VS_t^{G-V} are proxies of demand on payers over nonpayers. Additionally, we should consider dividend-supply factors such as Baker and Wurgler (2004b)'s measurements of dividend payment: $Initiate_t$, $Continue_t$ and $Listpay_t$ such that

$$(3.8) \qquad Initiate_t = \frac{New\ Payers_t}{Nonpayers_t - Delist\ Nonpayers_t},$$

$$(3.9) \qquad Continue_t = \frac{Old\ Payers_t}{Payers_t - Delist\ Payers_t},$$

$$(3.10) \qquad Listpay_t = \frac{List\ Payers_t}{List\ Payers_t + List\ Nonpayers_t}.$$

$Listpay$ is detrended by H-P filter since $Listpay_t$ is persistent and has the non-linear time trend. $Initiate$ and $Continue$ are still persistent but they do not have any linear or non-linear time-trends. Thus, we use $Initiate$ and $Continue$ without any detrending procedure.

The data for market return (r_M), risk-free rate (r_f), value premium $(r^V - r^G)$, size premium $(r^S - r^B)$, and momentum factor (r^{MOM}) are from the Fama and French library. Returns for equal-weighted indexes of dividend payers and nonpayers

$\left(r^D, r^N\right)$ and excess return realized from distribution of dividends (r_D) are computed by using CRSP/COMPUSTAT merged data. Returns for equal-weighted indexes of firms that repurchase stocks and firms that do not repurchase them are r^R and r^{NR}. In addition, returns for equal-weighted indexes of firms that pay out cash to shareholders and firms that do not pay out are r^P and r^{NP}.[4]

2.   Empirical Tests for Testable Hypotheses

In Table IV, we see the results of logit regression models following Fama and French (2001). The propensity to pay dividend is significantly correlated to firm characteristics: profitability, investment, market-to-book ratio and firm market size. Even logit regressions extend to propensities of total payout including stock repurchase, those characteristics are still significant on firm managers' payout policy decisions. Before going to the analysis of relationship between stock returns and PPDs, we have to check the relationship between dividend premiums and measures of dividend payment as the supply side for dividends. In Table V, dividend premiums definitely cause dividend supply to increase, business cycles have especially significant effects on the supply side for dividends. Additionally, empirical results show

$$\frac{\partial \hat{a}_{t+1}}{\partial \Delta x_t} > 0,$$

for dividend payers and nonpayers, and firms that pay out cash to shareholders and firms that do not. PPDs are procyclically time-varying, which is consistent with our rational expectations model of dividend policy. Furthermore, differences of PPDs have countercyclical time-variations. This means that the PPD spread between payers and

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[4]See Appendix B for the detail.

nonpayers, or payouts and non-payouts are narrower in good times such that

$$\frac{\partial \left[\hat{a}_{t+1}^{D} - \hat{a}_{t+1}^{ND}\right]}{\partial \Delta x_t} < 0 \text{ and } \frac{\partial \left[\hat{a}_{t+1}^{P} - \hat{a}_{t+1}^{NP}\right]}{\partial \Delta x_t} < 0.$$

The sensitivity of nonpayers' PPD for business cycles is higher than that of payers because marginal movements of payers' PPD are relatively smaller than those of nonpayers by persistence of dividend policy. In other words, both groups of payers and nonpayers are more likely to pay dividends according to investors' rational expectations and business cycles, but the PPD spread between them are higher in recessions.

In Table VI, TFP (Δx_t) and dividend premiums $\left(P_t^{D-N}, BM_t^{N-D}, VS_t^{G-V}\right)$ are positively correlated to each other[5]. Especially, TFP is significantly linked to P_t^{D-N} and VS_t^{G-V}, the latter of which is the minus value spread. This means that the value spread is wider in recession times. The business cycles and minus value spread $\left(VS_t^{G-V}\right)$ are negatively correlated to value premium in the next period $\left(r_{t+1}^{V} - r_{t+1}^{G}\right)$. This shows the countercyclical time-variations of value spread and value premium. The market risk premium $(r_{Mt+1} - r_{ft+1})$, risk-free rate (r_{ft+1}), excess return for dividend payers over nonpayers $\left(r_{t+1}^{D} - r_{t+1}^{N}\right)$ are countercyclically time-varying even though statistical inferences are not significant in Table VI. Similar to Baker and Wurgler (2004b), dividend premiums are negatively correlated to payer-minus-nonpayer at the significance level of 5% at most. Thus, the empirical results fairly support Testable Hypothesis III.2.

It is reasonable that the propensity to pay dividend is positively related to the future stock returns since the cash flow risk is definitely linked to the probability of dividend payment in the next period and the cumulated cash flow risks in discount

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[5]In Figure 13, we see that TFP and dividend premiums have the same movements.

risk effect (long-term dividend growth rate) must be associated to conditional PPDs. From firm dynamics and Proposition II.6 in Chapter II, given $\{D_{it+j}\}_{j=1}^{\infty}$ for any firm i,

$$\frac{\mathbb{E}_t\left[\Delta P_{it+1}\right]}{P_{it}} \approx \frac{\sum_{j=1}^{\infty}\Delta\hat{a}_{it+j}D_{it+j}}{P_{it}} \text{ and } \frac{\mathbb{E}_t\left[D_{it+1}\right]}{P_{it}} \approx \hat{a}_{it}\frac{D_{it+1}}{P_{it}},$$

in which $\Delta\hat{a}_{it+j}$ is the change in conditional $\hat{a}_{it+j}$ from t to $t+1$. Then, individual stock returns increase in PPDs such that

$$\frac{\partial r_{it+1}}{\partial\hat{a}_{it}} > 0,$$

and it is rational that excess returns of payers over nonpayers increase in $\hat{a}_{it}^D - \hat{a}_{it}^{ND}$ because this PPD spread explains the difference between dividend policies of payers and nonpayers, and that spread must be related to relative risk premium that is countercyclically time-varying. We document empirical results in Table VII, which are consistent with our logic about the relation between PPDs and future stock returns. According to total payouts: dividend payment and stock repurchase, we still have consistent results.

Baker and Wurgler (2004b) insist that managers cater to investors by paying dividends and the relative overpricing for payers makes future returns of payers and nonpayers negatively related to excess supply of dividends. Then, future stock returns of payers and nonpayers should be negatively correlated to PPDs of payouts and measures of dividend payment such as $Initiate_t$, $Continue_t$ and $Listpay_t$. However, in Table VII, future returns of payers and nonpayers, and total payouts and non-payouts are positively linked to PPDs and measures of dividend payment. These results which are consistent with our rational expectations model of dividend policy reject the catering theory of dividends. In addition, when we execute horse racing with our PPDs and $Initiate_t$ in Table VIII, PPDs have more power in explaining

future stock returns of payers and nonpayers, and total payouts and non-payouts. In addition, it is shown that even though the signs of coefficients for regressions of the market risk premium $(r_{Mt+1} - r_{ft+1})$ are consistent to the theory, they are not significant except TP^{P-NP}. Therefore, our rational expectations model of dividend policy fairly explains features of stock returns such as predictability and relative risk spread of payers and nonpayers, and payouts and non-payouts relative to catering theory of dividends.

D. Conclusions

In the previous chapter, we introduce a rational expectations model of dividend policy in order to explain cross-sectional anomalies such as the value premium and size premium, and this model produces rich implications related to business cycles. Furthermore, we simulated the countercyclicality of market risk premium, value spread and value premium. This countercyclicality is produced by the lumpiness in individual cash flows by managers' rational decisions in response to aggregate productivity and idiosyncratic productivity. Therefore, we build up a set of testable hypotheses by these countercyclical time-variations about relative risk premiums of dividend payers and nonpayers, and firms that pay out cash to shareholders including stock repurchases and firms that do not, and relationships between propensities to pay dividends as dividend-supply factors and future stock returns.

First, we find that propensities of dividend payment and stock repurchase are significantly linked to firm characteristics: profitability, investment, market-to-book ratio and firm market size. These propensities are positively correlated to business cycles. Also, the value premium and value spread are significantly countercyclical time-varying even though the market risk premium and risk free rate are counter-

cyclical but not significantly. Second, it is found that excess returns for dividend payers over nonpayers, or firms that pay out cash to shareholders over firms that do not are significantly linked to business cycles, especially relative future returns are fairly predicted by the countercyclical spread of fitted propensities to pay dividends or to pay out cash including stock repurchases. In addition, we compare our rational expectations model of dividend policy with the catering theory of dividends. The empirical results document that each future return of payers and nonpayers increases in PPDs, which is contradictory to the catering theory because security overpricing should have been negatively related to PPDs or measures of dividend payment.

CHAPTER IV

CONCLUSION

We consider an important dimension of corporate decision, dividend policy, to construct a general equilibrium model of production and investment with many firms to analyze stock returns. This model not only links firm characteristics such as size and book-to-market equity ratio to stock returns, but also explains the relationships of these variables with the propensity to pay dividends and the profitability of firms. We focus on the extensive margin of dividend policy such that dividend policy can be highly persistent with occasional discrete shifts. According to the model, firms pay no dividend if they are either young and growing or showing very poor performances. On the other hand, dividend-paying firms are the mature firms with relatively high book-to-market equity ratios or showing very good performances. The existence of persistently zero dividend payouts makes cash flow risks smaller due to the lack of covariations of these risks with the stochastic discount factor. This can generate the value and size premia, because of the diverse patterns of dividend payment for those respective firms. Quantitative results show that the model can explain the cross sections of stock returns by interactions between dividend payouts and other firm variables, which cries out for more rigorous studies. Modeling more corporate financial features, such as stock repurchases and capital structure, is a natural next step to further analyze this aspect. Finally, the potential lumpiness in individual cash flows has a few interesting implications for the time-series behaviors of aggregate variables as well. Specifically, the model, despite simple preferences used for the stochastic discount factor, generates countercyclical variations in market risk premiums and time-varying volatilities of aggregate dividend and asset returns. More realistic stochastic discount factors and the inclusion of labor or non-tradable goods

market will be useful additions to better understand this feature. We leave these to future works.

In addition, we empirically investigate the relevance of firm characteristics and aggregate productivity shocks in determining dividend payment propensity and stock returns, and we analyze the implications of serial correlations of stock returns. First, we find that propensities of dividend payment and stock repurchase are significantly linked to firm characteristics: profitability, investment, market-to-book ratio and firm market size. These propensities are positively correlated to business cycles. Also, the value premium and value spread are significantly countercyclical time-varying even though the market risk premium and risk free rate are countercyclical but not significantly. Second, it is found that excess returns for dividend payers over nonpayers, or firms that pay out cash to shareholders over firms that do not are significantly linked to business cycles, especially relative future returns are fairly predicted by the countercyclical spread of fitted propensities to pay dividends or to pay out cash including stock repurchases. In addition, we compare our rational expectations model of dividend policy with the catering theory of dividends. The empirical results document that each future return of payers and nonpayers increases in PPDs, which is contradictory to the catering theory because security overpricing should have been negatively related to PPDs or measures of dividend payment.

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APPENDIX A

TECHNICAL ASSUMPTIONS AND PROOFS

Technical Assumptions

Assumption IV.1. We assume that

$$\mathbb{E}_t\left[V_{KK}\right] > -\frac{e^{x+z}K^{\theta-4}}{18\beta\left(1-\delta\right)}\left(\begin{array}{c}\xi_2 e^{(\xi_2+2)x+2z}K^{2\theta} + 6K\left(K + \xi_1 e^{(1+\xi_2)x+z}K^{\theta}\left(\theta-1\right)\right)\\ +6\alpha_{21}e^{\xi_2 x}K^2\left(3\theta-2\right)\end{array}\right),$$

$$\mathbb{E}_t\left[V_{Kx}\right] > \frac{\xi_1 e^{(1+\xi_2)x+z}K^{\theta-3}\left(K + e^{x+z}K^{\theta}\right)\left(\xi_2 e^{x+z}K^{\theta} - 2K\right)}{2\beta},$$

and

$$\mathbb{E}_t\left[V_{Kz}\right] > -\frac{\xi_1 e^{(1+\xi_2)x+z}K^{\theta-2}\left(3K + e^{x+z}K^{\theta}\right)}{3\beta}.$$

Assumption IV.2. If S_{1t+u^1} and S_{2t+u^1} are in $\mathcal{S}^1$, and $P_{1t} = P_{2t}$, then

$$\frac{\sum_{u=u^1}^{\infty}\left(\mathbb{E}_{t+1}\left[M_{t,t+u}D_{it+u}\right] - \mathbb{E}_t\left[M_{t,t+u}D_{it+u}\right]\right)}{P_{1t}}$$
$$-\frac{\sum_{u=u^1}^{\infty}\left(\mathbb{E}_{t+1}\left[M_{t,t+u}D_{jt+u}\right] - \mathbb{E}_t\left[M_{t,t+u}D_{jt+u}\right]\right)}{P_{2t}} = o\left(1\right).$$

Proofs of Propositions

Proof of Proposition II.3

We suppress subscripts and superscripts for the simplicity. From (2.2), the first order conditions for the investment is

$$-\frac{\left(I + K\right)\left(\xi_1 e^{\xi_2 x}I^2 + 2K\left(\xi_1 e^{\xi_2 x}I + K - \xi_1 e^{(\xi_2+1)x+z}K^{\theta}\right)\right)}{2K^3}+$$
$$\beta\mathbb{E}_t\left[V_K\left(I + \left(1-\delta\right)K, x, z\right)\right] = 0.$$

By the implicit function theorem, $\partial I / \partial K$ is

(A.1)
$$\frac{\left[\begin{array}{c} 3\xi_1 e^{\xi_2 x} I^3 + 2IK\left(K + \xi_1 e^{\xi_2 x}\left(3I + e^{x+z}K^\theta\left(\theta - 2\right)\right)\right) \\ +2\xi_1 e^{\xi_2 x} K^2\left(I + e^{x+z}K^\theta\left(\theta - 1\right)\right) + 2\beta\left(1 - \delta\right)K^4\mathbb{E}_t\left[V_{KK}\right] \end{array}\right]}{K\left(3\xi_1 e^{\xi_2 x} I^2 + 2\xi_1 e^{\xi_2 x} K^2 + 2K\left(K - \xi_1 e^{\xi_2 x}\left(e^{x+z}K^\theta - 3I\right)\right) - 2\beta K^2\mathbb{E}_t\left[V_{KK}\right]\right)}.$$

We know that $\mathbb{E}_t\left[V_{KK}\right] < 0$ since the value function of dynamic programming is concave in Stokey and Lucas (1989). From the assumption $e^{x+z}K^\theta < 3I^0$ and the first condition of Assumption A.1.1, the numerator and denominator of $(A.1)$ are positive, hence

$$\frac{\partial I}{\partial K} > 0.$$

For $\partial I / \partial x$, we have

(A.2)
$$\frac{-\xi_1 e^{\xi_2 x}\left(I + K\right)\left(\xi_2 I^2 - 2K\left(-\xi_2 I + e^{x+z}K^\theta + \xi_2 e^{x+z}K^\theta\right)\right) + 2\beta K^2\mathbb{E}_t\left[V_{Kx}\right]}{3\xi_1 e^{\xi_2 x} I^2 + 2\xi_1 e^{\xi_2 x} K^2 + 2K\left(K - \xi_1 e^{\xi_2 x}\left(e^{x+z}K^\theta - 3I\right)\right) - 2\beta K^2\mathbb{E}_t\left[V_{KK}\right]}.$$

From the second condition in Assumption A.1.1., the numerator of $(A.2)$ is positive, thus

$$\frac{\partial I}{\partial x} > 0.$$

For $\partial I / \partial z$, the following is

(A.3)
$$\frac{\partial I}{\partial z} = \frac{2K\left(\xi_1 e^{(1+\xi_1)x+z}K^\theta\left(I + K\right) + \beta K^2\mathbb{E}_t\left[V_{Kz}\right]\right)}{3\xi_1 e^{\xi_2 x} I^2 + 2\xi_1 e^{\xi_2 x} K^2 + 2K\left(K - \xi_1 e^{\xi_2 x}\left(e^{x+z}K^\theta - 3I\right)\right) - 2\beta K^2\mathbb{E}_t\left[V_{KK}\right]}.$$

We have the assumption such that

$$\mathbb{E}_t\left[V_{Kz}\right] > -\frac{\xi_1 e^{(1+\xi_2)x+z}K^{\theta-2}\left(3K + e^{x+z}K^\theta\right)}{3\beta},$$

then, the numerator of $(A.3)$ is positive, therefore,

$$\frac{\partial I}{\partial z} > 0,$$

which completes the proof. □

Proof of Proposition II.5

We refer to Proposition II.1. Our recursive general equilibrium model is based on the industry equilibrium model (Hopenhayn (1992)). We can apply Theorem 2 in the proof of Proposition 2 of Appendix A in Zhang (2005). □

Proof of Proposition II.6

First, the cash flow risk effect is,

$$
-\frac{\mathbb{C}ov_t\left[M_{t,t+1}, \frac{D_{1t+1}}{P_{1t}}\right]}{\mathbb{E}_t\left[M_{t,t+1}\right]} + \frac{\mathbb{C}ov_t\left[M_{t,t+1}, \frac{D_{2t+1}}{P_{2t}}\right]}{\mathbb{E}_t\left[M_{t,t+1}\right]} = 0 + \frac{\mathbb{C}ov_t\left[\left(\frac{D_{2t}}{D_{2t+1}}\right)^\gamma, \frac{D_{2t+1}}{P_{2t}}\right]}{\mathbb{E}_t\left[M_{t,t+1}\right]} < 0.
$$

For the discount risk effect, from (2.6), by the law of iterated expectation, we can show the following:

$$
\mathbb{E}_t\left[P_{1t+1} - P_{1t}\right] = \mathbb{E}_t\left[\sum_{u=1}^\infty \left(\beta^u \mathbb{E}_{t+1}\left[\left(\frac{C_{t+1}}{C_{t+u+1}}\right)^\gamma D_{1t+u+1}\right] - \beta^u \mathbb{E}_t\left[\left(\frac{C_t}{C_{t+u}}\right)^\gamma D_{1t+u}\right]\right)\right]
$$

$$
= \sum_{u=u^0}^\infty \left(\beta^u \mathbb{E}_t\left[\left(\frac{C_{t+1}}{C_{t+u+1}}\right)^\gamma D_{1t+u+1}\right] - \beta^{u+1}\mathbb{E}_t\left[\left(\frac{C_t}{C_{t+u+1}}\right)^\gamma D_{1t+u+1}\right]\right).
$$

The innovation between ΔP_{1t+1} and $\mathbb{E}_t\left[\Delta P_{1t+1}\right]$ is

$$
\sum_{u=u^0}^\infty \beta^u \left(\mathbb{E}_{t+1}\left[\left(\frac{C_{t+1}}{C_{t+u+1}}\right)^\gamma D_{1t+u+1}\right] - \mathbb{E}_t\left[\left(\frac{C_{t+1}}{C_{t+u+1}}\right)^\gamma D_{1t+u+1}\right]\right).
$$

Similarly, for the stock of the firm 2,

$$
\Delta P_{2t+1} - \mathbb{E}_t\left[\Delta P_{2t+1}\right] =
$$

$$
\sum_{u=1}^\infty \beta^u \left(\mathbb{E}_{t+1}\left[\left(\frac{C_{t+1}}{C_{t+u+1}}\right)^\gamma D_{2t+u+1}\right] - \mathbb{E}_t\left[\left(\frac{C_{t+1}}{C_{t+u+1}}\right)^\gamma D_{2t+u+1}\right]\right).
$$

By Assumption IV.2, the difference between the innovations of expected capital gains is

$$\Delta \bar{P}_{t+1} - \mathbb{E}_t \left[\Delta \bar{P}_{t+1} \right] \equiv \frac{\Delta P_{1t+1} - \mathbb{E}_t \left[\Delta P_{1t+1} \right]}{P_{1t}} - \frac{\left(\Delta P_{2t+1} - \mathbb{E}_t \left[\Delta P_{2t+1} \right] \right)}{P_{2t}}$$

$$= o\left(1\right).$$

Then, by the independence of x_t, z_{1t} and z_{2t}, the difference of discount risk effects of firm 1 and 2 is

$$-\frac{\mathbb{C}ov_t \left[M_{t,t+1}, \frac{P_{1t+1}}{P_{1t}} \right]}{\mathbb{E}_t \left[M_{t,t+1} \right]} - \left(-\frac{\mathbb{C}ov_t \left[M_{t,t+1}, \frac{P_{2t+1}}{P_{2t}} \right]}{\mathbb{E}_t \left[M_{t,t+1} \right]} \right) = \frac{-\mathbb{C}ov_t \left[M_{t,t+1}, \Delta \bar{P}_{t+1} \right]}{\mathbb{E}_t \left[M_{t,t+1} \right]},$$

and

$$-\mathbb{C}ov_t \left[M_{t,t+1}, \Delta \bar{P}_{t+1} \right] = o\left(1\right).$$

Then, for $1 \leq u \leq u^0 - 1$,

$$\mathbb{C}ov_t \left[M_{t,t+1}, \beta^u \left(\mathbb{E}_{t+1} \left[\left(\frac{D_{2t+1}}{D_{2t+u+1}} \right)^\gamma D_{2t+u+1} \right] - \mathbb{E}_t \left[\left(\frac{D_{2t+1}}{D_{2t+u+1}} \right)^\gamma D_{2t+u+1} \right] \right) \right]$$

$$= \mathbb{E}_t \left[\left(\frac{D_{2t}}{D_{2t+1}} \right)^\gamma \beta^{u+1} \left(\mathbb{E}_{t+1} \left[\left(\frac{D_{2t+1}}{D_{2t+u+1}} \right)^\gamma D_{2t+u+1} \right] - \mathbb{E}_t \left[\left(\frac{D_{2t+1}}{D_{2t+u+1}} \right)^\gamma D_{2t+u+1} \right] \right) \right],$$

Let $\gamma = 1$, then by Jensen's inequality,

$$\mathbb{C}ov_t \left[M_{t,t+1}, \beta^u \left(\mathbb{E}_{t+1} \left[D_{2t+1} \right] - \mathbb{E}_t \left[D_{2t+1} \right] \right) \right]$$

$$= \beta^{u+1} \mathbb{E}_t \left[\frac{D_{2t}}{D_{2t+1}} \mathbb{E}_{t+1} \left[D_{2t+1} \right] \right] - \beta^{u+1} \mathbb{E}_t \left[\frac{D_{2t}}{D_{2t+1}} \mathbb{E}_t \left[D_{2t+1} \right] \right]$$

$$= \beta^{u+1} D_{2t} \left(1 - \mathbb{E}_t \left[\frac{1}{D_{2t+1}} \right] \mathbb{E}_t \left[D_{2t+1} \right] \right) < 0,$$

and

$$-\mathbb{C}ov_t \left[M_{t,t+1}, \Delta \bar{P}_{t+1} \right] < 0.$$

Now, we want to generalize the result above for $\gamma \geq 2$. Before the start, we assume that there do not exist firm-specific shock, $\mu_x = 0$, and the investment process is determined at time t[1]. Then,

$$\mathbb{C}ov_t\left[M_{t,t+1}, \beta^u\left(\mathbb{E}_{t+1}\left[\left(\frac{D_{2t+1}}{D_{2t+u+1}}\right)^{\gamma} D_{2t+u+1}\right] - \mathbb{E}_t\left[\left(\frac{D_{2t+1}}{D_{2t+u+1}}\right)^{\gamma} D_{2t+u+1}\right]\right)\right]$$

$$= \beta^{u+1} D_{2t}\left(\mathbb{E}_t\left[D_{2t+1}^{\gamma-1}\mathbb{E}_{t+1}\left[\frac{1}{D_{2t+u+1}^{\gamma-1}}\right]\right] - \mathbb{E}_t\left[\frac{1}{D_{2t+1}}\right]\mathbb{E}_t\left[\frac{D_{2t+1}^{\gamma}}{D_{2t+u+1}^{\gamma-1}}\right]\right).$$

For $u = 1$,

$$\mathbb{E}_t\left[D_{2t+1}^{\gamma-1}\mathbb{E}_{t+1}\left[\frac{1}{D_{2t+2}^{\gamma-1}}\right]\right]$$

$$= \mathbb{E}_t\left[e^{(\gamma-1)\rho_x x_t + (\gamma-1)\epsilon_{t+1}}\mathbb{E}_{t+1}\left[e^{-(\gamma-1)\rho_x^2 x_t - (\gamma-1)\rho_x \epsilon_{xt+1} - (\gamma-1)\epsilon_{xt+2}}\right]\right]\left(\frac{K_{2t+1}^{\theta}}{K_{2t+2}^{\theta}}\right)^{\gamma-1}$$

$$= e^{(\gamma-1)\rho_x(1-\rho_x)x_t + \frac{(\gamma-1)^2(1-\rho_x)^2\sigma_x^2}{2} + \frac{(\gamma-1)^2\sigma_x^2}{2}}\left(\frac{K_{2t+1}^{\theta}}{K_{2t+2}^{\theta}}\right)^{\gamma-1},$$

and

$$\mathbb{E}_t\left[\frac{1}{D_{2t+1}}\right]\mathbb{E}_t\left[\frac{D_{2t+1}^{\gamma}}{D_{2t+2}^{\gamma-1}}\right]$$

$$= \mathbb{E}_t\left[e^{-\rho_x x_t - \epsilon_{xt+1}}\right]\mathbb{E}_t\left[e^{\gamma\rho_x x_t + \gamma\epsilon_{xt+1}}\right]\mathbb{E}_t\left[e^{-(\gamma-1)\rho_x^2 x_t - (\gamma-1)\rho_x \epsilon_{xt+1} - (\gamma-1)\epsilon_{xt+2}}\right]\left(\frac{K_{2t+1}^{\theta}}{K_{2t+2}^{\theta}}\right)^{\gamma-1}$$

$$= e^{(\gamma-1)\rho_x(1-\rho_x)x_t + \frac{\sigma_x^2}{2} + \frac{\gamma^2\sigma_x^2}{2} + \frac{(\gamma-1)^2\rho_x^2\sigma_x^2}{2} + \frac{(\gamma-1)^2\sigma_x^2}{2}}\left(\frac{K_{2t+1}^{\theta}}{K_{2t+2}^{\theta}}\right)^{\gamma-1},$$

also, for $\gamma \geq 2$,

$$\frac{(\gamma-1)^2(1-\rho_x)^2\sigma_x^2}{2} - \left(\frac{\sigma_x^2}{2} + \frac{\gamma^2\sigma_x^2}{2} + \frac{(\gamma-1)^2\rho_x^2\sigma_x^2}{2}\right)$$

$$= -\sigma_x^2\left(\gamma + \rho_x - 2\gamma\rho_x + \gamma^2\rho_x\right) < 0,$$

---

[1]The first two restrictions are assumed for only mathematical simplicity.

which shows Jensen's inequality effect, and leads to

$$\mathbb{E}_t\left[D_{2t+1}^{\gamma-1}\mathbb{E}_{t+1}\left[\frac{1}{D_{2t+2}^{\gamma-1}}\right]\right] - \mathbb{E}_t\left[\frac{1}{D_{2t+1}}\right]\mathbb{E}_t\left[\frac{D_{2t+1}^{\gamma}}{D_{2t+2}^{\gamma-1}}\right] < 0.$$

This is the same as when $\gamma = 1$. In addition, by Jensen's inequality for $2 \leq u \leq u^0 - 1$,

$$\mathbb{E}_t\left[D_{2t+1}^{\gamma-1}\mathbb{E}_{t+1}\left[\frac{1}{D_{2t+u+1}^{\gamma-1}}\right]\right] - \mathbb{E}_t\left[\frac{1}{D_{2t+1}}\right]\mathbb{E}_t\left[\frac{D_{2t+1}^{\gamma}}{D_{2t+u+1}^{\gamma-1}}\right] < 0.$$

Thus, for $\gamma \geq 1$,

$$\frac{-\mathbb{C}ov_t\left[M_{t,t+1}, \Delta\bar{P}_{t+1}\right]}{\mathbb{E}_t\left[M_{t,t+1}\right]} < 0.$$

This result implies that

$$-\frac{\mathbb{C}ov_t\left[M_{t,t+1}, \frac{P_{1t+1}}{P_{1t}}\right]}{\mathbb{E}_t\left[M_{t,t+1}\right]} < -\frac{\mathbb{C}ov_t\left[M_{t,t+1}, \frac{P_{2t+1}}{P_{2t}}\right]}{\mathbb{E}_t\left[M_{t,t+1}\right]} \equiv \beta_1^{\text{disc}} < \beta_2^{\text{disc}}.$$

The proof is completed. $\qquad\square$

Proof of Proposition II.7

From (2.6), for some integer $u^0 > 0$

$$\frac{P_{1t}}{K_{1t}} = \sum_{u=u_0+1}^{\infty}\beta^u\mathbb{E}_t\left[M_{t,t+u}\frac{D_{1t+u}}{K_{1t}}\right] \text{ and } \frac{P_{2t}}{K_{2t}} = \sum_{u=1}^{\infty}\beta^u\mathbb{E}_t\left[M_{t,t+u}\frac{D_{2t+u}}{K_{2t}}\right].$$

The dividend equity ratio is

$$\frac{a_{t+u}\delta e^{x_{t+u}}K_{t+u}^{\theta}}{K_t},$$

in which

$$K_{t+u} = I_{t+u-1} + \left(1-\bar{\delta}\right)\left(I_{t+u-2} + \left(1-\bar{\delta}\right)K_{t+u-2}\right)\ldots$$

$$= \sum_{w=1}^{u}\left(1-\bar{\delta}\right)^{w-1}I_{t+u-w} + \left(1-\bar{\delta}\right)^{u}K_t.$$

Then, dividend-equity ratios for firm $i = 1, 2$ are

$$\frac{D_{it+u}}{K_{it}} = \frac{a_{it+u}\delta e^{x_{t+u}}}{K_{it}^{1-\theta}} \left[\sum_{w=1}^{u} \left(1-\bar{\delta}\right)^{w-1} \frac{I_{it+u-w}}{K_{it}} + \left(1-\bar{\delta}\right)^{u} \right]^{\theta}.$$

For simplicity, let us assume that $\bar{\delta} = 0$. We know that K_{t+1} is determined at t. That is,

$$\mathbb{E}_t \left[M_{t,t+u} \frac{D_{1t+u}}{K_{1t}} \right] - \mathbb{E}_t \left[M_{t,t+u} \frac{D_{2t+u}}{K_{2t}} \right] = \mathbb{E}_t \left[M_{t,t+u} \left(\frac{D_{1t+u}}{K_{1t}} - \frac{D_{2t+u}}{K_{2t}} \right) \right] > 0,$$

since for any $u^0 + 1 \leq w \leq u$, I/K is monotone decreasing with respect to K because of the diminishing return to scale, i.e.,

$$\frac{I_{1t+u-w}}{K_{1t}} > \frac{I_{2t+u-w}}{K_{2t}}.$$

The minimum of expected difference between $\frac{D_{1t+u}}{K_{1t}}$ and $\frac{D_{2t+u}}{K_{2t}}$ is defined as, for any $u \geq 0$,

$$d \equiv \min \mathbb{E}_t \left[\frac{D_{1t+u}}{K_{1t}} - \frac{D_{2t+u}}{K_{2t}} \right] > 0.$$

Then, for $\gamma > 1$,

$$\left(\frac{P_{1t}}{K_{1t}} - \frac{P_{2t}}{K_{2t}} \right) \frac{1}{D_{2t}^{\gamma}} \geq - \sum_{u=1}^{u_0} \beta^u \mathbb{E}_t \left[\frac{1}{C_{t+u}^{\gamma-1}} \frac{1}{K_{2t}} \right] + d \sum_{u=u^0+1}^{\infty} \beta^u \mathbb{E}_t \left[\frac{1}{C_{t+u}^{\gamma}} \right]$$

$$= \frac{d \left(\beta + \underline{g}\left(\gamma\right) \right)^{u^0+1}}{1 - \beta - \underline{g}\left(\gamma\right)} \mathbb{E}_t \left[\frac{1}{C_{t+u^0+1}^{\gamma}} \right]$$

$$- \frac{\beta \left(1 - \left(\beta + \bar{g}\left(\gamma-1\right)\right)^{u^0} \right)}{\left(1 - \beta - \bar{g}\left(\gamma-1\right)\right) K_{2t}} \mathbb{E}_t \left[\frac{1}{C_{t+1}^{\gamma-1}} \right],$$

in which

$$\underline{g}(\gamma) \equiv \min \left\{ \frac{\mathbb{E}_t \left[C_{t+u+1}^{-\gamma} \right] - \mathbb{E}_t \left[C_{t+u}^{-\gamma} \right]}{\mathbb{E}_t \left[C_{t+u}^{-\gamma} \right]} \right\},$$

$$\bar{g}(\gamma - 1) \equiv \max \left\{ \frac{\mathbb{E}_t \left[C_{t+u+1}^{-(\gamma-1)} \right] - \mathbb{E}_t \left[C_{t+u}^{-(\gamma-1)} \right]}{\mathbb{E}_t \left[C_{t+u}^{-(\gamma-1)} \right]} \right\}.$$

$\underline{g}(\gamma)$ is the minimum for growth rates of expected marginal utilities of consumption with γ, and $\bar{g}(\gamma - 1)$ is the maximum for growth rates of expected marginal utilities of consumption with $\gamma - 1$. If parametric restrictions are held such that $\mathbb{E}_t \left[1/C_{t+u^0+1}^{\gamma} \right] > \mathbb{E}_t \left[1/ \left(C_{t+1}^{\gamma-1} dK_{2t} \right) \right]$ and

$$\frac{\left(\beta + \underline{g}(\gamma) \right)^{u^0+1}}{1 - \beta - \underline{g}(\gamma)} > \frac{\beta \left(1 - (\beta + \bar{g}(\gamma - 1))^{u^0} \right)}{1 - \beta - \bar{g}(\gamma - 1)},$$

then,

$$\frac{P_{1t}}{K_{1t}} - \frac{P_{2t}}{K_{2t}} > 0 \Rightarrow \frac{K_{1t}}{P_{1t}} < \frac{K_{2t}}{P_{2t}},$$

which completes the proof. $\qquad \square$

APPENDIX B

DATA AND VARIABLE DEFINITIONS

Our variables in this paper are derived from aggregations of CRSP/COMPUSTAT merged data. The observations in the underlying 1962 to 2009 sample (annual sample size is 48) are selected as in Fama and French (2001), but some rules are different from them. We include firms with book equity (BE_t) below $250,000$ or assets (A_t) below $500,000$. The CRSP sample for computing equal-weighted returns of dividend payers and nonpayers includes NYSE, AMEX, and NASDAQ securities with exchange code of 1, 2 and 3. A firm must have market equity data (price and shares outstanding) for December of year t to be in the CRSP sample for that year. We include utilities and financial firms from both samples since we investigate not only patterns of PPD but also the relationship between PPDs and stock returns, and we had previously observed that lumpy dividend policies of utilities and financial firms are similar to other industrial firms.

Derived Variables

The market-to-book ratio is the ratio of the market value of the firm to its book value. Market value is equal to market equity at fiscal year end (Common Shares Outstanding (CSHO) * Price Close - Annual Fiscal Year (PRCC_F)) plus book debt (Debt in Current Liabilities (DLC)). Book value of a firm is assets (Assets - Total (AT)). Book equity is equal to common equity value (Common/Ordinary Equity Total (CEQ)). The book-to-market equity ratio is the ratio of the market equity of the firm to its book equity. The value stocks are the upper 30% of book-to-market equity ratios, and growth stocks are the lower 30% of book-to-market equity ratios.

Dividend Payers and Nonpayers

We count a firm-year observations as a payer if it has positive dividends per share by the ex data in the fiscal year t, or else it is a nonpayer. This method follows Baker and Wurgler (2004b). To aggregate this firm-level data as a supply factor for dividends into useful time series, two aggregate identities are helpful:

$$Payer_t = New\ Payer_t + Old\ Payer_t + List\ Payer_t,$$

$$Old\ Payer_t = Payer_{t-1} - New\ Payer_t - Delist\ Payer_t.$$

The first identity defines the number of payers and the second shows the evolution. *Payers* is the total number of payers, *New Payers* is the number of initiators among last year's nonpayers, *Old Payers* is the number of payers that also paid last year, *List Payers* is the number of payers this year that were not in the sample last year, *New Nonpayers* is the number of omitters among last year's payers, and *Delist Payers* is the number of last year's payers not in the sample this year. Note that analogous identities hold if one switches "Payers" and "Nonpayers" everywhere (Baker and Wurgler (2004b)). In addition, Baker and Wurgler (2004b) note that lists and delists are with respect to their sample, which involves several screens. But, in our sample, new lists include established COMPUSTAT firms when they first survive the screens. It also includes the established NASDAQ firms that appeared in COMPUSTAT for the first time in the 1970s. Likewise, delists include both delists from COMPUSTAT and firms that fall below the screens. Then, we define the three variables to capture dividend supply dynamics ((3.8), (3.9) and (3.10)).

Stock Repurchase

Fama and French (2001) use the change in treasury stock and the difference between purchases and sales of common and preferred stock in year t as the net repurchase. But, we only use the difference between purchases and sales of common and preferred stock in year t since we analyze the relationship between events of stock repurchase and stock returns. Furthermore, data for purchases and sales of common and preferred stock have longer sample size (since 1972) than data for treasury stock (since 1980s).

Index Returns

Most index returns are from the French and Fama library. $r_M - r_f$, the excess return on the market, is the value-weight return on all NYSE, AMEX, and NASDAQ stocks (from CRSP) minus the one-month Treasury bill rate (from Ibbotson Associates). BE/ME portfolios are constructed at the end of June. BE/ME is book equity at the last fiscal year end of the prior calendar year divided by ME at the end of December of the prior year. $r^V - r^G$ is the difference between equal-weighted returns of the upper 30% of BE/ME and the lower 30% of BE/ME. ME portfolios are constructed at the end of June. $r^S - r^B$ is the difference between equal-weighted returns of the upper 30% of ME and the lower 30% of ME. $r_{t+1}^D - r_{t+1}^N$ is the equal-weighted excess return on payers over nonpayers in year $t + 1$, and $r_{t+1}^P - r_{t+1}^{NP}$ is the equal-weighted excess return on firms that pay out cash to shareholders over firms that do not pay out in year $t + 1$. In these cases, we remove firms with more than 300% annual returns.

APPENDIX C

TABLES AND FIGURES

Table I. Benchmark Parameter Value Sets

Parameter	Model $\mathcal{M}$ (Monthly)	Model $\mathcal{Q}$ (Quarterly)	Description
Calibrated Outside the Model			
δ	0.01	0.03	Capital depreciation rate
ρ_x	0.983	0.95	Persistence coefficient of aggregate productivity
σ_x	0.0023	0.007	Conditional volatility of aggregate productivity
ρ_z	0.97	0.912	Persistence coefficient of firm-specific productivity
σ_z	0.10	0.30	Conditional volatility of firm-specific productivity
ϕ	1	1	Convexity parameter of investment adjustment cost
δ	0.6	0.6	Long-run average level of dividend payout ratios
β	0.998	0.994	Time preference coefficient
Calibrated Inside the Model			
μ_x	-2.0	-1.71	Long-run average level of aggregate productivity
θ	0.68	0.65	Curvature in the production function
ξ_1	323	458	Convexity parameter of cash holding cost
ξ_2	0.084	0.044	Procyclical parameter of cash holding cost

This table lists the benchmark parameters used to solve and simulate the model. We calibrate 12 parameters $\left(\bar{\delta}, \rho_x, \sigma_x, \rho_z, \sigma_z, \phi, \delta, \beta, \mu_x, \theta, \xi_1, \xi_2\right)$ in monthly frequency and quarterly frequency to be consistent with the empirical literature. The monthly model is denoted as Model $\mathcal{M}$, and the quarterly model, as Model $\mathcal{Q}$. We categorize all parameters into two groups. The first parameter group $\left(\bar{\delta}, \rho_x, \sigma_x, \rho_z, \sigma_z, \phi, \delta, \beta\right)$ is calibrated outside models, and the second parameter group $(\mu_x, \theta, \xi_1, \xi_2)$ is calibrated inside models by the method using the idea of generalized method of moments. The moments to be used in this calibration are from average values of policy functions converged on grids of compact state space: profitability $(\Pi(S_{it})/K_{it})$, investment-capital ratio $(I_+(S_{it})/K_{it})$, disinvestment-capital ratio $(I_-(S_{it})/K_{it})$, and paying or not-paying dividend policy (a_{it}).

Table II. Unconditional Moments of Market Values

U.S. Data Annualized Data	(%)	Model $\mathcal{M}$			Model $\mathcal{Q}$		
		$\gamma = 2$	$\gamma = 3$	$\gamma = 4$	$\gamma = 2$	$\gamma = 3$	$\gamma = 3.5$
Market Return and Risk-Free Rate							
$r_M - r_f$	4 to 8	1.14	4.67	11.2	1.40	5.81	8.75
$\sigma[r_M]$	19.4	13.3	20.1	27.3	11.6	17.7	20.9
$\sigma[r_i]$	25 to 32	47.1	48.7	51.1	21.8	22.6	22.8
$\Delta P_{t+1}/P_t$	2.10	2.02	2.51	3.20	1.49	2.16	2.58
D_{t+1}/P_t	4.70	3.87	6.06	9.40	3.64	5.18	6.17
r_f	1.80	4.75	3.90	1.42	3.73	1.54	0.00
$\sigma[r_f]$	3.00	0.93	1.14	1.23	1.17	2.06	1.62
$\sigma[M]$	0.49	0.22	0.37	0.57	0.26	0.43	0.54
Sharpe Ratio	0.50	0.23	0.38	0.59	0.27	0.44	0.54
Aggregate Dividend Growth							
$\Delta \log D$	2.50	2.40	2.39	2.40	2.59	2.56	2.56
$\sigma[\Delta \log D]$	13.4	11.5	11.4	11.4	13.9	13.8	13.6
Book-to-Market							
BE/ME	0.67	0.16	0.24	0.37	0.37	0.52	0.62
$\sigma[BE/ME]$	0.23	0.07	0.10	0.15	0.15	0.20	0.24
$\frac{(BE/ME)^{\text{payer}}}{(BE/ME)^{\text{non-payer}}}$	1.32	2.34	2.27	2.20	1.70	1.65	1.63
Price-Dividend Ratio							
P/D	22.1	26.3	16.8	10.9	28.9	20.5	17.3
$\sigma[\log P/D]$	26.3	8.49	16.8	24.6	12.0	23.5	29.2

This table reports a set of key unconditional moments of market values under the benchmark models $\mathcal{M}$ and $\mathcal{Q}$ with parameters in Table I. The empirical range of equity premium $(r_M - r_f)$ is from the variety of finance literature. The volatility of market return $(\sigma[r_M])$ is from Guvenen (2009) that is computed by Standard and Poor's 500 index covering 1890-1991. The cross-sectional volatility of individual stock returns $(\sigma[r_i])$ is reported by Zhang (2005). The capital gain $(\Delta P_{t+1}/P_t)$ and dividend price ratio (D_{t+1}/P_t) effects of market returns are reported by Fama and French (2002). The risk-free rate (r_f), its volatility $(\sigma[r_f])$, BE/ME, and $\sigma[BE/ME]$ are from Zhang (2005). $(BE/ME)^{\text{payer}}/(BE/ME)^{\text{non-payer}}$ is the ratio of average book-to-market equity ratios of dividend payers and non-payers. It is computed using CRSP/COMPUSTAT merged data. Empirical Sharpe ratio is reported by Cochrane (2005). The average of price dividend ratio (P/D), the average volatility of log of price dividend ratio $(\sigma[\log P/D])$, the aggregate dividend growth and its volatility $(\Delta \log D, \sigma[\Delta \log D])$ are reported by Guvenen (2009).

Table III. Size and Value Factors and the Size-BE/ME Portfolios

	Factor Portfolios			Size-BE/ME Portfolios					
	$r_M - r_f$	SMB	VMG	SG	SN	SV	BG	BN	BV
Annualized Data(%)									
1927-2006 data (Fama and French (2007))									
4 to 8		1.67	4.19	8.69	12.9	14.4	9.18	10.0	11.8
$\Delta P_{t+1}/P_t$		2.51	3.43	5.70	9.04	11.2	5.80	5.54	7.13
D_{t+1}/P_t		−0.84	0.77	2.98	3.87	3.21	3.39	4.49	4.69
1945-2005 data (Chen, Petkova, and Zhang (2008))									
4 to 8		2.70	5.20	8.60	12.4	15.1	7.80	8.50	11.7
$\Delta P_{t+1}/P_t$		3.00	4.95	2.10	5.50	10.3	2.70	1.80	4.40
D_{t+1}/P_t		−0.30	0.25	6.50	6.90	4.80	5.10	6.70	7.30
Estimated Expected Values (Chen, Petkova, and Zhang (2008))									
4 to 8		2.13	6.10	4.80	9.30	13.2	5.60	6.00	9.30
$\Delta P_{t+1}/P_t$		3.06	4.40	2.10	5.50	9.40	2.40	1.50	3.90
D_{t+1}/P_t		−0.93	1.70	2.70	3.80	3.80	3.10	4.50	5.40
Model $\mathcal{M}$ (Monthly)									
$\gamma = 2$	1.14	12.6	19.9	4.61	7.02	23.6	−14.4	5.19	6.54
$\Delta P_{t+1}/P_t$		16.4	17.7	4.29	4.74	20.6	−18.7	−1.45	0.45
D_{t+1}/P_t		−3.82	2.2	0.33	2.28	2.99	4.32	6.64	6.09
$\gamma = 3$	4.67	8.88	17.4	5.93	9.04	20.7	−9.97	8.90	10.1
$\Delta P_{t+1}/P_t$		15.6	15.2	5.39	5.65	16.0	−19.0	−1.48	0.69
D_{t+1}/P_t		−6.74	2.22	0.54	3.39	4.62	9.03	10.4	9.38
$\gamma = 4$	11.2	3.85	14.3	8.05	11.7	20.9	−0.62	14.7	15.1
$\Delta P_{t+1}/P_t$		14.3	11.1	7.19	6.77	13.8	−14.7	−1.44	0.88
D_{t+1}/P_t		−10.4	3.21	0.86	4.92	7.12	14.1	16.1	14.2
Model $\mathcal{Q}$ (Quarterly)									
$\gamma = 2$	1.40	3.28	6.17	4.06	5.78	9.99	−0.50	4.59	5.91
$\Delta P_{t+1}/P_t$		7.40	2.62	4.02	5.53	9.09	−0.50	−2.73	−0.34
D_{t+1}/P_t		−4.13	3.55	0.04	0.25	0.90	0.00	7.32	6.25
$\gamma = 3$	5.81	1.60	6.97	4.94	7.08	10.5	0.76	7.91	9.09
$\Delta P_{t+1}/P_t$		7.47	2.17	4.89	6.76	9.44	0.76	−2.61	0.53
D_{t+1}/P_t		−5.87	4.80	0.05	0.32	1.10	0.00	10.5	8.56
$\gamma = 3.5$	8.75	0.48	6.90	5.65	7.82	11.4	2.68	10.1	10.7
$\Delta P_{t+1}/P_t$		7.43	1.48	5.59	7.41	10.2	2.67	−2.73	0.99
D_{t+1}/P_t		−6.95	5.41	0.06	0.41	1.21	0.01	12.8	9.69

This table lists the size and value factors and the six size-BE/ME portfolios. We follow the Fama-French method to pool the factor portfolios, SMB (small minus big) and VMG (value minus growth, previously HML), and the six value-weighted size-BE/ME portfolios (Fama and French (2006)). Firms below the median size are small (S) and those above are big (B) in simulated 2703 firms. We assign firms to growth (G), neutral (N), and value (V) groups if their BE/ME is in the bottom 30%, middle 40%, or top 30% of simulated firms. The six portfolios, small and big growth (SG and BG), small and big neutral (SN and BN), and small and big value (SV and BV) are the intersections of these sorts. In our models $\mathcal{M}$ and $\mathcal{Q}$, SMB is the simulated expected returns on the three small-size stock portfolios minus the returns on the three big-size stock portfolios such that, SMB$=\frac{SG+SN+SV}{3} - \frac{BG+BN+BV}{3}$,and VMG$=\frac{SV+BV}{2} - \frac{SG+BG}{2}$, which is the value-growth factor, VMG is the expected returns on the two value portfolios minus the expected returns on the two growth portfolios. The empirical capital gain ($\Delta P_{t+1}/P_t$), dividend price ratio (D_{t+1}/P_t) effects, and returns for size and value portfolios are reported by Fama and French (2007), and Chen, Petkova, and Zhang (2008).

Table IV. Logit Regressions of Propensities of Payouts: Dividend Payment and Stock
Repurchase, 1962 to 2009

	$\frac{\Pi_{it}}{A_{it}}$	$\frac{I_{it}}{A_{it}}$	$\frac{M_{it}}{A_{it}}$	PME_{it}
$Payer_{it}$	7.55	-3.44	-0.63	1.64
	[14.5]	[-5.5]	[-11.9]	[12.4]
$Totalpay_{it}$	6.65	-3.16	-0.58	1.54
	[14.3]	[-5.44]	[-12.2]	[11.2]
$StockRp_{it}$	2.53	-2.18	-0.31	0.02
	[7.70]	[-3.60]	[-6.10]	[2.73]

This table lists cross-sectional Logit regressions for propensities of dividend payment and stock repurchase such that

$$\mathbb{P}\left\{Payer_{it} = 1\right\} = \text{logit}\left(a_1 + b_1\frac{\Pi_{it}}{A_{it}} + c_1\frac{I_{it}}{A_{it}} + d_1\frac{M_{it}}{A_{it}} + e_1 PME_{it}\right) + u_{it},$$

$$\mathbb{P}\left\{TotalPay_{it} = 1\right\} = \text{logit}\left(a_2 + b_2\frac{\Pi_{it}}{A_{it}} + c_2\frac{I_{it}}{A_{it}} + d_2\frac{M_{it}}{A_{it}} + e_2 PME_{it}\right) + u_{it},$$

$$\text{and } \mathbb{P}\left\{StockRp_{it} = 1\right\} = \text{logit}\left(a_3 + b_3\frac{\Pi_{it}}{A_{it}} + c_3\frac{I_{it}}{A_{it}} + d_3\frac{M_{it}}{A_{it}} + e_3 PME_{it}\right) + u_{it}.$$

Coefficients and t-values in brackets are averages of annual values.

Table V. Statistics for Measures of Payout: Dividend Payment and Stock Repurchase, Solow Residual and Dividend Measures, 1962 to 2009

	ρ (AR(1))	Unit Root	Solow Residual	Dividend Premium		
			Δx_t	P_t^{D-N}	BM_t^{N-D}	VS_t^{G-V}
$Initiate_{t+1}$	0.76 [0.00]	-2.61 [0.10]	**0.21** [0.15]	**0.81** [0.00]	**0.73** [0.00]	**0.61** [0.00]
$Continue_{t+1}$	0.59 [0.00]	-2.61 [0.10]	**0.44** [0.00]	0.17 [0.24]	0.16 [0.27]	**0.62** [0.00]
$Listpay_{t+1}$	0.14 [0.33]	-5.71 [0.00]	-0.03 [0.81]	**0.21** [0.15]	**0.32** [0.03]	0.09 [0.58]
$\hat{a}_{t+1}^{D}$	0.78 [0.00]	-2.14 [0.23]	0.03 [0.85]	0.06 [0.67]	0.05 [0.76]	**0.37** [0.01]
$\hat{a}_{t+1}^{ND}$	0.71 [0.00]	-2.95 [0.05]	**0.21** [0.15]	**0.41** [0.01]	**0.55** [0.00]	**0.31** [0.03]
DS_{t+1}^{D-N}	0.60 [0.00]	-3.52 [0.01]	**-0.26** [0.07]	**-0.48** [0.00]	**-0.71** [0.00]	-0.01 [0.93]
$\hat{a}_{t+1}^{P}$	0.63 [0.00]	-2.91 [0.05]	0.11 [0.46]	0.12 [0.42]	0.14 [0.34]	0.26 [0.07]
$\hat{a}_{t+1}^{NP}$	0.61 [0.00]	-3.37 [0.02]	**0.25** [0.09]	**0.45** [0.00]	**0.65** [0.00]	0.19 [0.20]
TP_{t+1}^{P-NP}	0.54 [0.00]	-3.66 [0.00]	**-0.22** [0.13]	**-0.46** [0.00]	**-0.70** [0.00]	-0.02 [0.87]
$\hat{a}_{t+1}^{R}$	0.39 [0.02]	-3.85 [0.01]	**0.27** [0.09]	0.06 [0.73]	0.04 [0.82]	0.12 [0.45]
$\hat{a}_{t+1}^{NR}$	0.33 [0.04]	-4.29 [0.00]	**0.31** [0.05]	0.16 [0.31]	0.18 [0.26]	0.10 [0.54]
SR_{t+1}^{R-NR}	0.30 [0.09]	-4.03 [0.00]	0.08 [0.63]	-0.16 [0.31]	**-0.25** [0.13]	0.12 [0.47]

This table lists the statistics for $Initiate_{t+1}$, $Continue_{t+1}$ and $Listpay_{t+1}$ (detrended by H-P filter) such that $Initiate_t = \frac{New\ Payers_t}{Nonpayers_t - Delist\ Nonpayers_t}$, $Continue_t = \frac{Old\ Payers_t}{Payers_t - Delist\ Payers_t}$, and $Listpay_t = \frac{List\ Payers_t}{List\ Payers_t + List\ Nonpayers_t}$. Also, propensities to pay out cash to shareholders (dividend payment and stock repurchase) in Table IV are detrended by H-P filter. It shows the correlations between them and total factor productivity (aggregate productivity shock, Δx_t), dividend premium $\left(P_t^{D-N}\right)$, difference between average book-to-market equity ratios of nonpayers and payers $\left(BM_t^{N-D}\right)$ and the minus value spread $\left(VS_t^{G-V}\right)$, and p-values are in brackets. ρ is coefficient of $AR(1)$ to test the unit-root using Dickey-Fuller test.

Table VI. Statistics for Solow Residual, Demand for Dividend Measures and Stock Returns, 1962 to 2009

	ρ (AR(1))	Unit Root	Solow Residual	Dividend Premium		
			Δx_t	P_t^{D-N}	BM_t^{N-D}	VS_t^{G-V}
Δx_t	0.16 [0.21]	-4.37 [0.00]	1			
P_t^{D-N}	0.85 [0.00]	-2.21 [0.20]	**0.25** [0.09]	1		
BM_t^{N-D}	0.73 [0.00]	-2.93 [0.05]	0.19 [0.20]	**0.73** [0.00]	1	
VS_t^{N-D}	0.82 [0.00]	-2.18 [0.22]	**0.32** [0.02]	**0.63** [0.00]	**0.43** [0.00]	1
r_{Mt+1}	-0.12 [0.35]	-8.41 [0.00]	-0.07 [0.60]	0.06 [0.67]	0.05 [0.72]	0.06 [0.64]
r_{ft+1}	0.86 [0.00]	-1.91 [0.33]	-0.07 [0.62]	-0.05 [0.71]	**-0.55** [0.00]	-0.05 [0.71]
$r_{Mt+1} - r_{ft+1}$	-0.12 [0.34]	-8.41 [0.00]	-0.06 [0.67]	0.07 [0.63]	0.13 [0.35]	0.07 [0.61]
$r_{t+1}^V - r_{t+1}^G$	0.11 [0.36]	-6.73 [0.00]	**-0.21** [0.11]	-0.13 [0.40]	-0.12 [0.41]	**-0.21** [0.15]
$r_{t+1}^S - r_{t+1}^B$	0.26 [0.04]	-5.68 [0.00]	-0.07 [0.60]	**0.28** [0.06]	**0.34** [0.02]	0.01 [0.94]
$r_{t+1}^D - r_{t+1}^N$	0.07 [0.63]	-6.16 [0.00]	-0.12 [0.40]	**-0.38** [0.01]	**-0.45** [0.00]	**-0.30** [0.04]
r_{Dt+1}	0.64 [0.00]	-3.01 [0.04]	**-0.25** [0.08]	-0.06 [0.66]	-0.06 [0.67]	**-0.36** [0.01]

This table lists the statistics for TFP (Δx_t), dividend premium (P^{D-N}), difference between average book-to-market equity ratios of nonpayers and payers (BM^{N-D}), the minus value spread (VS^{G-V}), market return (r_M), risk free rate (r_f), market risk premium $(r_M - r_f)$, value premium $(r^V - r^G)$. These data are from the Fama and French library. Excess return of dividend payers over nonpayers $(r^D - r^N)$, and excess return of dividend distribution over capital gain (r_D) are analyzed. It shows the correlations between them and p-values are in brackets. ρ is coefficient of $AR(1)$ to test the unit-root using Dickey-Fuller test.

Table VII. Measures of Payout: Dividend Payment and Stock Repurchase and Stock Returns, 1962 to 2009

	$Initiate_t$	$Continue_t$	$Listpay_t$	$\hat{a}_t^D$	$\hat{a}_t^{ND}$	DS_t^{D-N}
$r_{t+1}^V - r_{t+1}^G$	-0.09	**-0.28**	-0.00	-0.20	-0.19	0.05
	[0.58]	[0.06]	[0.98]	[0.18]	[0.19]	[0.72]
$r_{t+1}^S - r_{t+1}^B$	**0.40**	0.03	-0.02	0.02	**0.35**	**-0.48**
	[0.01]	[0.85]	[0.91]	[0.90]	[0.01]	[0.00]
$r_{t+1}^D - r_{t+1}^N$	**-0.44**	**-0.22**	-0.13	-0.16	**-0.44**	**0.43**
	[0.00]	[0.14]	[0.40]	[0.27]	[0.00]	[0.00]
r_{t+1}^D	0.19	-0.12	-0.07	0.10	**0.24**	**-0.22**
	[0.20]	[0.42]	[0.60]	[0.49]	[0.09]	[0.13]
r_{t+1}^N	**0.35**	0.03	0.01	0.15	**0.39**	**-0.37**
	[0.02]	[0.83]	[0.93]	[0.30]	[0.01]	[0.01]
$r_{t+1}^P - r_{t+1}^{NP}$	**-0.40**	-0.21	-0.12	-0.15	**-0.42**	**0.42**
	[0.00]	[0.16]	[0.43]	[0.30]	[0.00]	[0.00]
r_{t+1}^P	0.21	-0.11	-0.06	0.11	**0.26**	**-0.24**
	[0.16]	[0.48]	[0.70]	[0.46]	[0.08]	[0.10]
r_{t+1}^{NP}	**0.34**	0.03	0.02	0.15	**0.38**	**-0.37**
	[0.02]	[0.84]	[0.92]	[0.31]	[0.01]	[0.01]

This table lists the correlations between propensities to pay out cash to shareholders (dividend payment and stock repurchase) in Table IV, and $Initiate_{t+1}$, $Continue_{t+1}$ and $Listpay_{t+1}$ in Table V and value premium $\left(r_{t+1}^V - r_{t+1}^G\right)$, size premium $\left(r_{t+1}^S - r_{t+1}^B\right)$. These returns are from the Fama and French library. In addition, excess return of dividend payers over nonpayers $\left(r_{t+1}^D - r_{t+1}^N\right)$, payers' equal-weighted return $\left(r_{t+1}^D\right)$, nonpayers' equal-weighted return $\left(r_{t+1}^N\right)$, excess return of total payers over nonpayers $\left(r_{t+1}^P - r_{t+1}^{NP}\right)$, total payers' equal-weighted return $\left(r_{t+1}^P\right)$ and nonpayers' equal-weighted return $\left(r_{t+1}^{NP}\right)$ are analyzed in this Table. p-values are in brackets.

Table VII. Continued

	$\hat{a}_t^P$	$\hat{a}_t^{NP}$	TP_t^{P-NP}	$\hat{a}_t^R$	$\hat{a}_t^{NR}$	SR_t^{R-NR}
$r_{t+1}^V - r_{t+1}^G$	-0.19	-0.18	0.09	-0.21	**-0.26**	-0.02
	[0.20]	[0.20]	[0.54]	[0.19]	[0.11]	[0.89]
$r_{t+1}^S - r_{t+1}^B$	0.19	**0.44**	**-0.43**	0.17	**0.28**	-0.14
	[0.20]	[0.00]	[0.00]	[0.31]	[0.08]	[0.39]
$r_{t+1}^D - r_{t+1}^N$	-0.20	**-0.51**	**0.49**	-0.03	**-0.24**	**0.38**
	[0.17]	[0.00]	[0.00]	[0.82]	[0.15]	[0.01]
r_{t+1}^D	0.18	**0.32**	**-0.28**	0.03	0.15	-0.23
	[0.23]	[0.02]	[0.05]	[0.84]	[0.35]	[0.17]
r_{t+1}^N	**0.22**	**0.47**	**-0.44**	0.04	0.23	**-0.35**
	[0.13]	[0.00]	[0.00]	[0.80]	[0.16]	[0.03]
$r_{t+1}^P - r_{t+1}^{NP}$	-0.17	**-0.48**	**0.48**	-0.01	-0.21	**0.40**
	[0.23]	[0.00]	[0.00]	[0.96]	[0.21]	[0.01]
r_{t+1}^P	0.18	**0.35**	**-0.30**	0.03	0.17	**-0.24**
	[0.21]	[0.02]	[0.04]	[0.83]	[0.32]	[0.14]
r_{t+1}^{NP}	**0.21**	**0.48**	**-0.44**	0.03	0.22	**-0.37**
	[0.15]	[0.00]	[0.00]	[0.85]	[0.17]	[0.02]

Table VIII. Regressions of Stock Returns on Measures of Payout: Dividend Payment and Stock Repurchase, 1962 to 2009

	$Initiate_t$	DS_t^{D-ND}	TP_t^{P-NP}	$\hat{a}_{Dt}$	$\hat{a}_{Pt}$	R^2
$r_{t+1}^D - r_{t+1}^N$	**-1.68** [-3.11]					0.19
		2.37 [4.47]				0.19
	-1.00 [-1.32]	**1.85** [2.31]				0.26
$r_{t+1}^P - r_{t+1}^{NP}$	**-1.50** [2.96]					0.16
			2.11 [5.11]			0.23
	-0.75 [-0.97]		**1.78** [2.65]			0.28
$r_{Mt+1} - r_{ft+1}$	0.03 [0.07]					0.00
		-0.50 [-0.70]				0.01
			-1.37 [-2.32]			0.06
				0.54 [0.88]		0.01
					0.76 [1.33]	0.02

This table lists regressions of excess return of dividend payers over nonpayers $\left(r_{t+1}^D - r_{t+1}^N\right)$, excess return of total payers over nonpayers $\left(r_{t+1}^P - r_{t+1}^{NP}\right)$, and market risk premium $\left(r_{Mt+1} - r_{ft+1}\right)$ on $Initiate_t$, propensities to pay out cash to shareholders (dividend payment or stock repurchase) in Table IV such that

$$y_{t+1} = \alpha + \beta_1 Initiate_t + \beta_2 \left(DS_t^{D-ND} \text{ or } TP_t^{P-NP}\right) + \beta_3 \left(\hat{a}_{Dt} \text{ or } \hat{a}_{Pt}\right) + u_t.$$

t-values adjusted by Newey-West autocorrelation consistent covariance estimators are in brackets.
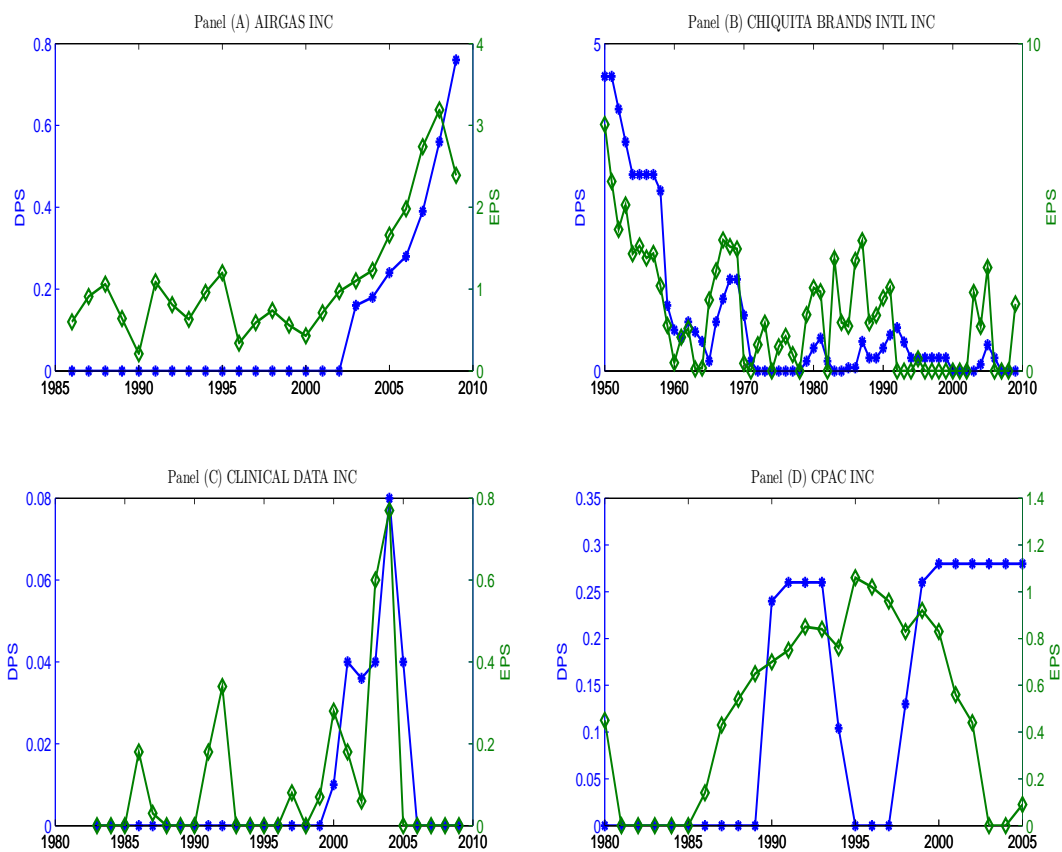
Fig. 1. Lumpy Dividend Policies
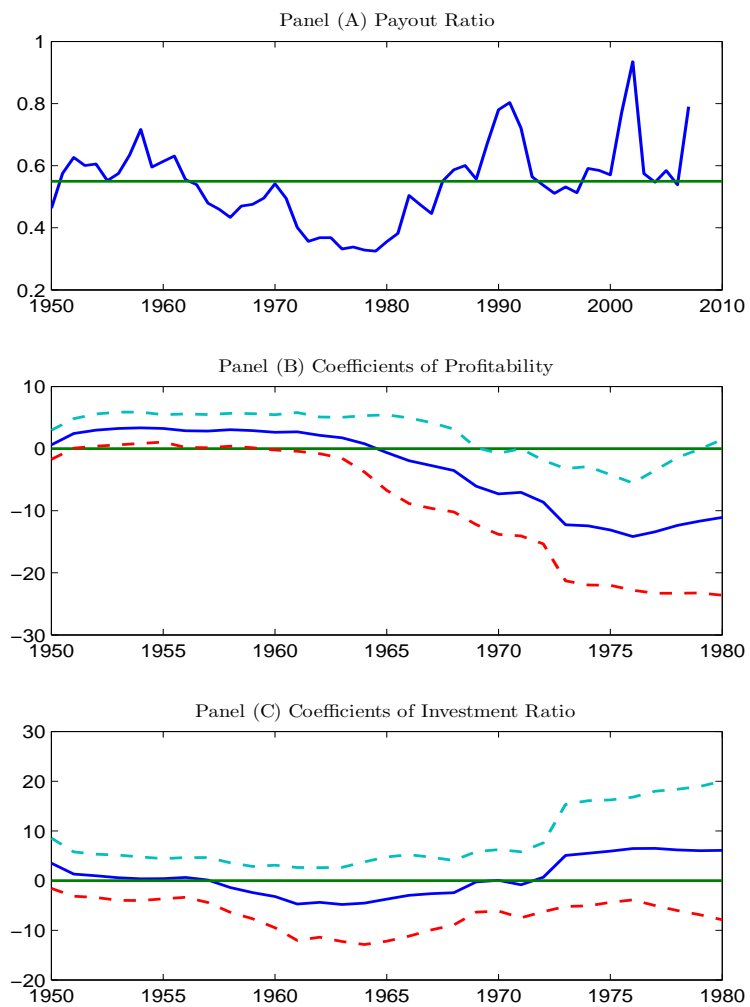
Fig. 2. Aggregate Payout Ratios
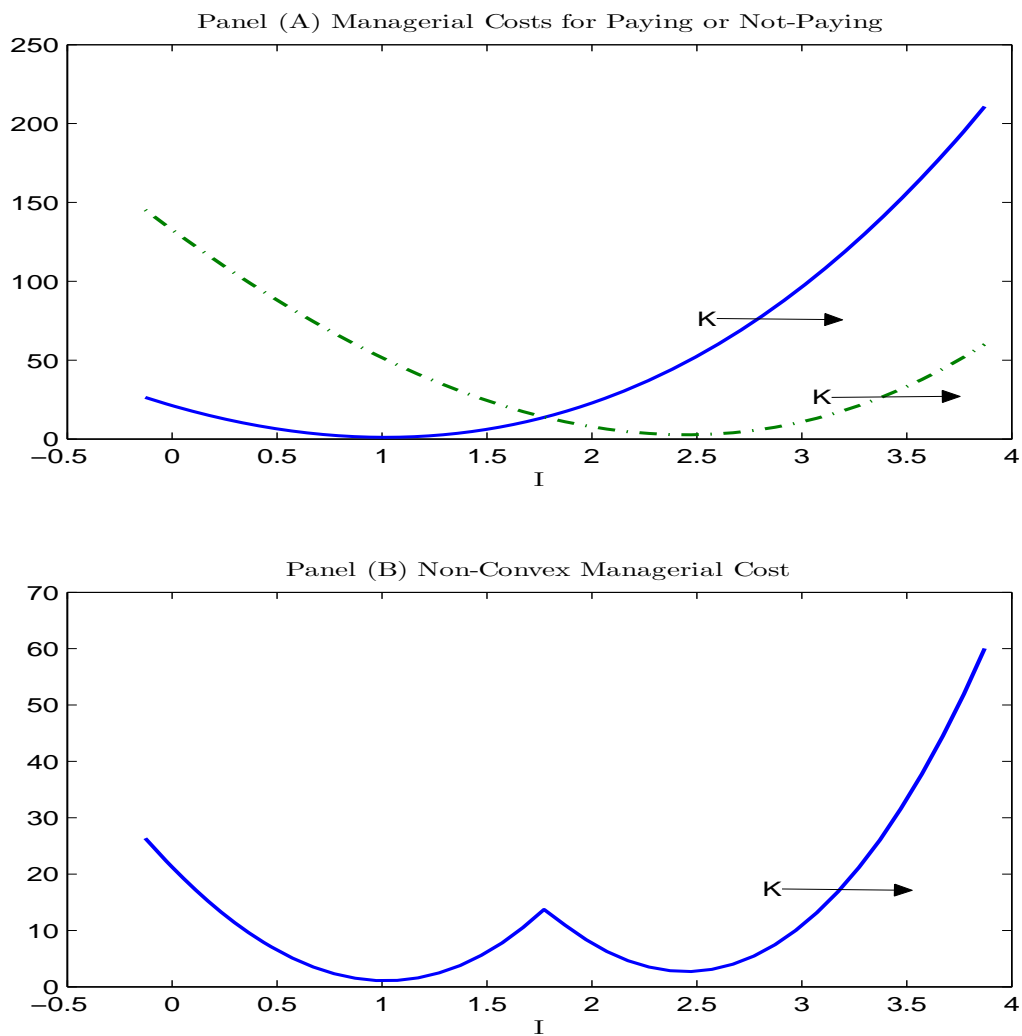
Fig. 3. Non-convex Managerial Cost: $\Pi + \Xi$
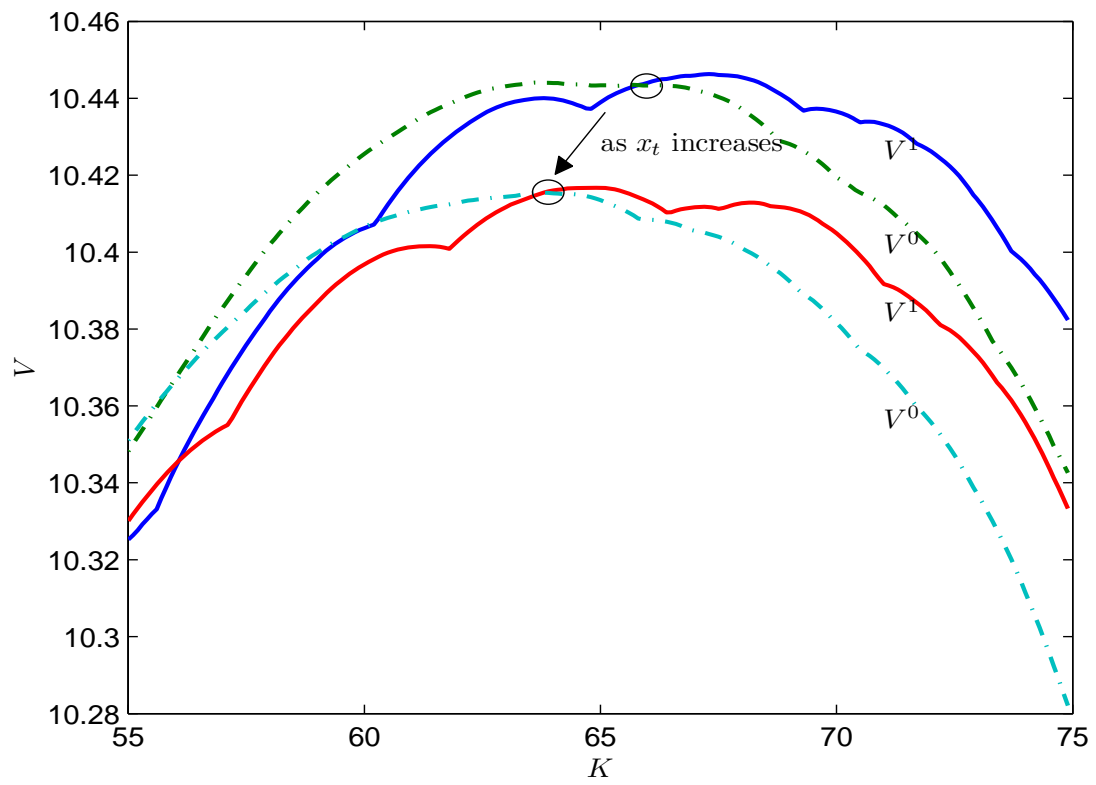
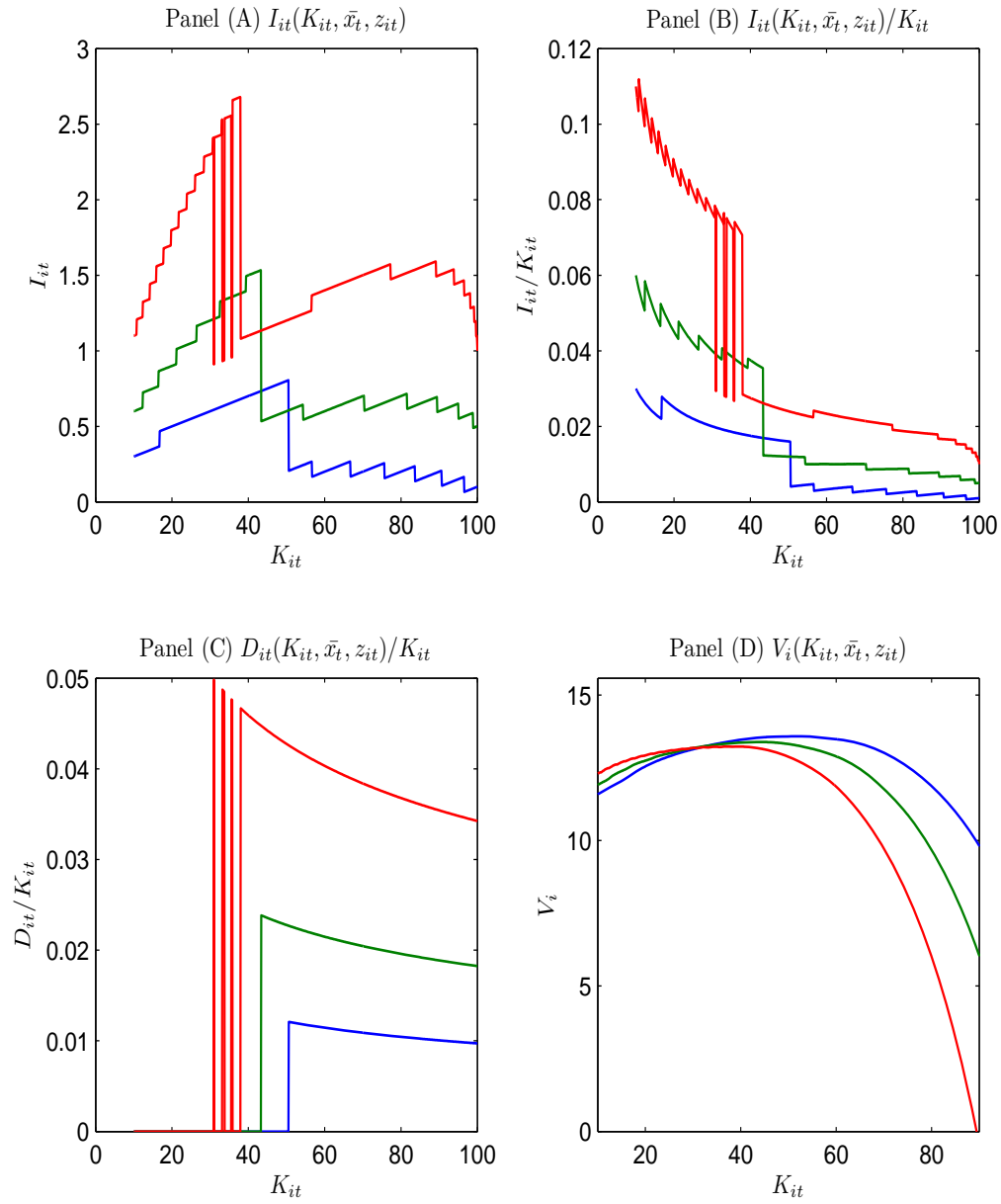Fig. 4. V^0 and V^1 according to Increase in x

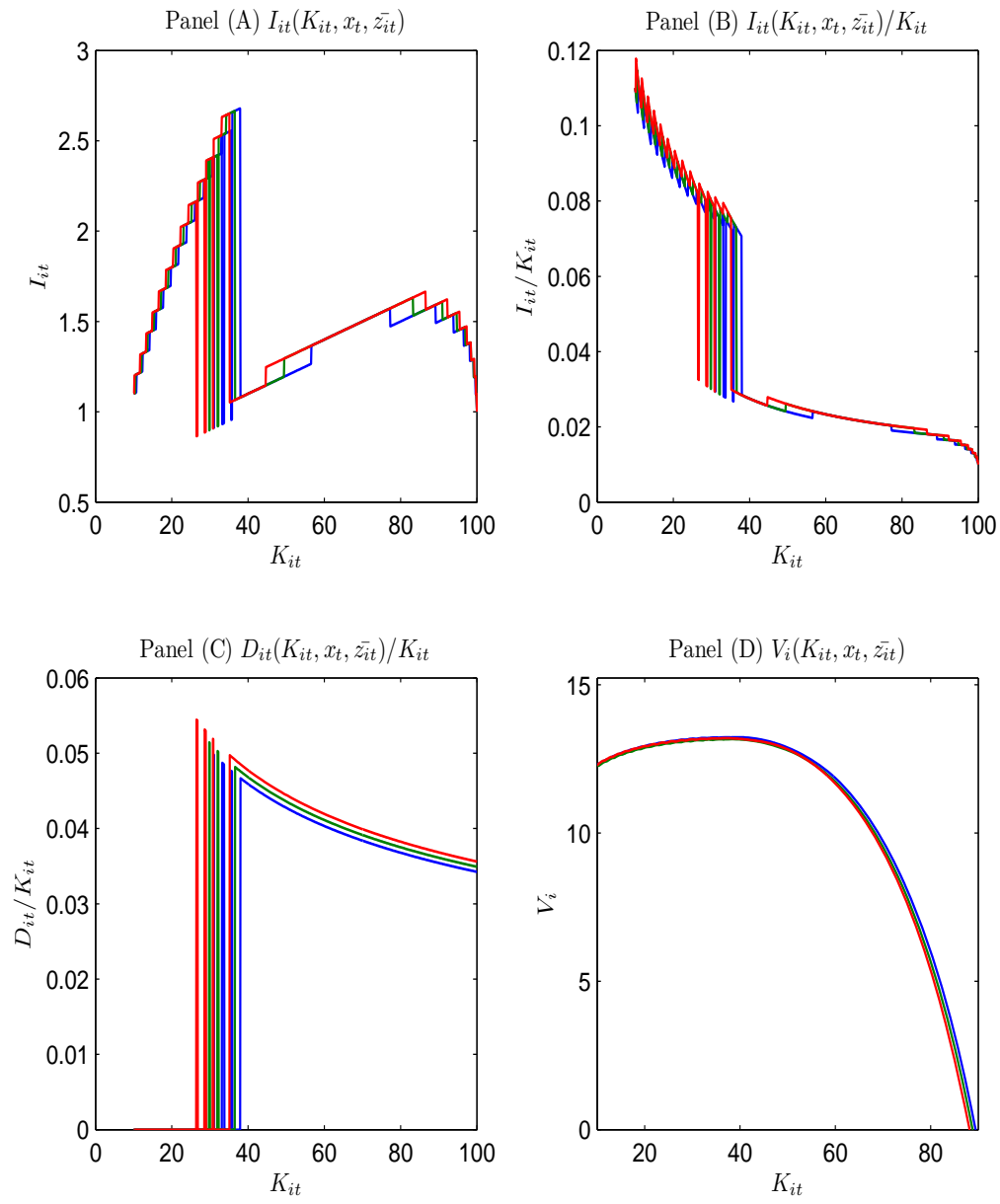Fig. 5. The Optimal Policy Functions Given x_t: Model $\mathcal{M}$

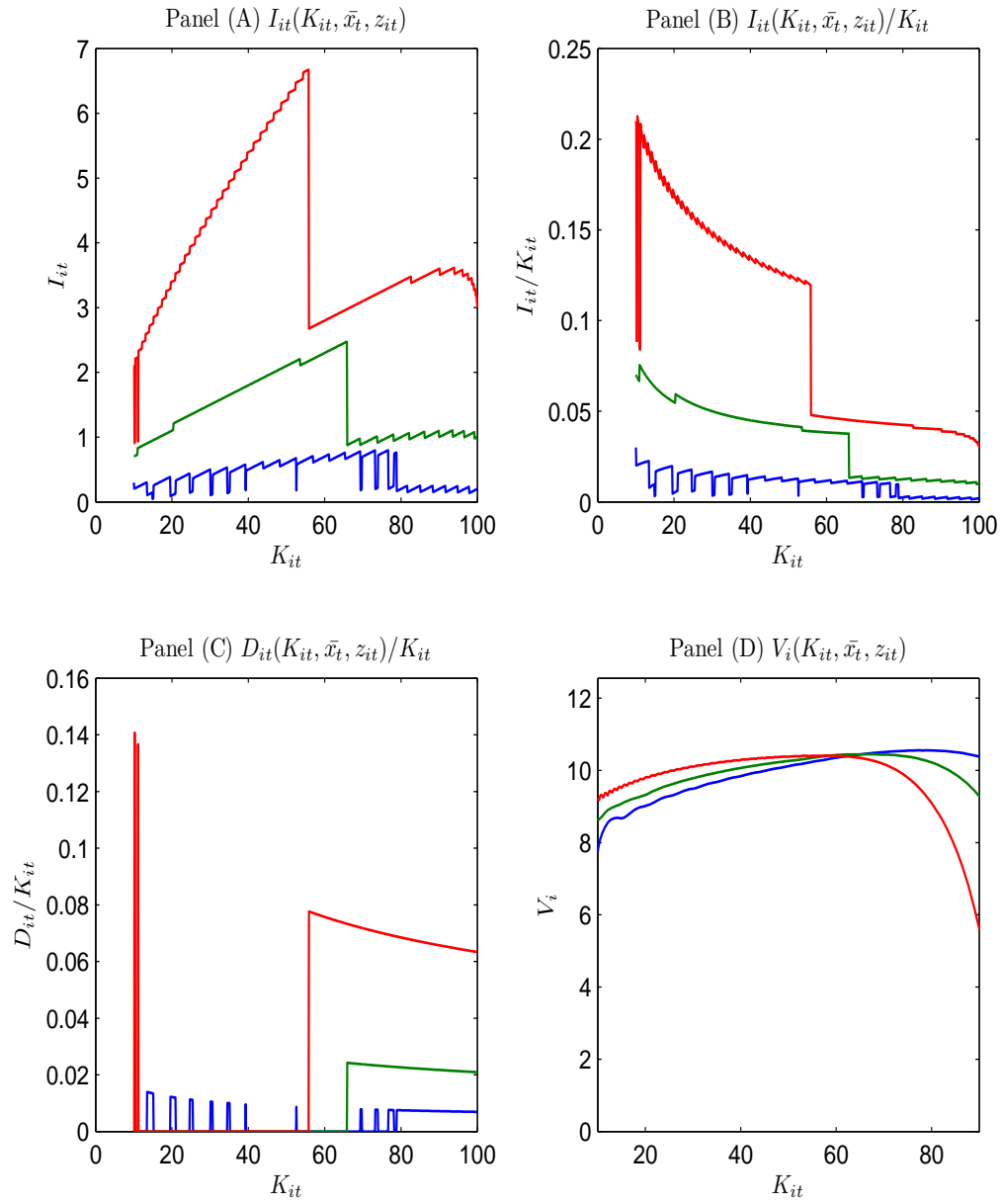Fig. 6. The Optimal Policy Functions Given z_t: Model $\mathcal{M}$

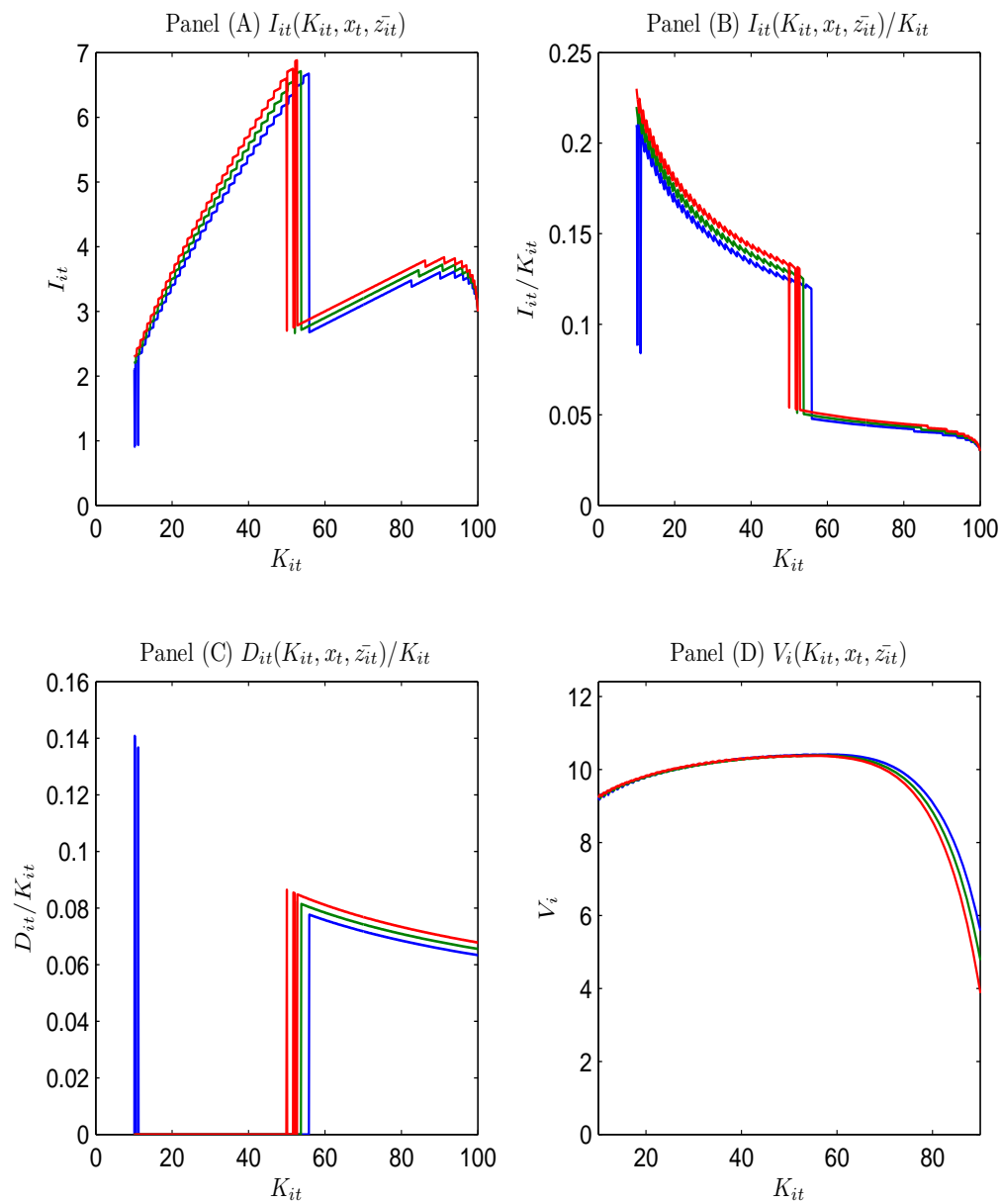Fig. 7. The Optimal Policy Functions Given x_t: Model $\mathcal{Q}$

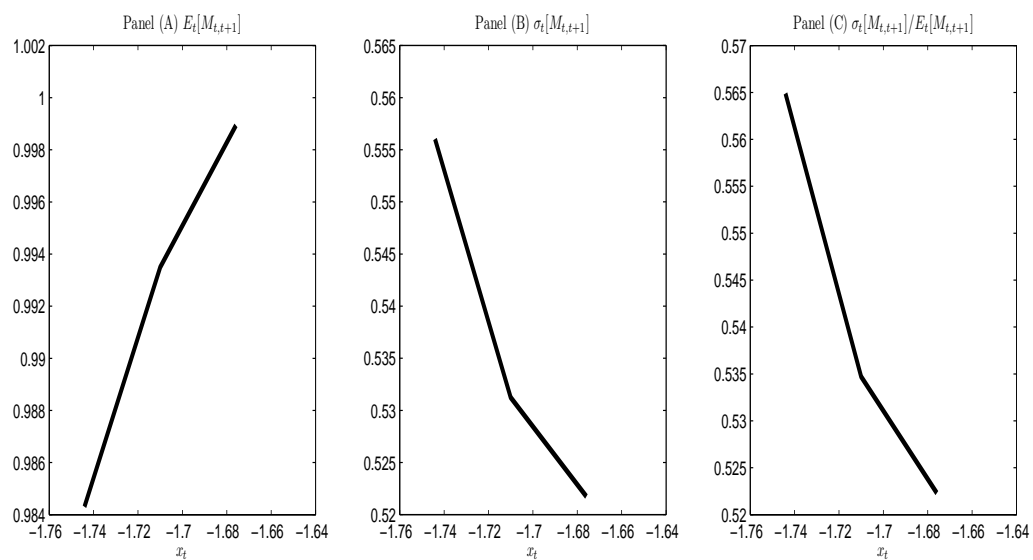Fig. 8. The Optimal Policy Functions Given z_t: Model $\mathcal{Q}$

Fig. 9. Countercyclical Time-Varying Risks

Panel (A) $E[r_{M,t+1}|x_t]$

$\gamma=4$

$\gamma=3$

$\gamma=2$

$\gamma=1$

Panel (B) β_Ms on x_t

$\gamma=1$

$\gamma=2$

$\gamma=3$

$\gamma=4$

Panel (C) $E[r_{M,t+1}|x_t]$

$\gamma=4$

$\gamma=3.5$

$\gamma=3$

$\gamma=2$

Panel (D) β_Ms on x_t

$\gamma=2$

$\gamma=3$

$\gamma=3.5$

$\gamma=4$
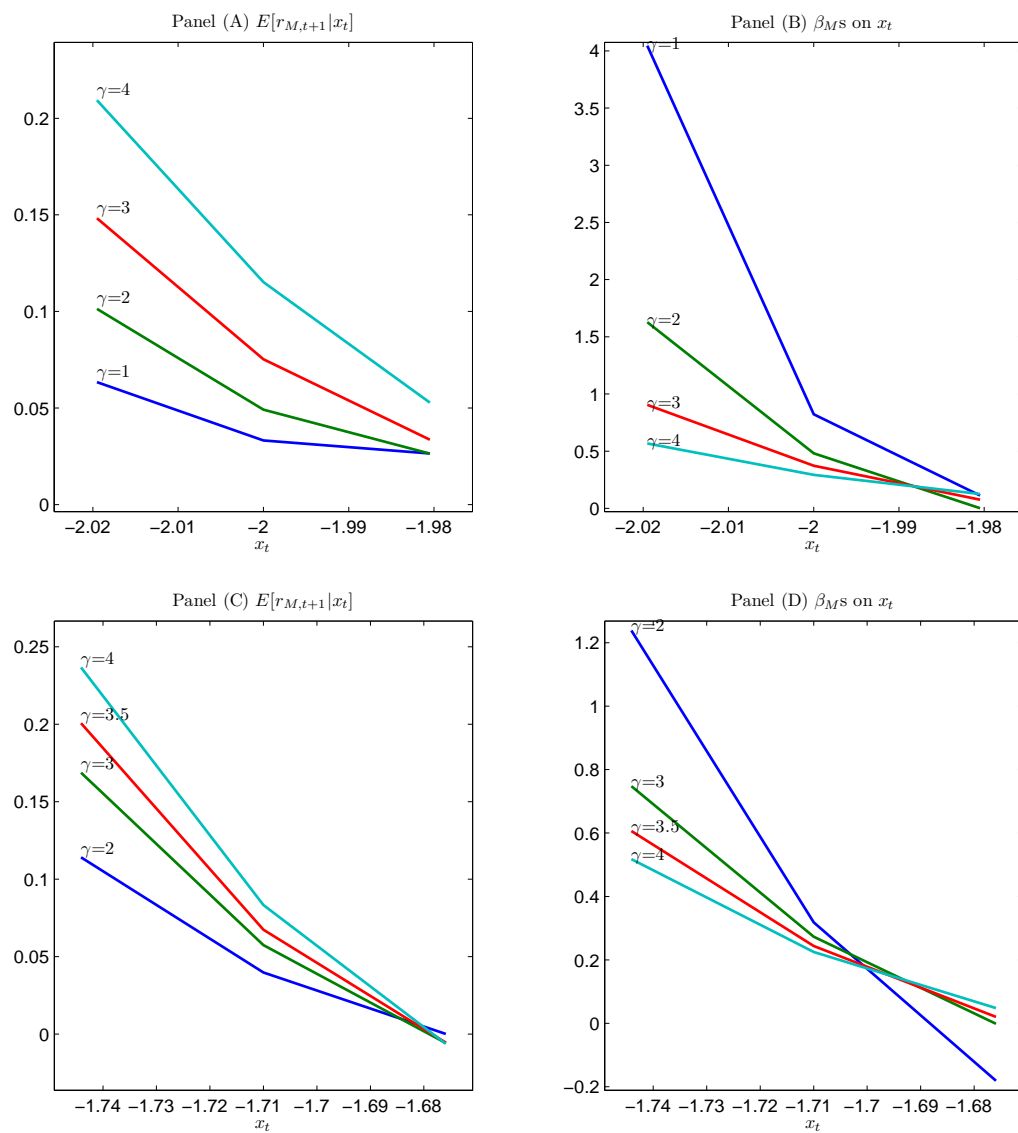
Fig. 10. Conditional Expected Market Returns and β_M
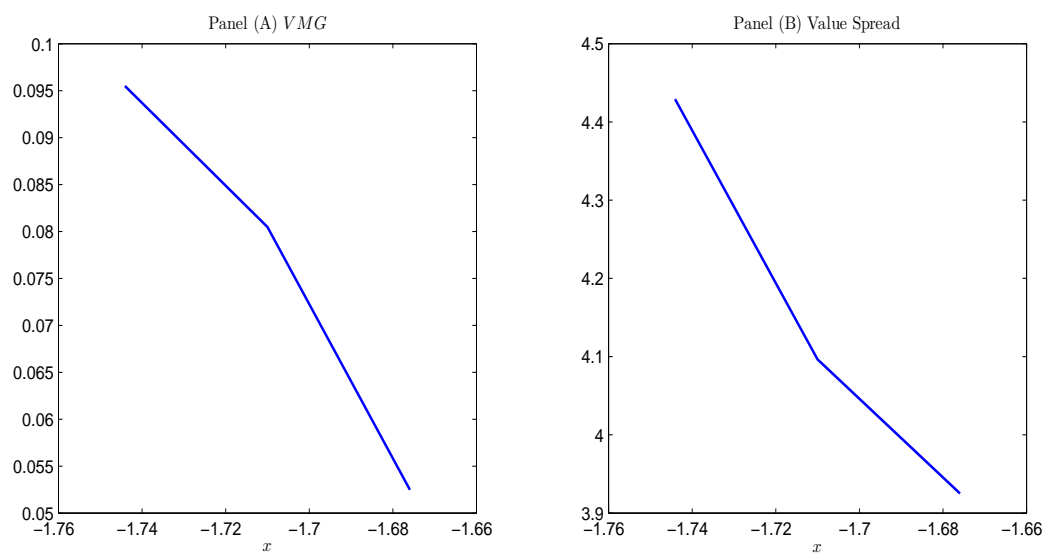
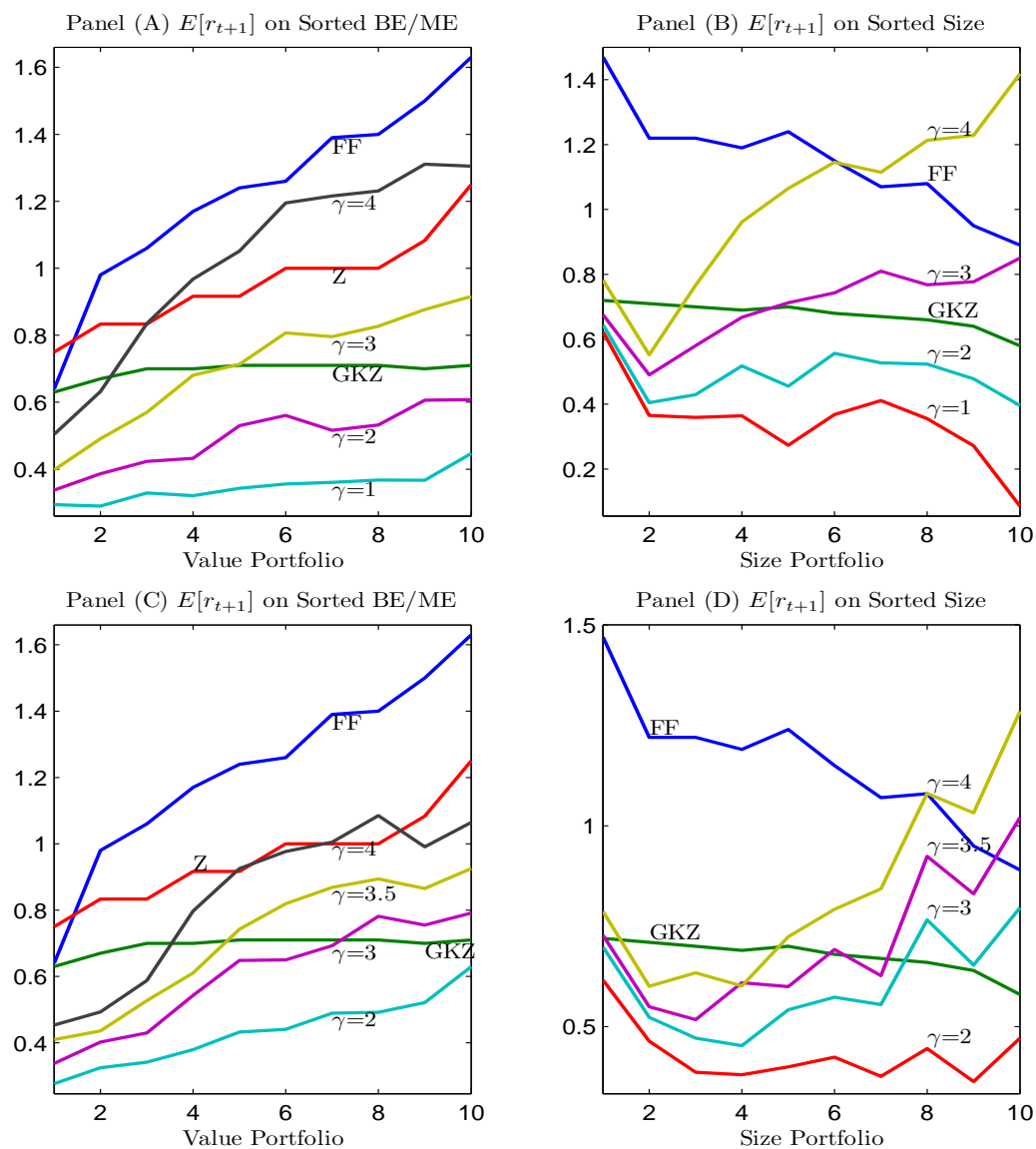Fig. 11. Time-Varying VMG and Value Spread in Quarterly Frequency

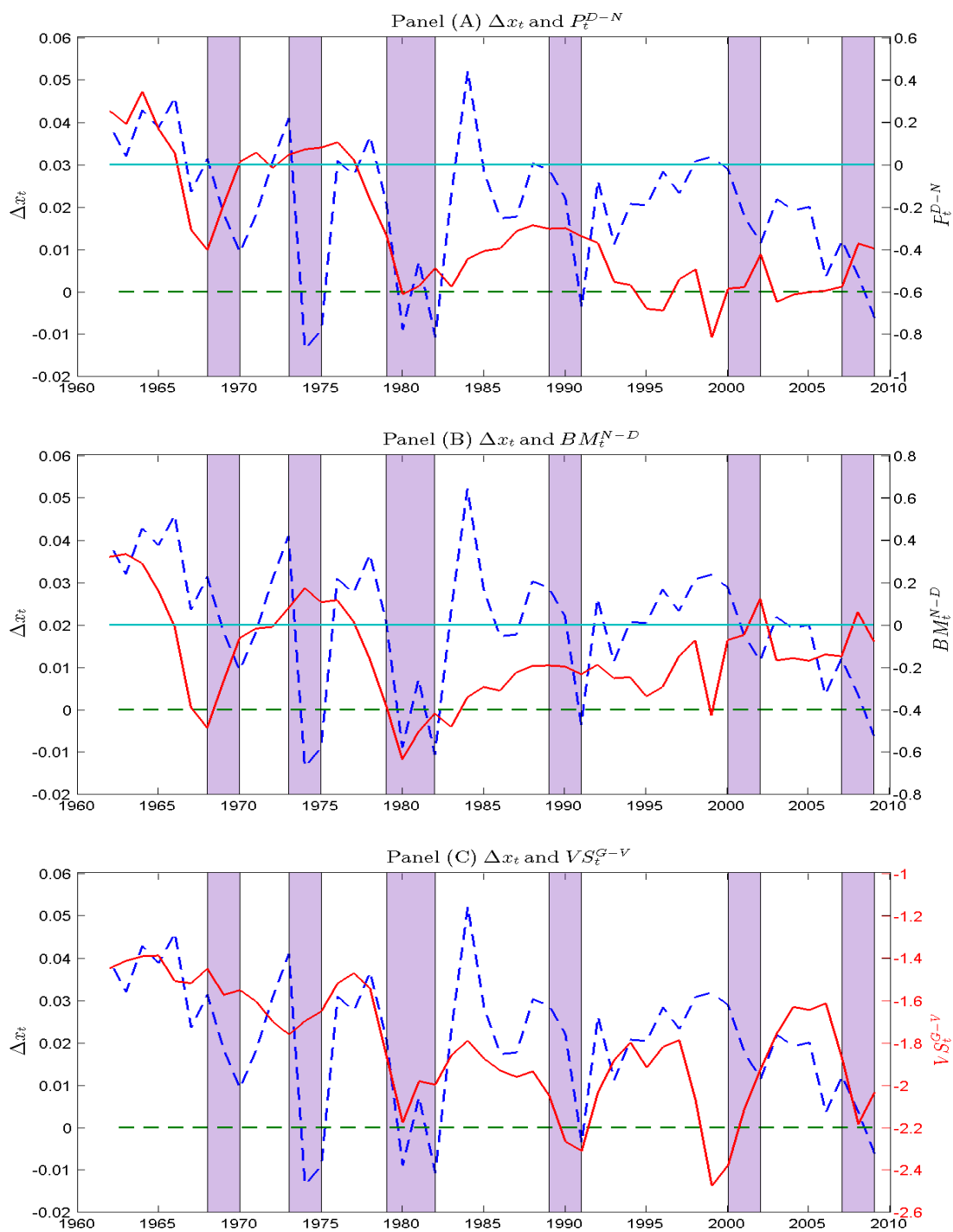Fig. 12. Expected Returns on 10 Portfolios Formed on BE/ME and Market Size

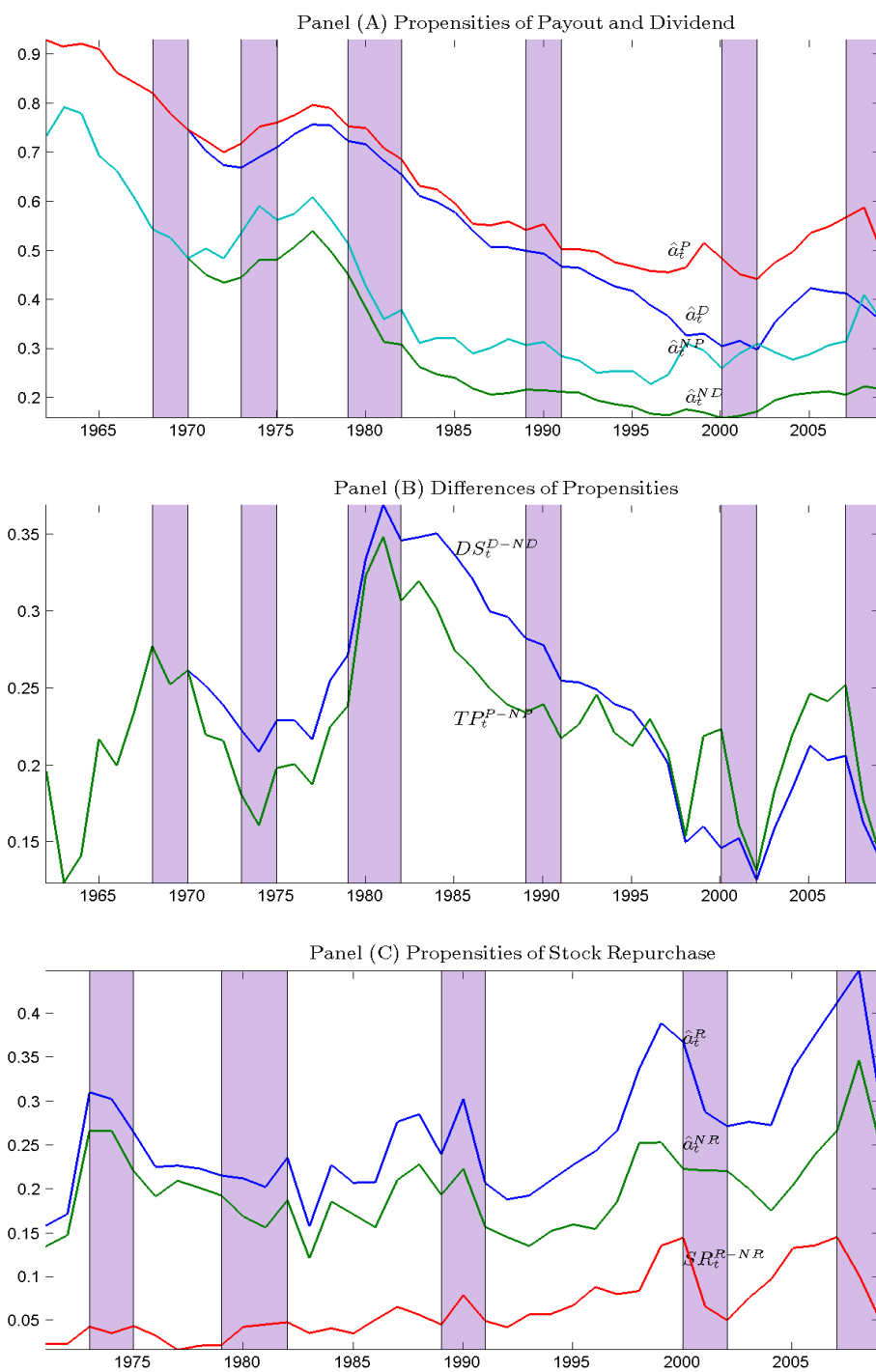Fig. 13. Solow Residual and Dividend Premiums, 1962 to 2009

Fig. 14. Propensities of Payouts: Dividend Payment and Stock Repurchase, 1962 to 2009

VITA

Changwoo Nam received his Bachelor of Arts degree in philosophy from Sung Kyun Kwan University in August of 1999. He received his Master of Arts degree in economics from Seoul National University in February of 2002, and he received his Master of Science degree in economics from the University of Texas at Austin in May of 2006. He received his Ph.D. in economics from Texas A&M University in August of 2011. His fields of specialization are financial economics, macroeconomics and econometrics. Changwoo Nam can be reached at Korea Development Institute, P.O.Box 113, Hoegiro 49 Dongdaemun-gu, Seoul, 130-868, Republic of Korea, or by phone at 82-2-958-4114.