Rational Stock Market Catering

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Abstract

Tests using American data from 1970 to 2015 support the Catering theory of corporate investment. These empirical results are widely interpreted as support for behavioral finance. We present a simple rational model of corporate investment, equity issuance, and dividends. The Catering tests are carried out on data generated by the model. The same pattern of coefficients is obtained using model generated data and using real data. To distinguish the interpretations we examine the cross section of firm decisions during periods of booms, high market sentiment, and mispricing as identified by the behavioral literature. The estimated coefficients do not match the behavioral predictions. The model also shows that the impact of productivity shocks may be more complex than usually assumed, due to interactions between the investor's budget and the firm's source and uses of funds.

Key Words: investment, equity issuance, dividends, share repurchases, Catering
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1 Introduction

According to Catering Theory, stock market pricing is driven by the whims of investors. Firms that are particularly dependent on the stock market ('equity dependent') respond to those fluctuations by catering their investment decisions to the opportunities created by those investor whims. If investor demand for equity is particularly high, equity dependent firms are particularly able to finance their investment by issuing equity. Similarly, if investors favor dividends by putting a premium on dividend paying stocks, firms react by increasing dividends. This behavioral theory was developed by Stein (1996). Studies by Baker, Stein, and Wurgler (2003), Baker and Wurgler (2004), and Polk and Sapienza (2009) test for Catering and find clear empirical support.

In reality a great deal of investment is managed by professional money managers, so it is not at all clear that the typical firm manager is more financially sophisticated than the typical investor. Suppose therefore, that contrary to usual Catering Theory, both the firm manager and the investor are rational. The manager is maximizing the market value of the firm which depends on investor demand for equity. How will the firm decisions from what we might call rational Catering Theory compare to the predictions of the usual behavioral Catering Theory? To answer this a suitable rational model is needed.

The setup of our model is designed to include those elements necessary to carry out the main tests used in the Catering theory literature. Our model is not intended as a complete model of the corporation. The purpose is to determine whether the behavioral predictions are similar to, or different from a basic rational model. The literature has focused on Catering predictions for corporate investment, equity issuance, and dividend policy. Accordingly, in the model there is an investor who picks consumption, net equity purchases, and bank account deposits each period. There is a firm that picks dividend payments, net equity issues, and investment each period. Equity pricing depends, as usual, on the investor's intertemporal marginal rate of substitution.

The treatment of dividends is more developed than is common in the investment literature. In our model the firm selects both dividends and net equity repurchases. These are not defined to be the same thing. We need this distinction to carry out the standard Catering tests. There is also an empirical justification for making this distinction. If dividends were the same thing as negative equity issuance, there ought to be a very strong negative correlation between dividends and net equity. Empirically the correlation is quite close to zero (-0.03).

It should also be stressed that in our model consumption is not generally equal to dividends. While consumption is partly supported by dividends; share repurchases and interest on the bank account also matter. Because the firm will normally issue or repurchase shares in response to shocks, the market value of equity (price per share times the number of shares) is not a constant multiple of the price per share. They can easily move in opposite directions with the market value of the firm increasing while the price per share falls – or vice versa.

Our paper has three stages. The first stage is to calibrate the model parameters to match some basic unconditional moments generated by the model with the corresponding moments in real data. We find that a reasonably parameterized version of the model produces unconditional moments that are generally similar to those estimated using real data. So the model does seem to capture some key aspects of actual corporate and investor decisions. In particular, the 'lagged investment effect' of Eberly, Rebelo, and Vincent (2012), the famous 'dividend smoothing' of Lintner (1956), and the above-mentioned imperfect negative correlation between dividends and net equity issuance are all present.

The second stage is to use the model generated data to carry out empirical tests that have been used in previous studies as evidence for behavioral Catering theory. These tests are based on the work of Baker, Stein, and Wurgler (2003), Baker and Wurgler (2004), and Polk and Sapienza (2009). We first use real data to carry out the same tests as used in previous studies. We find the same pattern of estimated coefficients as found in previous studies. Next the model generated data is used to carry out the same tests. The same pattern of estimated coefficients is found. So these empirical tests are not able to distinguish between behavioral and rational interpretations.

The third stage is to carry out further empirical tests of the relative merits of the two perspectives. To do this we observe that the studies of behavioral Catering Theory use somewhat unusual methods to define equity market mispricing. They use high market-to-book and future stock returns to measure mispricing. But in the asset pricing literature, the market-to-book is often interpreted as a rational factor. Furthermore, the use of future stock returns as an explanatory variable is problematic in that it is not within the decision maker's true information set. So both of these measures have problems. What is more, neither of these are the commonly used measures of equity mispricing within the rest of the behavioral finance literature. Therefore a natural idea is to examine more conventional measures of equity market mispricing from the rest of the behavioral finance literature, to see if the Catering results survive.

Three measures of equity mispricing seem particularly prominent in the behavioral literature. Following Shiller (2015) it is commonly thought that boom periods are times of excessively high stock prices. Baker and Wurgler (2006) have a well known sentiment index which takes into account a number of factors. Stambaugh and Yuan (2015) provide stock specific measures of mispricing. All three of these offer plausible alternative approaches to measuring market mispricing grounded in the behavioral literature. Of course, according to the rational model there is no stock market mispricing to start with.

We use these three measures of mispricing, one at a time, in otherwise conventional Catering tests. The cross-sectional coefficient pattern predicted by behavioral Catering is not observed in the data for any of these three measures. In fact, the wrong sign is quite common in tests based on these more conventional behavioral definitions. These tests are not readily carried out on the model data because in the model these measures are not well defined within the model.

These three stages of results motivate closer attention to the driving mechanism in the rational model. to do this, consider a firm that has a positive shock to productivity. The usual corporate finance intuition says that this firm will increase investment to take advantage of the shock. The firm's stock price will jump to reflect the benefits from improved productivity at the firm. While this intuition seems reasonable and familiar, in the model this intuition is not complete.

When there is a positive productivity shock, marginal Q increases, and the firm will invest more to take advantage. In order to do this the firm needs extra resources to invest. The extra resources can come from cutting dividend payments to investors and/or by issuing net new shares to investors. In the short run less resources are moving from the firm to the investor, and more resources are flowing in the other direction. In the long run, the flow reverses. In the short run Q increases and then in the long run it gradually returns to the steady state value. But the impact of a shock on the price of a share is very different. Using the main set of parameters, the price of a share very slowly drifts up before returning to steady state in the distant future. For some parameter values it is even possible for the share price to drop in response to a positive productivity shock.

How does all of this affect the investor? The positive productivity shock is beneficial. The investor has a fairly low intertemporal elasticity of substitution. So consumption gradually increases and it remains elevated for a very long time. In order to pay for the increased consumption, and at the same time provide more resources to the firm, money has to come from somewhere. It comes from the investor's alternative source of money which in our model is a bank account. The investor takes money out of the bank in the short run, and only several years later will the bank account be built back up as the firm starts making net payments to the investor. A key feature of the model is the flow of resources back and forth between investors and firms. These flows are determined by both investor consumption needs and corporate investment opportunities.

The rest of the paper is organized as follows. The previous literature is discussed in section 2 and particular attention is devoted to the implications of behavioral Catering Theory. Then we setup the rational model and tease out some of the implications for the impact of productivity shocks. Section 3 presents the model. The solution method and parameter choices are discussed in section 4. How shocks affect the firm and the investor is analyzed in section 5. Impulse responses are used to help show how the elements of the effects fit together into a coherent picture. Next, we describe the behavioral Catering theory predictions and then test these predictions on both real data and on model generated data. Section 6 provides extensive empirical tests of Catering Theory as developed in past studies. Each test is carried out using both real data and using data generated by the model. Empirical tests to distinguish between behavioral Catering and rational Catering are important. These are presented in section 7. The rational model has some implications for natural experiment studies. These are considered in section 8. Section 9 provides the conclusion.

2 Behavioral Catering and Related Literature

Traditional Catering Theory assumes that there is stock market mispricing, and firms are run by rational managers who seek to take advantage of the exogenous mispricing. They may take advantage by issuing equity, changing their dividend policy or by changing their investments to match the whims of investors. Baker, Stein, and Wurgler (2003) suggest that firms needing external equity will have investment that is quite sensitive to stock mispricing. They identify the equity dependent firms using the Kaplan-Zingales (KZ) index. The KZ index was developed by Lamont, Polk, and Saa-Requejo (2001) based on Kaplan and Zingales (1997). Firms are ranked into quintiles by the KZ index. Investment regressions are run for each quintile. High KZ quintile (equity dependent) firms are predicted to have particularly strong sensitivity of investment to market-to-book ratio.

In order to get at the mispricing more directly Baker, Stein, and Wurgler (2003) argue that when the stock price is too high, in addition to taking advantage right now, the manager will know that it is coming down in the future. This idea motivates the use of future realized returns as an explanatory variable. The prediction is that if the current stock price is too high, then subsequent stock returns should be negative. Accordingly the coefficient of investment on subsequent returns is negative. That coefficient is expected to be particularly strong for the high KZ firms. Finally, Baker, Stein, and Wurgler (2003) predict that high KZ firms equity issuance will be positively related to market-to-book, and negatively related to subsequent returns.

Baker and Wurgler (2004) examine the role of dividends. The demand for dividends is assumed to fluctuate for non-fundamental reasons. Firms will tend to pay dividends when the demand for dividends is particularly strong. This is measured by examining the typical market-to-book ratios for dividend paying and non-dividend paying firms. When the demand for dividends is high, firms are predicted to be more likely to initiate dividends or to increase dividends. If a lot of firms are paying large dividends (showing that the demand for dividend is excessive), then the difference in future stock returns of dividend paying and non-dividend paying stocks are predicted to be low.

Polk and Sapienza (2009) ask whether stock market mispricing affects corporate investment beyond the effect on equity issuance. This is of potential importance since stock market fluctuations affect the valuation of existing corporate equity even if the firm is not actively issuing or repurchasing shares. A great deal of corporate investment seems to take place independent of seasoned equity issuance. Accordingly they directly control for the impact of equity issuance and see whether there is a further effect of stock market mispricing on corporate investment. To measure mispricing, they use discretionary accruals, and they also consider times at which high abnormal investment firms command a stock market price premium relative to low abnormal investment firms. The basic tests are again cross-sectional tests of the connection between investment and subsequent stock returns. According to Catering Theory abnormal investment has a negative correlation with subsequent stock returns.

All three of these high-profile studies find empirical support for the Catering predictions. The fact that all three of these studies support the same perspective lends credibility to the exogenous stock market mispricing perspective that underlies the studies.

None of these papers seriously consider the possibility that there might be rational forces at work. In order to consider this requires a model of rational decisions. The standard rational investment models are not well suited since they do not flesh out the distinctions between dividends, share issuance and share repurchases. So it may have been unclear what to expect from rational decision making.

The next section provides a particularly simple rational model in which those issues can be studied and compared to the predictions from behavioral Catering Theory. Compared to traditional investment models based on Hayashi (1982), our model has a more developed treatment of dividends, share issuance and share repurchases. This is needed to consider the standard Catering tests.

Our study is related to investment based asset pricing, in the sense that we use somewhat similar modeling tools to provide a rational explanation for the cross-sectional empirical facts, which we discussed previously. However, the investment based asset pricing literature often makes assumptions about the pricing kernel or returns, rather than modeling the investor problem, see Carlson, Fisher, and Giammarino (2004), Zhang (2005), Belo (2010), Belo, Lin, and Yang (2014), and Clementi and Palazzo (2015) among many others. Also, these models are not suited to answer questions about corporate policies, such as dividends and equity financing. So, generally, these models are not suitable for our purposes. Empirical work on investment such as Erickson and Whited (2000) and Frank and Shen (2016) also generally leaves the investor problem underdeveloped in order to focus on the firm problem. But again that precludes study of the interactions which are the heart of Catering Theory.

Our model has some similarities to Rouwenhorst (1995). He considers a model in which, like ours, the firm owns the capital. His investors supply labor to the firm, which is not considered in our model. Our investors have a bank account which is not considered in his model. He does not distinguish between dividends and net equity. As a result, some of the issues that we study cannot happen in his model. Of course, our model has nothing to say about labor income or employment. The absence of a bank account in his model means that in his model there is a fairly tight connection between consumption and investment. In our model the investor can draw down the bank account to fund both increased investment by the firm and increased consumption in response to a positive productivity shock.

Jermann and Quadrini (2011) is a study of firm decisions that shares our interest in the interplay between the household and the firm. They study the cyclical behavior of debt and labor decisions by the firm. In their model there is a negotiation process in the event of a default. In our study the firm is picking equity, dividends and investment. We leave out considerations of debt and labor since they do not figure in to the standard Catering theory tests. Of course, adding such features to our model might be an interesting topic for subsequent work.

Our paper also adds to the literature studying corporate equity policies. Bolton, Chen, and Wang (2013) study market timing incentives for investment in a rational model. They study a continuous time model with switches between normal conditions and crisis states. A key idea that they develop is the interplay between fixed costs of outside financing and the cash holding incentives of firms – neither of which are in our model. Instead, we focus on issues pertaining to the distinction between dividends and equity issuance and how these affect the tests of Catering Theory. This distinction is potentially an important contribution given the evidence on the separation of dividends and equity policies in the data that we explain in detail.

The corporate finance literature on equity finance commonly assumes that the investor is risk neutral and that the going rate of return at the bank is constant. For simplicity that constant is often set to zero, as in Lucas and McDonald (1990). The impact of market conditions on equity issuing decisions have been studied in many papers including Baker and Wurgler (2002), Huang and Ritter (2005), Covas and Haan (2011) and Frank and Goyal (2014). Bhamra, Kuehn, and Strebulaev (2010) study the impact of aggregate risk on leverage but they do not have equity market decisions. An agency theoretic model is studied by Levy and Hennessy (2007). Bond, Edmans, and Goldstein (2012) provides a helpful survey of studies that focus on the impact of information aggregation in the market and how that might have a feedback on the corporation. These are not designed to consider the potential impact of investor preferences per se on firm decisions. Thus our paper may also provide a contribution to the literature on equity financing by firms. Leary (2009) studies the impact of the introduction of Certificates of Deposit in 1961 and the Credit Crunch of 1966. Both affected the willingness of banks to lend. He provides evidence that both of these wound up having effect of corporate leverage. So the firms were adapting to investors in these instances.

Titman, Wei, and Xie (2004) examine the long term relationship between corporate investment and stock returns. They find that firms with high investment have poor benchmark adjusted subsequent stock returns. This result is particularly strong for firms with higher cash flow or less debt. These are presumably firms that are relatively unconstrained. They interpret the finding as investors under-reacting to corporate empire building rather than in terms of managerial Catering to the stock market. Similar results are found for asset growth by Cooper, Gulen, and Schill (2008).

Warusawitharana and Whited (2016) consider the impact of equity market misvaluation on corporate financing and investment. They make the somewhat unusual assumption that the firm is maximizing the value of a block of shares that are owned by investors that neither purchase shares from the firm, nor sell shares back to the firm. They find effects similar to those in previous Catering Theory studies, but the effects are of relatively modest magnitude since the firm may use cash holding as a buffer. Our model uses more traditional assumptions about the corporate objective function, and we have no exogenous misvaluation shocks. We show that market mispricing is not needed to generate the usual Catering predictions.

3 The Model: Catering to a Rational Stock Market

The economy consists of a firm, and an investor. The firm inherits leftover physical capital from last period, and the obligation in the form of number of shares it had outstanding last period. Each period the firm picks investment in physical capital, the dividends to pay on shares, and the number of shares to issue. The firm faces investment adjustment cost, dividend adjustment cost, and equity issuance cost. The investor inherits savings in the bank account, and firm shares. Each period the investor picks consumption, purchases of firm shares, and amount of wealth to put in the bank account.

At that start of period t, holdings from last time are inherited, and shocks are revealed. There is an aggregate shock to the economy denoted x_t, and a firm-specific shock denoted z_t. Both shocks affect firm production. The aggregate shock also affects the return on the bank account.

In equilibrium everyone optimizes and the decisions must be consistent. In particular the number of shares issued by the firm are also the number of shares purchased by the investor.

3.1 Investor's Problem

To describe the investor problem we use the following notation. At the start of the period t the investor has holdings of, b_t in the saving account, s_t the number of firm shares. The investor receives $s_t d_t$ dividends on share holdings and picks a consumption/investment plan for the period with three components. Consumption is denoted c_t. The net investment in firm shares is $p_t(s_{t+1} - s_t)$. The deposit of money in a bank account is given by $\frac{b_{t+1}}{1 + r_t^b}$. The investor drives utility from consumption and has a CRRA utility function $\frac{c^{1-\gamma}}{1-\gamma}$. The investor's problem is

$$\underset{\{c_{t+j},b_{t+j+1},s_{t+j+1}\}_{j=0}^{\infty}}{\text{Max}} E_t \sum_{j=0}^{\infty} \beta^j u(c_{t+j}),$$

$$\text{s.t.} \qquad c_t + s_{t+1}p_t + \frac{b_{t+1}}{1+r_t^b} = s_t(d_t + p_t) + b_t,$$

$$c_t > 0, s_{t+1} \geq 0; b_0, s_0, \text{given.}$$

The Lagrange multiplier on the investor's budget constraint is $\beta^t \lambda_t$. We denote the first derivatives with respect to the first and second argument of an arbitrary function $g(.,.)$, by $g_1(.,.)$ and $g_2(.,.)$, respectively. The investor first order conditions with respect to consumption, bank account deposits, and shareholdings are

$$\begin{aligned} (c_t) :& \lambda_t = u_1(c_t) \\ (b_{t+1}) :& \lambda_t \frac{1}{1+r_t^b} = E_t[\beta \lambda_{t+1}] \\ (s_{t+1}) :& \lambda_t p_t = E_t[\beta \lambda_{t+1}(d_{t+1} + p_{t+1})] \end{aligned} \tag{1}$$

Thus the investor problem is standard. As usual the intertemporal marginal rate of substitution is,

$$M_{t,t+j} = \beta^j \frac{\lambda_{t+j}}{\lambda_t}. \tag{2}$$

3.2 Bank

There is a bank that takes deposits and pays interest on those deposits. The return on the bank account depends on the aggregate state of the economy which is denoted x_t. The sensitivity of the bank account return to the aggregate shock is denoted ξ^b. The return on the bank account is

$$r_t^b = r_f + (e^{\xi^b x_t} - 1). \tag{3}$$

It is assumed that $r_f = \dfrac{1-\beta}{\beta} > 0$ is a constant. The innovation to the return on the bank account is $(e^{\xi^b x_t} - 1)$.

It is worth stressing that our modeling of the bank means that this is a partial equilibrium model. To endogenize the bank would require extra structure and assumptions.[1] The aggregate productivity, e^{x_t}, follows the AR(1) process and

$$x_t = \rho_x x_{t-1} + \varepsilon_t^x, \text{ where } \varepsilon_t^x \sim N(0, \sigma_x^2). \tag{4}$$

The key feature of the bank account is that the return is exogenous and it fluctuates with the state of the economy.[2]

3.3 Firm's Problem

The firm's problem is,

$$\begin{aligned}
&\underset{\{d_{t+j}, s_{t+j+1}, k_{t+j+1}, i_{t+j}\}_{j=0}^{\infty}}{\text{Max}} E_t \sum_{j=0}^{\infty} M_{t,t+j}(s_{t+j} d_{t+j} + (s_{t+j} - s_{t+j+1}) p_{t+j}) \\
&\text{s.t.} \qquad s_t d_t + i_t + \phi^d + \phi^i + \phi^s \\
&\qquad\qquad = (1-\tau) f(x_t, z_t, k_t) + \tau \delta k_t + (s_{t+1} - s_t) p_t \\
&\qquad\qquad k_{t+1} = (1-\delta) k_t + i_t \\
&\qquad\qquad s_{t+1} \geq 0, d_t \geq 0; k_0, \ s_0, \ d_0 \text{ given.}
\end{aligned}$$

The firm maximizes the present value of the payments to shareholders (dividends plus net share repurchases). The firm starts the period with s_t shares outstanding, inherits k_t in capital from last period, and observes the value of the aggregate shock x_t, and the firm specific shock z_t. The price of a share is p_t. Each period the firm picks dividends d_t, net shares to issue $(s_{t+1} - s_t)$, capital k_t, and investment i_t. Capital depreciates at rate δ. There are adjustment costs on dividends ϕ^d, investment ϕ^i, and issuing net equity ϕ^s. The firm has a Cobb-Douglas profit function $f(x_t, z_t, k_t) = e^{x_t + z_t} k_t^{\alpha}$, and profits are taxed by the rate

[1] In a general equilibrium model one would need to solve for the equilibrium values of r_t^b.

[2] We have also considered a version of the model in which there is no bank account, but the investor has an exogenous stochastic wage income. Since the wage income is sensitive to the aggregate state, it is perhaps not surprising that this version of the model produces rather similar results. A nice feature of the bank account relative to wages is that the bank account gives the investor an ability to increase or reduce savings without buying or selling firm equity.

τ. The firm-specific productivity, e^{z_t}, follows the AR(1) process and

$$z_t = \rho_z z_{t-1} + \varepsilon_t^z, \text{ where } \varepsilon_t^z \sim N(0, \sigma_z^2) \tag{5}$$

We assume a quadratic investment adjustment cost with parameter a_i,

$$\phi^i(i_t, k_t) = \frac{a_i}{2} k_t (\frac{i_t}{k_t})^2 \tag{6}$$

The investment adjustment cost function is homogenous of degree one in (i_t, k_t) and convex in the size of adjustment (i_t), consistent with the literature on costly adjustment since Lucas (1967). As a result, the firm's problem is independent of the firm size (k_t).

It is well known that there are underwriting costs associated with issuing equity and so we assume an asymmetric equity issuance cost of the following form, with parameter a_s.

$$\phi^s(s_t, s_{t+1}, p_t) = a_s p_t (s_{t+1} - s_t) \ \mathbb{1}\{s_{t+1} - s_t > 0\} \tag{7}$$

Thus the equity adjustment cost is a function of the total value of raised equity, $p_t(s_{t+1} - s_t)$, and whether the firm is issuing new shares, $\mathbb{1}\{s_{t+1} - s_t > 0\}$. The firm incurs cost only for issuing new shares and not for repurchasing shares. Empirical evidence of the importance of underwriting costs is provided by Altınkılıç and Hansen (2000).

Following Jermann and Quadrini (2011) there is an adjustment cost for changing the dividend level. We assume an asymmetric linear dividend adjustment cost function[3], with parameter a_d.

$$\phi^d(d_{t-1}, d_t, s_t) = a_d s_t (d_{t-1} - d_t) \ \mathbb{1}\{d_t - d_{t-1} < 0\} \tag{8}$$

This cost is a function of total value of dividend adjustment, $s_t(d_{t-1} - d_t)$, and is only incurred if the firm is reducing its dividend per share, $\mathbb{1}\{d_t - d_{t-1} < 0\}$.

Dividend adjustment cost is a way of capturing firm's dividend smoothing behavior, one of the most well documented facts in the finance literature. Lintner (1956) showed that

[3] A version that assumes quadratic dividend adjustment cost was also considered. The qualitative results for tests of Catering theory go through. However with quadratic adjustment costs on dividends it is very hard to match the dividend moments. So, while the results do not depend on the functional form we chose for dividend adjustment costs, the data seems to be more similar to the main model rather than quadratic.

firms are primarily concerned with the stability of dividends. In addition, event studies (Benartzi, Michaely, and Thaler, 1997), and survey evidence (Brav, Graham, Harvey, and Michaely, 2005) provide evidence suggesting that changing dividends has an asymmetric effect on firms. Theoretical agency-based models of Allen, Bernardo, and Welch (2000), DeAngelo and DeAngelo (2007), and Lambrecht and Myers (2012) show that the dividend smoothing behavior could derive from a rational model of the world with various agency frictions[4]. However, the explicit modeling of the agency problem is beyond the scope our paper.

Because there is a representative investor, all shares must be held by this investor. Accordingly the changes in ownership by the investor must match the share issuance/repurchase policy of the firm.[5] The end of period value of the firm for the new owner, is equal to the expected discounted value of next period's cash flows. A more detailed discussion of the objective function is provided in the Appendix B.

The first order conditions of the firm's problem are:

$$
\begin{aligned}
(d_t) :& \phi_2^d(d_{t-1}, d_t, s_t) = E_t\Big[M_{t,t+1}(-\phi_1^d(d_t, d_{t+1}, s_{t+1}))\Big] \\
(s_{t+1}) :& \phi_2^s(s_t, s_{t+1}, p_t) = E_t\Big[M_{t,t+1}(-\phi_1^s(s_{t+1}, s_{t+2}, p_{t+1}) - \phi_3^d(d_t, d_{t+1}, s_{t+1}))\Big] \\
(i_t) :& Q_t = 1 + \phi_1^i(i_t, k_t) \\
(k_{t+1}) :& Q_t = E_t\Big[M_{t,t+1}\big((1-\tau)f_3(x_{t+1}, z_{t+1}, k_{t+1}) + \tau\delta - \phi_2^i(i_{t+1}, k_{t+1}) + (1-\delta)Q_{t+1}\big)\Big]
\end{aligned}
$$

The first order conditions for dividends (d_t) and for net share issuance (s_{t+1}) are both determined by balancing the current period marginal adjustment cost against the (appropriately discounted) future marginal adjustment cost. These are not fully symmetric. In the firm's objective function both dividend payments and capital gains matter. Both of these depend on s_{t+j}. So there are two adjustment cost terms that affect the choice of s_t. But

[4]Information asymmetry models have also been used to explain dividend smoothing, e.g. Fudenberg and Tirole (1995) and DeMarzo and Sannikov (2008). However, empirical evidence by Leary and Michaely (2011) and Michaely and Roberts (2012) on the profile of firms that smooth more is not consistent with the predictions of the asymmetric information models. These cross sectional evidence is primarily consistent with agency models' predictions.

[5]In a heterogeneous investor model, a firm could sell new shares to a new investor while old shareholders hold their shares. In that case the problem is a bit more complex. Warusawitharana and Whited (2016) deal with this by making the stark assumption that the firm cares about the shareholders who neither buy nor sell their shares.

dividends only affects one of these terms, and so the first order condition for d_t has only one marginal adjustment cost term.

The first order conditions for investment and capital are quite natural given the literature, for example see Miao (2014). The condition for investment says that Q equals 1 plus the marginal adjustment cost. The condition for next period capital says that Q must also be equal to the (appropriately discounted) after tax value of the marginal product (f_3), with a tax depreciation benefit. It also must factor in the marginal cost of adjusting investment (ϕ_2^i), and the effect on future Q.

3.4 Equilibrium

The firm's state variables are given by the vector $SF_t = [x_t, z_t, k_t, s_t, d_t]$. The investor's vector of state variables is $SI_t = [s_t, b_t]$.

A market equilibrium consists of sequences of $\{c_t, b_{t+1}, s_{t+1}, d_t, i_t, k_{t+1}; p_t, r_t^b\}$ such that the investor's and the firm's problems are solved and the markets for firm shares clears.

3.5 Model Mechanism to Create the Cross-Sectional Patterns

This section clarifies the mechanism whereby the model generates the patterns, discussed in section 2, in particular, the stronger sensitivity of investment/equity issuance to market prices for equity dependent firms.

In the model, firms have three ways of raising capital for investment purposes. First, using internal cash flows; second, cutting dividends; and third, issuing new shares. Define an equity dependent firm as a firm with low levels of cash flow and dividends. Therefore, by definition, the equity dependent firm must primarily rely on equity issuance to fund its investments.

Cost of issuing new shares, in our model, consists of two type of costs. First, the direct cost, i.e. the flotation cost that is captured by the equity issuance cost function $\phi^s(s_t, s_{t+1}, p_t)$. Second, the indirect cost that is the additional dividends that the firm must pay next period on the new shares. Note that the indirect cost exists only if there is a dividend adjustment cost.[6] If a firm issues new shares today to raise additional capital, at one extreme, if it cannot reduce its dividend per share (infinite dividend adjustment cost), it must pay larger total dividend next period because of the additional dividends paid per new share, so it incurs the indirect cost of lower financial flexibility next period. On the other extreme, If there is no dividend adjustment cost, the firm can freely adjust its dividend per share next period to keep the total dividend constant, thus there is no indirect cost.

The direct cost, i.e. equity issuance cost, is only a function of total value of raised equity and does not depend on the price or the number of new shares. The indirect cost, however, depends on the number of new shares, because the larger the number of new shares, the larger the additional dividend it has to pay to those shares. Therefore, to raise a particular value of equity, the indirect cost is decreasing in the price of shares. This is because with higher the share price, a smaller number of shares need to be issued to raise the target value of equity. So, generally, the total cost of issuing new shares in decreasing in price, since the direct cost does not depend on price and the indirect cost is decreasing in price.

The average cost of capital for equity independent firms, i.e. firms with abundant cash flows and large dividends, does not depend strongly on cost of issuing new shares because equity issuance is not their main way of raising capital. However, for equity dependent firms, the average cost of capital is strongly and negatively related to stock prices, because their primary way of raising capital is equity issuance. Thus, higher stock prices corresponds to lower cost of capital, which is in turn associated with higher investment rates. Therefore, the model predicts that equity dependent firms should have a higher sensitivity of investment/equity issuance for market prices.

4 Model Parameters

Due to the large number of state variables, solving the model using value function iteration methods is not attractive. The model is solved using a second order perturbation method around the steady state. Details of adapting the model to be solved with this method and

[6] Even though existence of the dividend adjustment cost is necessary for the indirect cost to exist, it is not restricted to take a particular functional form. In other words, as long as there exists a dividend adjustment cost of any form, the firm incurs the indirect cost on issuing new shares.

characterizing equations are provided in Appendix C.

Table 1 provides the baseline parameters. The model is solved and calibrated to match moments at the annual frequency. Most of the parameters are consistent with previous studies. We set the coefficient of relative risk aversion (γ) to 3 and so the intertemporal elasticity of substitution is 1/3. This parameter is the source of considerable debate. Our choice means that the investor is relatively reluctant to substitute consumption across time periods. The investor's discount factor (β) is set to be 0.96 to match the average risk free rate in the model, i.e. the interest on bank deposits, to the average of 3-month T-bill rates over the sample period. The corporate tax rate is set to 25%.

The technology parameters were selected based on the following moments. The depreciation rate (δ) is pinned down to match the mean of investment rate, with higher rates of depreciation corresponding to higher investment rates. The curvature of the profit function (α) influences the standard deviation of investment, and the average profitability. As α decreases, the firm faces more severe decreasing return to scale, which results in being more conservative in responding to shocks, i.e. less investment volatility, and to lower average profitability. Choosing the adjustment cost parameters is rather straightforward. Standard deviation of investment is used to pin down the investment adjustment cost parameter (a_i). Conditional mean of equity issuance and repurchases are used to set equity issuance cost parameters (a_s and cs[7]). Finally the mean and standard deviation of dividend rate is used to choose dividend adjustment cost parameters (a_d and cd).

To choose the parameters of the stochastic processes, we use the aggregate moments too. The standard deviation and autocorrelation of profitability are related to both aggregate and firm-level productivity parameters (ρ_x, σ_x and ρ_z, σ_z). However, the aggregate productivity parameters are also related to the aggregate moments, in particular, the ratio of consumption volatility to profits volatility and the correlation between consumption and profits. The ratio of consumption volatility to profits volatility is also informative about the sensitivity of the bank interest rate to the aggregate shock (ξ_b). The aggregate moments, and firm level profitability moments are jointly used to set stochastic processes' parameters.

Table 2 provides a number of moments both for the real data and for the model generated

[7]Parameters cs and cd are explained in detail in Appendix C.

data using the parameters set out in Table 1. Details of generating simulated data from the model and sources of real data is explained in section 6. It is important to note that, other than the aforementioned moments used in picking parameters, we do not cherry-pick the rest of moments. Our set of moments in table 2 contains mean, standard deviation, autocorrelation and all pairwise correlations of all of the observable policy variables in the model.

Panel A examines consumption. The ratio of consumption volatility to profits volatility is 0.01 both in the real data and in the model generated data. The correlations among consumption, investment and cash flow are very similar in the model generated data and in the real data. Despite the much greater smoothness of consumption, it is true that consumption and profits are highly correlated. In the data that correlation is 0.60 while in the model it is 0.64. So the relationship between investor consumption and firm actions are fairly similar in the model and in real data.

Panel B examine firm level data. In each case the mean, standard deviation, and the autocorrelation is provided. The investment to capital ratio is 0.10 for both the real data and the model data; and the standard deviations are very close to each other. According to Eberly, Rebelo, and Vincent (2012) the best predictor of current period is last period investment. This implies a strong autocorrelation for investment. Empirically we see that the autocorrelation of investment is 0.24 for real firms. In the model we get a slightly stronger value of 0.27. Since the strong autocorrelation of investment is an important empirical feature, it is reassuring that this effect is strongly present in the model generated data.

Corporate cash flow to capital ratio is 0.14 both in the real data and the model data. There is more variation in the real data (0.09) than there is in the model data (0.02). There is also a stronger autocorrelation in the real data than in the model generated data.

The ratio of dividends to capital is fairly small both for real firms (0.02) and for model generated firms (0.04). A key aspect of the literature on dividends going back to Lintner (1956) is the fact that firms seem reluctant to cut dividends and prefer to keep them smooth and gradually increasing. Empirically we see this quite strongly reflected in the fact that the autocorrelation coefficient is 0.70. The model also produces strong dividend smoothing and the corresponding coefficient is 0.74.

Equity issuance and equity repurchases are fairly similar in the model and in the real data. The key difference is that these are much more highly autocorrelated in the model generated data than they are in the real data. In many models of capital structure decisions it is assumed that there are fixed costs of adjusting leverage. Equity is of course part of the leverage ratio. In our model there are no fixed issuance or repurchase costs. Introduction of nontrivial fixed costs would, of course, reduce the autocorrelation.

The bottom of table 2 provides a number of firm level correlations. While these are broadly similar in the model and in real data, there are also important differences. Investment is more highly correlated with cash flow in our model than it is in real data.[8] The correlation between investment and the change in equity is 0.20 both in the model generated data and in the real data.

In the real data the correlation of profits with dividends is 0.27 while in the model it is -0.06. This is perhaps the largest failing of the model. In the real world it is well known that larger firms pay more dividends than do smaller firms. Large firms also are also more prone to smooth dividend payments than are smaller firms. The interpretation of this fact is not entirely settled, and our analysis does not resolve it either.[9] The correlation between dividends to capital and change in equity to capital is -0.03 in real data and -0.14 in the model generated data. This is an important feature of the model to generate the imperfect (close to zero) negative correlation between dividends and net equity change. All previous models in the literature define negative dividends as equity issuance (creating a strong negative correlation between dividends and equity issuance), which is clearly not plausible based on the real data.

Table 2 is informative. It suggests that despite leaving out many, presumably important aspects of firm decisions, the model does produce a number of moments that are fairly similar to real data. It also highlights places where there seems to be room for improvement.

[8] Of course, this correlation has been the source of debate in an extensive literature. We have transactions costs in our model, but we do not have 'financing constraints' in the usual sense of the term.

[9] In subsequent work we intend to examine this issue. Since it is at best tangential to the main purpose of this paper, we do not pursue it in this paper.

5 Model Mechanism

5.1 Response to Shocks

The model has both firm-specific and aggregate shocks. These shocks are quite different quantitatively, but qualitatively they are fairly similar. The firm-specific shocks have larger effects on the firm.

It should be noted that we define an aggregate shock to be a shock that affects both the bank account and the firm production function. However, we have a representative firm model. So the investor cannot avoid shocks to the firm production function by holding many such firms. In this sense both of our shocks are really aggregate shocks. To allow for many heterogenous firms would be of real interest, but might not add much to our primary goal of interpreting the empirical tests of Catering theory reported in the literature.

To understand how the firm responds to a shock it is helpful to examine a firm that starts in steady state and then is hit by a one standard deviation positive shock. Figure 1a show the effect of an aggregate shock that hits the firm at date 1. This is for the parameters listed in Table 1. A negative shock produces responses that are mirror images of the positive shock responses.

When there is a positive shock the economy is more productive and the investor is better off. Because the intertemporal elasticity of substitution is low (1/3), the investor wants to start consuming more right away.[10] The higher consumption is then maintained for a very extended period of time. In order to pay for the consumption the investor needs to get money, and at each date that can come either from the bank account or from the firm.

Because the firm is temporarily more productive (marginal Q is high) it makes sense to have high investment initially. This means that the firm acquires a large capital stock and has high profits.

In order for the firm to undertake the investment, the firm needs resources. It gets these resources partly by cutting the dividends that are paid to the investor, and partly by selling more shares to the investor. Both of these have the effect of leaving more money in the firm

[10] This effect is also found in Rouwenhorst (1995). However since he does not develop the distinction between equity repurchases and dividends, the dividend implications are quite different from ours.

in the short run.

The net payout from the firm is negative for the first few years. Eventually the firm uses the enhanced capital stock to generate a positive net payout. The share price drifts up fairly gradually as the future net payouts come closer in time to the present.

How does the investor manage to both consume more, and at the same time, transfer more resources to the firm? The money must come from somewhere. In our model this cash is coming by the investor leaving less money in the bank. So it makes sense that the bank account falls for the first few years.[11]

The firm-specific shock examined in figure 1b produce very similar patterns of responses albeit with larger magnitudes.

Figure 2 considers an alternative situation. All the parameters are the same as in figure 1a except for the cost of equity issuance ($cs = 2$). Equity issuance is now more convex. This has similar effects to the main case for consumption and for corporate investment. But it produces a very different pattern of firm financial behavior.

With large equity issuance being more expensive, the firm issues new shares much more slowly. In order to still get money from the investor this means that the firm must cut dividends much more sharply and for a longer period of time. There is a more extended period with negative net payout by the firm. Accordingly the market value of the share actually turns negative for a few years in response to the positive productivity shock.[12]

5.2 Impact of Adjustment Costs

The model includes adjustment costs on investment, dividends, and share issuance. In this section we consider their impact on the moments of the model. To what extent does the model mechanism hinge on these functions?

To Be Completed

[11]Of course, one could think of other closely related setups in which there are other places from which the investor can draw down resources. For instance, we examined a model in which the investor has exogenous wage income. That model behaves quite similarly. Another possibility would be to give the investor access to other financial assets. Qualitatively such setups are likely to generate similar behavior.

[12]The fact that the investor is injecting resources into the firm at the same time that the firm has a falling market value might seem odd. Of course, this serves to build up the stock of capital in the firm which will be used in later years to support consumption.

6 Catering Tests on Real Data and Model Data

6.1 Data

To generate the model generated sample, we start by simulating the model for 4000 firms, each for 500 years. Firms are ex ante identical and their differences only come from their exposure to different histories of firm-level productivity shocks. In the simulation when capital or number of shares hits zero for the first time, we eliminate that firm from the sample forever. We dispose the first 470 periods and only keep the last 30 periods of the simulations to ensure that the tests are run on a stationary sample and also match the average firm age in the cleaned real data sample (30 years). Among the remaining firms in the simulation, we randomly select 1000 of them and these firms will be our sample of firms for one simulation. We repeat this process for 100 times to create our main simulated sample. All numbers corresponding to the model in all tables are the average of the target values across these 100 simulations.

The real data is from standard sources. The risk-free rate is the 3 month Treasury bill rate. Consumption is "Personal consumption expenditures (PCE)" from the Bureau of Economic Analysis. It includes expenditures on non-durable goods and services, and excludes durable goods.

The firm data is from Compustat between 1970 and 2015. Firms are dropped if they have fewer than 20 consecutive years of available data, and if the shares outstanding or the total assets were recorded as negative or as missing. Financial firms (SIC 6000-6999) are also dropped from the sample. The following data items were winsorized at 1% and 99%: total assets (AT), property plant and equipment ($PPENT$), operating income before depreciation ($OIBDP$), investment (I), total dividends (Div), and equity finance (ΔEq).

Table 3 provides summary statistics for both samples. Panel A provides the information based on 2716 real firms. They have an average of just under 30 years of data. Panel B reports the average of target values across 100 simulations, each with 1000 firms and 30 years of simulated data.

Most of the descriptive statistics are fairly similar in Panels A and B. The average investment to capital ratio is 0.09 in real data and 0.10 in model generated data. Equity issuance to capital is 0.03 in real data on average and 0.01 in model generated data.

Probably the most important difference between real data and model generated is that the real world variables generally have higher standard deviations than do model generated data. This is particularly true for equity issuance where fixed costs may be of importance in reality, but absent from our model.

6.2 Investment Tests

Table 4 summarizes the results for all investment regressions in the style of Baker, Stein, and Wurgler (2003) and Polk and Sapienza (2009). The full tables of all tests are available in the online appendix. The top panel provides the tests using real data. The bottom panel provides the tests using data generated by simulating the model.

In all of the tests, following the original catering tests, we use the Kaplan-Zingales (KZ) index as the equity dependence measure. The KZ index as developed by Lamont, Polk, and Saa-Requejo (2001) is

$$KZ_{it} = -1.002\frac{CF_{it}}{K_{it}} - 39.368\frac{D_{it}}{K_{it}} - 1.315\frac{C_{it}}{K_{it}} + 3.139LEV_{it} + 0.283Q_{it} \tag{9}$$

where K_{it} is total assets, CF_{it} is cash flow, D_{it} is total dividends, C_{it} is cash balance, LEV_{it} is financial leverage, and Q_{it} is Tobin's q of firm i at time t. In the original catering tests, Q_{it} was dropped in the tests to avoid econometric issues in regressions on Q_{it} and a 4-factor KZ index was used. Since we do not have cash balance and debt in our model, there is no counterpart for these variables in the simulated data. So to carry out the tests, we create the KZ index only based on the first two elements, $\frac{CF_{it}}{K_{it}}$ and $\frac{D_{it}}{K_{it}}$. To make sure that we do not radically change the tests, we compare the results of all the tests, using real data, for the 4-factor and 2-factor KZ indexes and results are very similar.

To run the tests we need to sort firms into quintiles of KZ index, i.e. equity dependence. To sort the firms, we closely follow Baker, Stein, and Wurgler (2003), first we calculate the median value of KZ index for each firm in the sample, and then sort firms, at each year, into 5 groups based on this measure. The first quintile (Lowest KZ, or L) consists of equity independent firms and the fifth quintile (Highest KZ, or H) consists of the most equity dependent firms.

Consider the first row in table 4, panel A which is based on Baker, Stein, and Wurgler (2003). The tests are traditional regressions that explain investment using the market-to-book ratio and cash flow as explanatory variables, as in equation 10. In the following regression α_i and β_t are the firm fixed effect and year dummy, respectively.

$$\frac{I_{it}}{K_{it}} = \alpha_i + \beta_t + \gamma MktBk_{it} + \theta \frac{CF_{it}}{K_{it}} + \varepsilon_{it} \tag{10}$$

In the table, only the γ coefficients are shown. In the first column all data is used. Next firms are sorted into KZ quintiles and the same regression is run separately for each group. To save on space, only the lowest and the highest and the difference of two columns are shown in the tables. The key prediction from Baker, Stein, and Wurgler (2003) is that the coefficient on market-to-book in the higher KZ quintiles should be greater than in the lower quintiles. This is observed. In the final column the difference between the highest and lowest quintiles is constructed and the test statistic of the hypothesis that it is different from zero is presented. It is statistically significant.

The corresponding results for model generated data are provided in the first row of table 4, panel B. As in the real data there are positive and significant coefficients on both market-to-book and on cash flow. When sorted according to the KZ index we get the same pattern of increasing coefficients in the higher KZ quintiles. As in the real data, with the model generated data the difference between the highest and lowest quintiles is positive and statistically significant. This basic test of Catering theory in the style of Baker, Stein, and Wurgler (2003) does produce the predicted sign pattern in real data, but the same pattern also emerges from the model generated data.

The second row of table 4, panel A provides a Catering test based on Polk and Sapienza (2009) on the real data. They were motivated to show that Catering emerges even after controlling for equity issuance. So equity issuance is not the full Catering story. Accordingly they added controls for equity issuance to the investment regressions, as in equation 11.

$$\frac{I_{it}}{K_{it}} = \alpha_i + \beta_t + \gamma MktBk_{it} + \theta \frac{CF_{it}}{K_{it}} + \eta \frac{EqIssue_{it}}{K_{it}} + \varepsilon_{it} \tag{11}$$

The coefficient magnitudes are a bit different from the first row, but the same key pattern across the KZ quintiles emerges. In the final column we see that the difference between the top and bottom KZ quintiles is the same as under the Baker, Stein, and Wurgler (2003) style test. This result strengthens Catering as a robust feature of the data.

The second row of table 4, panel B carries out the corresponding tests using model generated data. Once again a positive and increasing coefficient on market-to-book is observed as we move from lower KZ quintiles to higher quintiles. Thus this test of Catering Theory in the style of Polk and Sapienza (2009) does produce the predicted coefficient pattern with real data. Once again the same pattern is observed in data generated by the model.

Rows 3 and 4 both panels of table 4 carries out similar tests to previous ones but instead of using market-to-book as the crucial variable it uses future stock returns. The idea is that if the investment is being driven by stock market overvaluation then there will be a negative relationship between future stock returns and current investment. This effect ought to be particularly strong for high KZ quintile firms. As for the previous case, rows 3 and 4 of panel A carry out the test using real data while the bottom rows of panel B carry out the corresponding tests using model generated data. In the third row of panel A the predicted negative sign on $R_{t,t+3}$ is observed and, as expected, it is stronger in the highest KZ quintile. However the difference is only statistically significant at the 0.10 level. So this is not such a strong effect in the real data. In the third row of panel B when the same test is carried out with model generated data the same pattern emerges more clearly and the difference across quintiles is more clear cut. In forth rows of panels A and B following Polk and Sapienza (2009) we again add equity issuance as an extra control variable. This has the effect of strengthening the pattern across the KZ quintiles for real data. The difference is now statistically significant at the 0.05 level. Once again the predicted pattern is also observed in the model generated data. Once again the statistical significance is stronger in the model data. The overall conclusion is that the investment regressions considered in table 4 support Catering theory, but do not distinguish between behavioral and rational interpretations.

6.3 Equity Issuance Tests

Baker, Stein, and Wurgler (2003) examined the ability of market-to-book to explain equity issuance, as a direct test of the equity issuance Catering channel. Equation 12 characterizes this test.

$$\frac{EqIssue_{it}}{K_{it}} = \alpha_i + \beta_t + \gamma MktBk_{it} + \theta \frac{CF_{it}}{K_{it}} + \varepsilon_{it} \tag{12}$$

The idea is that for equity dependent firms market-to-book should have a positive and particularly strong ability to predict equity issuance. The same logic applies if we replace market-to-book with future returns. But in the case of future returns, equity issuance negatively predicts future returns and the relation is particularly strong for equity dependent firms. This is studied in table 5. In this case also Panel A is for real data while panel B is for data generated by the model, and only the γ coefficients are reported. It is shown in the first row of each panel, that as predicted, for the top KZ quintile the coefficient on market-to-book is positive and larger than for the bottom KZ index quintile. The pattern is monotonic increasing across the quintiles. So high market to book firms are more likely to issue equity as predicted by Catering Theory.

The second rows of both panels show the results for equity issuance relation to future returns. For both the real data and the simulated data, the coefficient on future returns is negative and stronger for high KZ values. Similar to the investment tests, the overall conclusion is that these patterns in sensitivity of equity issuance to market prices across different groups of firms can also be generated from a rational setting, therefore is not able to distinguish between the behavioral and rational approaches.

6.4 Dividend Tests

When the stock market place a premium on dividend paying firms, then firms will tend to start paying dividends and also increase their dividends according to Baker and Wurgler (2004). In table 6 this idea is tested using real data in Panel A, and on model simulated data in Panel B.

Under the behavioral Catering hypothesis dividend premium positively predicts the fraction of firms that will increase their dividends next period. Dividend premium is defined as the difference of log of market-to-book ratios of dividend paying and non-dividend paying stocks. In our model, a firm can choose its dividend arbitrarily close to zero but it never pays absolute zero dividend. To replicate the test, at each year, we sort firms into two groups based on total dividend to assets ratio. Then we calculate the dividend premium as follows,

$$P_t^{HD-LD} = log(M\bar{kt}Bk_t^{HD}) - log(M\bar{kt}Bk_t^{LD}) \tag{13}$$

Where $M\bar{kt}Bk_t^{HD}$ is the average of market-to-book ratio for high dividend paying group at time t, and $M\bar{kt}Bk_t^{LD}$ is the average of market-to-book ratio for low dividend paying group at time t. Using this measure, we run the time series regression in equation 14.

$$DivInc_t = \alpha P_{t-1}^{HD-LD} + \varepsilon_t \tag{14}$$

The dependent variable in Baker and Wurgler (2004) is the fraction of firms that initiate dividends at a particular period. Because of the same reason that firms in the model do not pay absolute zero dividends, we modify this variable to $DivInc_t$, which is the fraction of firms, at time t, that have increased their total dividend to assets since $t-1$.

α is reported in the first column of table 6. Using real data the coefficient is 0.325 and strongly significant, as predicted. Using model generated data the coefficient is 0.409, but not statistically significant. So this feature of the data is relatively weak in our model.

Under the behavioral Catering hypothesis dividend increases ought to be followed by negative dividend return premiums. Dividend increase is proxied by $DivInc_t$, which we defined above. Future dividend return premium, $R_{t,t+3}^{HD-LD}$, is defined by the difference in future returns of high dividend paying and low dividend paying groups of firms. In this case, we run the test in equation 15.

$$R_{t,t+3}^{HD-LD} = \beta DivInc_t + \varepsilon_t \tag{15}$$

β coefficients are reported in the last four columns of table 6. To ensure about the results, we also change the dependent variable to one-year future returns and repeat the same test. As can be seen in Panel A, this does show up strongly and significantly in the real data over the next three years. This same basic pattern is obtained in Panel B when model generated data issued. Again for the next three years the coefficient on DivInc is negative and statistically significant.

The overall results in Table 6 suggest that the basic predicted effects in Dividend Tests are not all that different in the model and in the real data. Given how challenging it has been for the finance literature to develop a satisfactory account of corporate dividend policy, these results are reassuring that the model does seem to be useful.

7 Distinguishing Rational and Behavioral Catering

Both behavioral Catering theory and the rational model produce the same coefficient patterns. How do we tell them apart? To do that, recall the underlying behavioral idea. Periods during which the stock market is overvalued are the times that the equity dependent firms invest most and issue equity most. So a key step is to identify the periods of stock market overvaluation. Past Catering Theory tests used high market-to-book and realized subsequent returns, to measure overvaluation. But in the rational model those same patterns of coefficients are predicted, so those approaches to identifying overvaluation are not sufficient. Furthermore, those are not standard methods of identifying market overvaluation even within the behavioral literature.

How then to identify stock market overvaluation? Three measures seem particularly prominent. First, in popular discussions and in more serious works such as Shiller (2015), it is common to identify periods during which the economy is booming, $Boom_t$, as periods of stock market overvaluation. This suggests comparing the behavior of equity dependent firms during booms. We construct the annual measure $Boom_t$ using the NBER business cycles and following the method in Guvenen, Ozkan, and Song (2012).

Second, Baker and Wurgler (2006) have developed an index of investor sentiment, $Sent_t$, which they used to study stock returns. This suggests comparing the behavior of equity dependent firms during high sentiment periods.

Third, Stambaugh and Yuan (2015) provide a firm-specific measure of mispricing, $Misp_{it}$, based on many known anomalies in the asset pricing literature. This measure is an updated and modified version of a previously constructed measure of mispricing by Stambaugh, Yu, and Yuan (2015).

In each of the three cases the key question is whether the equity dependent firms are more prone to invest (or issue equity) during the overvaluation period. To test this hypothesis we run the regressions in equations 16 and 17.

$$\frac{I_{it}}{K_{it}} \text{ or } \frac{EqIssue_{it}}{K_{it}} = \alpha_i + \beta_t + \omega X_t + \gamma MktBk_{it} + \theta \frac{CF_{it}}{K_{it}} + \varepsilon_{it} \tag{16}$$

$$\frac{I_{it}}{K_{it}} \text{ or } \frac{EqIssue_{it}}{K_{it}} = \alpha_i + \beta_t + \omega X_t + \gamma R_{it,t+3} + \theta \frac{CF_{it}}{K_{it}} + \varepsilon_{it} \tag{17}$$

In each test, X_t is replaced by one of the three alternatives introduced earlier – $Boom_t$, $Sent_t$, and $Misp_{it}$ – and the tests are run for each KZ group.

Table 7 summarizes the results for all specifications by reporting ω coefficients. The first two columns specify the test. Next the ω coefficient is reported for the lowest KZ quintile (L), for the highest KZ quintile (H), and for the difference of the two (H-L). The last column shows the behavioral Catering predicted sign for (H-L), which is uniformly a prediction that the coefficient is positive. The positive sign means that for equity dependent firms investment/equity issuance is more sensitive to market-to-book/future returns, when there is more mispricing.

Results of the tests in table 7 are not consistent with the prediction of the behavioral approach. The cross-sectional coefficient pattern predicted by behavioral Catering is not observed in the data for any of these three measures.

8 Some Implications for Natural Experiments

Natural experiments are widely used in corporate finance. Hennessy and Strebulaev (2015) have stressed that natural experiments, like other empirical methods, do not avoid the impact of the underlying data generating structure. If the expectations turn out to have been mistaken then the interpretation of the natural experiment can also be seriously wrong. Random assignment does not resolve the problem.

With this in mind, suppose that we wish to run a natural experiment using data generated by our model. Suppose that we have correctly identified the moment of the naturally occurring shocks. Would we correctly interpret the impact of the shock? In part this hinges on how rapidly the firm responds to the shock on the dimension under study. If expectations are roughly correct and there is a strong and rapid response, the method is likely to work. If there is a small initial impact or a lengthy adjustment period over a number of years, then the natural experiment is unlikely to pick up the impact. In our model, the firm-specific shocks have stronger impacts on the firm than aggregate shocks. So firm-specific shocks are more likely to be identifiable than aggregate shocks, even though both are in the model.

Some firm actions happen rapidly in our model, while others happen very slowly. We observe rapid responses to productivity shocks in consumption, Q, profits, investment, and almost as rapidly in the capital stock. For these effects it seems plausible to imagine that they could be correctly identified in a natural experiment that correctly knew when the shock was taking place.

The dividend response to a productivity shock is very slow moving. Initially dividends per share drop, and it takes 10 periods for them to return to where they were initially. But after the 10 periods they continue to rise for a very long time as the firm is return resources gradually to the investor. It seems very hard to imagine that a natural experiment or an event study could pick up the impact of a productivity shock on dividends.

The response of the number of shares is also very slow moving, although it is not quite as complex. Initially the number of shares increases, and then it drops back to steady state. Depending on exactly what parameters are used, it generally takes about 80 periods for the number of shares to reach a peak, and as many periods again to return to steady state. Again, it seems quite implausible to imagine that such an effect could be picked up in a natural experiment study.

9 Conclusion

When the stock market is booming, some firms react by issuing equity or by investing more than usual. When the stock market seems to be paying a premium for high dividend firms, some firms react by initiating dividend payments or by increasing those payments. This is called Catering to the investors and the evidence that it actually happens, as identified in certain tests, has been interpreted as evidence for behavioral finance. However, the possibility that the test evidence might reflect rational behavior is not generally taken seriously in such studies. This may have been due to the fact that the available rational models were not well structured to consider the problem.

In this paper we provide a simple rational model with the necessary elements to carry out the Catering tests on model generated data. When we do the tests the same pattern of coefficients is found on the model generated data as is found when testing real data. So these tests do not distinguish between a behavioral perspective and a rational perspective.

The previous tests of Catering theory used somewhat unusual approaches to identify stock market mispricing. Accordingly we also carried out standard tests of Catering theory using measures of stock market mispricing that seem to be conventional in the behavioral finance literature. We considered boom periods, periods of high sentiment, and a direct measure of individual stock mispricing. When each of these three measures are used within the usual Catering tests, the behavioral predictions fail entirely. Coefficients frequently have the wrong sign or they are statistically insignificant. From a rational perspective this is reassuring since in the rational model there is no stock market mispricing to start with.

Firms do appear to act as if the care about their investors. As they should. When money is particularly valuable inside the firm, money tends to flow from the investor to the firm. When money is relatively less valuable inside the firm, it tends to flow back to the investors. It does seem reasonable to call this Catering to the investor, and it emerges naturally as equilibrium responses to changing conditions.

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A Appendix: Variable Definition

We construct firm-level variables as follows. Item names refer to Compustat data items.

- C: Aggregate consumption is the sum of real value of consumption expenditures on Nondurable goods and on services. Consumption data is from Bureau of Economic Analysis.

- K: Capital stock is total assets in the beginning of each period, that is lagged value of AT.

- I: Total investment is net of capital expenditure, acquisitions and sales of properties $(CAPX + AQC - SPPE)$.

- CF: Cash flow (or profits) is operating income before depreciation $(OIBDP)$.

- Div: Total dividend is $max(DVC, 0)$.

- $EqIssue$: Equity issuance is $max(SSTK, 0)$.

- $EqRep$: Equity repurchase is $-1 \times max(PRSTKC, 0)$.

- ΔEq: Net change in equity (aggregation of the above two variables) is $max(SSTK, 0) - max(PRSTKC, 0)$.

- $MktBk$: Market to book ratio is market value of assets $(PRCC\_F \times L.CSHO + L.AT - max(SEQ, 0) - TXDB)$ divided by book value of assets $(L.AT)$. Note that to calculate beginning of period market value, lagged values of number of shares outstanding and total assets must be used.

- $R_{t,t+3}$: Future return is the cumulative return over the next three years $(F3.PRCC\_F - PRCC\_F)/PRCC\_F$.

- $DivInc$: Fraction of firms that increase their total dividend in a given year is calculated by counting the number of firms that have increased their dividend rate from the previous year $(Div/K - L.Div/K > 0)$ and dividing that by the total number of firms in the dataset in that year.

- P^{HD-LD}: Dividend premium is difference between market prices of high-dividend firms and low-dividend firms. We sort firms into two groups based on their dividend rate (Div/K). Then, for each group, we calculate the average market to book ratio and take the difference of logs of these averages ($log(MktBk^{avg}(HiDiv)) - log(MktBk^{avg}(LoDiv))$).

- $R^{HD-LD}_{t,t+3}$: Future dividend return premium is the difference between future returns of high-dividend firms and low-dividend firms. We sort firms into two groups based on their dividend rate (Div/K). Then, for each group, we calculate the average future returns and take the difference of these averages ($R^{avg}_{t,t+3}(HiDiv) - R^{avg}_{t,t+3}(LoDiv)$).

B Appendix: Firm's Objective Function

The firm's objective at time t is to maximize investor's wealth, $s_t d_t + s_t p_t$. However, share price at each time depends on the expected future dividends of the firm. From the investor's FOC with respect to s_{t+1}, we know:

$$s_{t+1} p_t = E_t[M_{t,t+1}(s_{t+1} d_{t+1} + s_{t+1} p_{t+1})] \tag{18}$$

To write the firm's objective function in a recursive form we start by adding and subtracting $s_{t+1} p_t$ and substituting for it from the above equation,

$$s_t d_t + s_t p_t = s_t d_t + s_t p_t - s_{t+1} p_t + s_{t+1} p_t \tag{19}$$

$$= s_t d_t + (s_t - s_{t+1}) p_t + E_t[M_{t,t+1}(s_{t+1} d_{t+1} + s_{t+1} p_{t+1})] \tag{20}$$

Note that equation (20) has an actual interpretation. That is the resale value for the current shareholders ($s_t p_t$), is equal to the value of shares at the end of the period ($E_t[M_{t,t+1}(s_{t+1} d_{t+1} + s_{t+1} p_{t+1})]$), net of the amount the new shareholder pay to/receive from the firm as a result of share issuance/repurchase ($(s_t - s_{t+1}) p_t$).

If we repeat this procedure to substitute for $s_{t+1}p_{t+1}$ in equation (20), we have:

$$\begin{aligned} s_t d_t + s_t p_t &= s_t d_t + (s_t - s_{t+1})p_t \\ &\quad + E_t[M_{t,t+1}(s_{t+1}d_{t+1} + (s_{t+1} - s_{t+2})p_{t+1} + \\ &\quad E_{t+1}[M_{t+1,t+2}(s_{t+2}d_{t+2} + s_{t+2}p_{t+2})])] \\ &= s_t d_t + (s_t - s_{t+1})p_t + E_t[M_{t,t+1}(s_{t+1}d_{t+1} + (s_{t+1} - s_{t+2})p_{t+1}] \\ &\quad + E_t[M_{t,t+2}(s_{t+2}d_{t+2} + s_{t+2}p_{t+2})])] \end{aligned} \tag{21}$$

If we keep repeating this process, we can write the firm's objective function in the following recursive form:

$$s_t d_t + s_t p_t = E_t \sum_{j=0}^{\infty} M_{t,t+j}(s_{t+j}d_{t+j} + (s_{t+j} - s_{t+j+1})p_{t+j}) \tag{22}$$

C Appendix: Model Solution

Solving the model with perturbation methods requires it to behave smoothly, i.e. no kinks, around the steady state so that the characterizing equations are differentiable around this point. In the model there are inequality constraints, due to the non-negativity conditions and indicator functions in the adjustment costs, that makes the model nondifferentiable. Therefore, to characterize the model with first order conditions and use the perturbation method, we need to replace these non-smooth conditions with smooth approximations. In particular, we replace non-negativity constraints with penalty functions, and replace indicator functions with its analytical approximation.

The penalty function takes the general form of

$$\Psi(w) = e^{-\psi w}, \tag{23}$$

where w is an arbitrary model variable and the penalty parameter, ψ, takes a large value, say 10000. Replacing the non-negativity constraints with penalty functions, the investor problem becomes,

$$\begin{aligned} \underset{\{c_{t+j}, b_{t+j+1}, s_{t+j+1}\}_{j=0}^{\infty}}{\text{Max}} \quad & E_t \sum_{j=0}^{\infty} \beta^j (u(c_{t+j}) - \Psi(c_{t+j}) - \Psi(s_{t+j+1})) \\ \text{s.t.} \quad & c_t + s_{t+1} p_t + \frac{b_{t+1}}{1 + r_t^b} = s_t(d_t + p_t) + b_t \\ & b_0 \text{ and } s_0 \text{ given.} \end{aligned} \tag{24}$$

Therefore, the investor first order conditions with respect to consumption, bank account, and share holdings are modified as follows,

$$\begin{aligned} (c_t): \quad & \lambda_t = u_1(c_t) - \Psi_1(c_t) \\ (b_{t+1}): \quad & \lambda_t \frac{1}{1 + r_t^b} = E_t[\beta \lambda_{t+1}] \\ (s_{t+1}): \quad & \Psi_1(s_{t+1}) + \lambda_t p_t = E_t[\beta \lambda_{t+1}(d_{t+1} + p_{t+1})] \end{aligned} \tag{25}$$

Notice that the derivative of penalty function shows up in the first order conditions for c_t and s_{t+1}. Apart from the penalty function the investor first order conditions are standard.

The indicator functions in the dividend adjustment cost and equity issuance cost functions impose kinks at the steady state, and need to be smoothed. Therefore, we replace the indicator functions with a smooth approximation of the indicator, that is

$$\mathbb{1}\{w > 0\} \approx \frac{0.01}{0.01 + exp(-c \times w)} \tag{26}$$

where w is an arbitrary model variable and $c > 0$ is a constants. Note that using the above approximation function adds a parameter (c) to the problem.[13] This parameter controls the curvature of the approximation function.

Replacing indicator functions and non-negativity constraints makes the firm's problem

[13] When using the indicator approximation function for equity issuance cost we denote this parameter by cs. In the case of dividend adjustment cost function the parameter is cd.

differentiable. The modified firm's problem becomes,

$$\begin{aligned}
\underset{\{d_{t+j},s_{t+j+1},k_{t+j+1},i_{t+j}\}_{j=0}^{\infty}}{\text{Max}} \quad & E_t \sum_{j=0}^{\infty} M_{t,t+j}(s_{t+j}d_{t+j} + (s_{t+j} - s_{t+j+1})p_{t+j} - \Psi(s_{t+j+1}) - \Psi(d_{t+j})) \\
\text{s.t.} \quad & s_t d_t + \phi^d + s_t p_t + i_t + \phi^i \\
& \quad = (1-\tau)f(x_t, z_t, k_t) + \tau\delta k_t + s_{t+1}p_t - \phi^s \\
& k_{t+1} = (1-\delta)k_t + i_t \\
& k_0,\ s_0,\ d_0 \text{ given.}
\end{aligned} \tag{27}$$

The Lagrangian multiplier on the law of motion for capital is $\beta^t Q_t$. The firm's modified first order conditions for dividends, shares outstanding, investment, and capital are given by,

$$\begin{aligned}
(d_t): \quad & \phi_2^d(d_{t-1}, d_t, s_t) + \Psi_1(d_t) = E_t\Big[M_{t,t+1}(-\phi_1^d(d_t, d_{t+1}, s_{t+1}))\Big] \\
(s_{t+1}): \quad & \phi_2^s(s_t, s_{t+1}, p_t) + \Psi_1(s_{t+1}) = E_t\Big[M_{t,t+1}(-\phi_1^s(s_{t+1}, s_{t+2}, p_{t+1}) - \phi_3^d(d_t, d_{t+1}, s_{t+1}))\Big] \\
(i_t): \quad & Q_t = 1 + \phi_1^i(i_t, k_t) \\
(k_{t+1}): \quad & Q_t + \Psi_1(k_{t+1}) = \\
& E_t\Big[M_{t,t+1}\big((1-\tau)f_3(x_{t+1}, z_{t+1}, k_{t+1}) + \tau\delta - \phi_2^i(i_{t+1}, k_{t+1}) + (1-\delta)Q_{t+1}\big)\Big]
\end{aligned}$$

Table 1: Parameter Choices

This table reports the parameter choices for the model. The model is calibrated to match annual macro and firm level data.

Parameter	Symbol	Value
PREFERENCES		
Relative risk aversion	γ	3
Discount factor	β	0.96
TECHNOLOGY: GENERAL		
Capital share in production function	α	0.65
Capital depreciation rate	δ	0.10
TECHNOLOGY: COST FUNCTIONS		
Capital adjustment cost parameter	a_i	0.08
Dividend adjustment cost linear parameter	a_d	0.25
Stock issuance cost linear parameter	a_s	0.06
Dividend adjustment cost indicator approximation parameter	cd	2500
Stock issuance cost indicator approximation parameter	cs	0.05
STOCHASTIC PROCESSES		
Persistence coefficient of aggregate productivity	ρ_x	0.75
Conditional volatility of aggregate productivity	σ_x	0.03
Persistence coefficient of firm-specific productivity	ρ_z	0.70
Conditional volatility of firm-specific productivity	σ_z	0.10
Sensitivity of interest rate on bank savings to aggregate productivity	ξ_b	0.003
OTHER		
Tax rate	τ	25%
Penalty function parameter	ψ	10000

Table 2: Sample Moments

This table presents the selected aggregate (panel A) and firm-level (panel B) moments of the model and the real data. The real data are from Bureau of Economic Analysis and CRSP/Compustat merged database and the sample period is from 1970 to 2015. Financial firms (SIC code between 6000 and 6999) and firms with less than 20 consecutive years of data in the dataset are dropped. Firms were also dropped if the shares outstanding or the total assets were recorded as negative or as missing. All variables are winsorized at 1% level on each tail every year. In panel A, investment and cash flows are deflated by the consumer price index (CPI) before aggregation so that they are in real terms. Aggregate moments are consumption volatility to cash flow volatility ($SD(C)/SD(CF)$), and the correlations among consumption (C), investment (I) and cash flows (CF). In panel B, firm-level moments include mean, standard deviation, autocorrelation, and all pairwise correlations of investment rate (I/K), profitability (CF/K), dividend rate (Div/K), equity issuance ($EqIssue/K$), and equity repurchase ($EqRep/K$). The model-implied moments are the mean value of the corresponding moments across 100 simulations, each with 1,000 firms and 30 annual observations for each firm that matches the average life of a firm in the cleaned real data. See the appendix for variable details.

	Data				Model			
Panel A. Aggregate moments								
Ratios:								
$SD(C)/SD(CF)$	0.01				0.01			
Correlations:								
	(a)	(b)	(c)		(a)	(b)	(c)	
(a) C	1				1			
(b) I	0.22	1			0.31	1		
(c) CF	0.60	0.51	1		0.64	0.54	1	
Panel B. Firm level moments								
Ratios:								
	Mean	SD	AC(1)		Mean	SD	AC(1)	
I/K	0.10	0.08	0.24		0.10	0.07	0.27	
CF/K	0.14	0.09	0.61		0.14	0.02	0.36	
Div/K	0.02	0.01	0.70		0.04	0.01	0.74	
$EqIssue/K$	0.03	0.07	0.12		0.01	0.00	0.53	
$EqRep/K$	-0.01	0.02	0.22		-0.01	0.00	0.66	
Correlations:								
	(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)
(a) I/K	1				1			
(b) CF/K	0.32	1			0.86	1		
(c) Div/K	0.11	0.27	1		0.21	-0.06	1	
(d) $\Delta Eq/K$	0.20	0.06	-0.03	1	0.20	0.24	-0.14	1

Table 3: Summary Statistics

This table presents the summary statistics for the main variables used in the tests, both for the real data (panel A) and for the simulated data from the model (panel B). The real data are from CRSP/Compustat merged database and the sample period is from 1970 to 2015. Financial firms (SIC code between 6000 and 6999) and firms with less than 20 consecutive years of data in the dataset are dropped. Firms were also dropped if the shares outstanding or the total assets were recorded as negative or as missing. All variables are winsorized at 1% level on each tail every year. The simulated data from the model are the mean value of the corresponding variable across 100 simulations, each with 1,000 firms and 30 annual observations for each firm that matches the average life of a firm in the cleaned real data. See the appendix for variable details.

	Obs.	Mean	SD	p25	Median	p75
PANEL A. DATA						
I/K	77,578	0.09	0.11	0.03	0.06	0.12
$EqIssue/K$	78,698	0.03	0.12	0.00	0.00	0.01
$MktBk$	74,884	1.63	1.34	0.94	1.20	1.78
$R_{t,t+3}$	72,276	0.34	1.25	-0.30	0.06	0.55
CF/K	78,469	0.14	0.14	0.09	0.14	0.21
Div/K	78,698	0.02	0.02	0.00	0.01	0.02
KZ Index	78,469	-0.71	0.87	-1.08	-0.44	-0.13
$DivInc$	45	0.34	0.14	0.27	0.32	0.38
P^{HD-LD}	45	-0.07	0.16	-0.18	-0.10	0.01
$R^{HD-LD}_{t,t+3}$	42	-0.36	0.30	-0.59	-0.27	-0.16
Number of firms: 2716				Average years: 29.97		
PANEL B. MODEL						
I/K	29,000	0.10	0.08	0.05	0.10	0.15
$EqIssue/K$	29,000	0.01	0.01	0.00	0.00	0.01
$MktBk$	29,000	1.15	0.58	0.73	1.04	1.48
$R_{t,t+3}$	27,000	0.12	0.01	0.12	0.13	0.13
CF/K	29,000	0.14	0.02	0.13	0.14	0.15
Div/K	29,000	0.05	0.02	0.03	0.04	0.06
KZ Index	30,000	-2.04	0.97	-2.55	-1.85	-1.35
$DivInc$	29	0.52	0.15	0.42	0.50	0.59
P^{HD-LD}	29	0.83	0.01	0.82	0.83	0.84
$R^{HD-LD}_{t,t+3}$	27	-0.01	0.01	-0.01	0.00	0.00
Number of firms: 1000 ($\times$ 100 simulations)				Average years: 30		

Table 4: Investment Tests: Data vs. Model

This table summarizes results of the investment tests for the real data (panel A) and for the simulated data from the model (panel B). The first two rows on each panel show investment (I/K) sensitivity to market prices ($MktBk$) when we run the regressions in equations 13 and 14. The second two rows on each panel show investment (I/K) sensitivity to future returns ($R_{t,t+3}$). Column (1) shows the coefficients when all firms are pooled. Column (2) and (3) show them for the 1st and the 5th quintiles of a sort on the KZ index. Column (4) shows the difference. See the appendix for variable details. Numbers in parentheses are, in panel A, firm-clustered standard errors, and in panel B, standard errors of the means of the estimated coefficients across 100 simulations. The Z-score for the difference of coefficients (H-L) is shown in brackets. The *, **, and *** symbols denote statistical significance at 10%, 5% and 1% levels.

		(1) All	(2) L	(3) H	(4) H-L
PANEL A. DATA					
BSW STYLE	$MktBk$	0.007***	-0.004**	0.008***	0.012***
		(0.001)	(0.002)	(0.001)	[6.40]
PS STYLE	$MktBk$	0.002**	-0.005***	0.003***	0.008***
		(0.001)	(0.001)	(0.001)	[4.42]
BSW STYLE	$R_{t,t+3}$	-0.006***	-0.004***	-0.006***	-0.003*
		(0.000)	(0.001)	(0.001)	[-1.66]
PS STYLE	$R_{t,t+3}$	-0.004***	-0.002	-0.005***	-0.003**
		(0.000)	(0.001)	(0.001)	[-2.00]
PANEL B. MODEL					
BSW STYLE	$MktBk$	0.097***	0.067***	0.179***	0.112***
		(0.001)	(0.001)	(0.001)	[86.15]
PS STYLE	$MktBk$	0.095***	0.065***	0.179***	0.115***
		(0.001)	(0.001)	(0.002)	[82.21]
BSW STYLE	$R_{t,t+3}$	-0.094***	-0.053***	-0.718***	-0.666***
		(0.009)	(0.009)	(0.043)	[-15.26]
PS STYLE	$R_{t,t+3}$	-0.065***	-0.033***	-0.626***	-0.033***
		(0.006)	(0.007)	(0.038)	[-15.28]

Table 5: Equity Issuance Tests: Data vs. Model

This table summarizes results of the equity issuance tests for the real data (panel A) and for the simulated data from the model (panel B). The first row on each panel shows equity issuance ($EqIssue/K$) sensitivity to market prices ($MktBk$) when we run the regression in equation 15. The second row on each panel show equity issuance ($EqIssue/K$) sensitivity to future returns ($R_{t,t+3}$). Column (1) shows the coefficients when all firms are pooled. Column (2) and (3) show them for the 1st and the 5th quintiles of a sort on the KZ index. Column (4) shows the difference. See the appendix for variable details. Numbers in parentheses are, in panel A, firm-clustered standard errors, and in panel B, standard errors of the means of the estimated coefficients across 100 simulations. Coefficients of the first row in panel B are multiplied by 10, for easier readability. The Z-score for the difference of coefficients (H-L) is shown in brackets. The *, **, and *** symbols denote statistical significance at 10%, 5% and 1% levels.

		(1) All	(2) L	(3) H	(4) H-L
Panel A. Data					
	$MktBk$	0.032***	0.002	0.045***	0.043***
		(0.002)	(0.002)	(0.002)	[14.77]
	$R_{t,t+3}$	-0.008***	-0.005***	-0.013***	-0.008***
		(0.001)	(0.001)	(0.001)	[-5.06]
Panel B. Model					
	$MktBk$	0.008***	0.013***	0.015***	0.002*
		(0.001)	(0.001)	(0.001)	[1.71]
	$R_{t,t+3}$	-0.010***	-0.006***	-0.042***	-0.045***
		(0.002)	(0.002)	(0.004)	[-11.72]

Table 6: Dividend Tests: Data vs. Model

This table presents the results of dividend tests for the real data (panel A) and for the simulated data from the model (panel B). The first row on each panel shows the coefficient of regressing fraction of firms that increase their total dividend (*DivInc*) on lagged dividend premium ($L.P^{HD-LD}$), as in equation 17 in text. The second row on each panel shows the coefficient of regressing future dividend return premium ($R^{HD-LD}_{t,t+3}$) on fraction of firms that increase their total dividend (*DivInc*), as in equation 18 in text. We also repeat the tests for single year returns in the last three columns. Numbers in parentheses are, in panel A, firm-clustered standard errors, and in panel B, standard errors of the means of the estimated coefficients across 100 simulations. The *, **, and *** symbols denote statistical significance at 10%, 5% and 1% levels.

		Div Premium Test	Future Dividend Return Premium Test			
		DivInc	$R^{HD-LD}_{t,t+3}$	$R^{HD-LD}_{t,t+1}$	$R^{HD-LD}_{t+1,t+2}$	$R^{HD-LD}_{t+2,t+3}$
Panel A. Data						
	$L.P^{HD-LD}$	0.325***				
		(0.075)				
	DivInc		-0.868***	-0.411***	-0.407***	-0.394***
			(0.143)	(0.081)	(0.080)	(0.074)
	N	44	42	44	43	42
	adj. R^2	0.290	0.459	0.358	0.367	0.397
Panel B. Model						
	$L.P^{HD-LD}$	0.409				
		(0.306)				
	DivInc		-0.006***	-0.002***	-0.002***	-0.002***
			(0.0002)	(0.0001)	(0.0001)	(0.0001)
	N	28	26	28	27	26
	adj. R^2	0.015	0.720	0.586	0.599	0.597

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

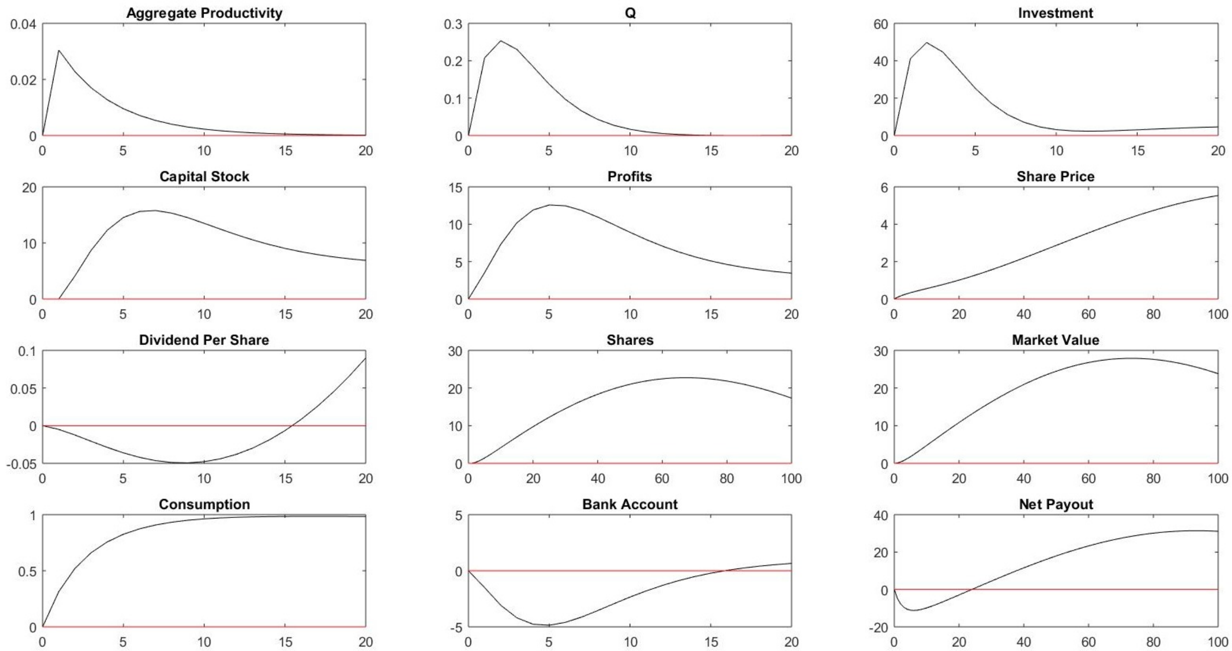
Table 7: Distinguishing Behavioral and Rational Approaches: Using Boom Periods, Sentiment and Mispricing

This table summarizes results of the distinguishing tests using boom periods (*Boom*) in panel A, sentiment (*Sent*) in panel B and firm-level mispricing (*Misp*) in panel C. Each row reports the estimated coefficients on (*Boom*)/(*Sent*)/(*Misp*) in the 1st (L) and the 5th (H) KZ quintiles and their difference (H-L), in various specifications, indicated by their regression variables in the first two columns. The first two rows on each panel report the coefficients in regressions of investment (I/K) on market prices ($MktBk$) and future returns ($R_{t,t+3}$), respectively, as in equation 19 and 20 in text. In the second two rows we change the dependent variable to equity issuance ($EqIssue/K$) and run the same tests. In all specifications we also control for cash flows (CF/K). Numbers in parentheses are firm-clustered standard errors. The Z-score for the difference of coefficients (H-L) is shown in brackets. The *, **, and *** symbols denote statistical significance at 10%, 5% and 1% levels.

Regression Variables		Coefficient on $Boom/Sent/Misp$			Predicted Sign
Dependent	Independent	L	H	H-L	Behavioral
PANEL A. BOOM					
I/K	$Boom$, $MktBk$, CF/K	0.017**	-0.015	-0.032**	+
		(0.008)	(0.011)	[-2.35]	
I/K	$Boom$, $R_{t,t+3}$, CF/K	-0.010	-0.060***	-0.050***	+
		(0.009)	(0.011)	[-3.64]	
$EqIssue/K$	$Boom$, $MktBk$, CF/K	-0.007	-0.029***	-0.022***	+
		(0.005)	(0.006)	[-3.01]	
$EqIssue/K$	$Boom$, $R_{t,t+3}$, CF/K	-0.005***	-0.005***	0.000	+
		(0.001)	(0.001)	[-0.07]	
PANEL B. SENTIMENT					
I/K	$Sent$, $MktBk$, CF/K	0.002	0.002	0.000	+
		(0.002)	(0.003)	[-0.08]	
I/K	$Sent$, $R_{t,t+3}$, CF/K	0.003	0.001	-0.003	+
		(0.002)	(0.004)	[-0.54]	
$EqIssue/K$	$Sent$, $MktBk$, CF/K	0.008***	0.010***	0.002	+
		(0.003)	(0.003)	[0.37]	
$EqIssue/K$	$Sent$, $R_{t,t+3}$, CF/K	0.008***	-0.005	-0.012***	+
		(0.003)	(0.003)	[-3.07]	
PANEL C. MISPRICING					
I/K	$Misp$, $MktBk$, CF/K	0.074***	0.069***	-0.006	+
		(0.012)	(0.015)	[-0.29]	
I/K	$Misp$, $R_{t,t+3}$, CF/K	0.069***	0.059***	-0.011	+
		(0.011)	(0.016)	[-0.54]	
$EqIssue/K$	$Misp$, $MktBk$, CF/K	0.023***	0.035***	0.012	+
		(0.006)	(0.008)	[1.24]	
$EqIssue/K$	$Misp$, $R_{t,t+3}$, CF/K	0.016***	0.034***	0.018*	+
		(0.005)	(0.009)	[1.78]	

Figure 1: Impulse Responses: Baseline Parameters

(a) Panel A. Response to Aggregate Shocks



(b) Panel B. Response to Firm-Specific Shocks

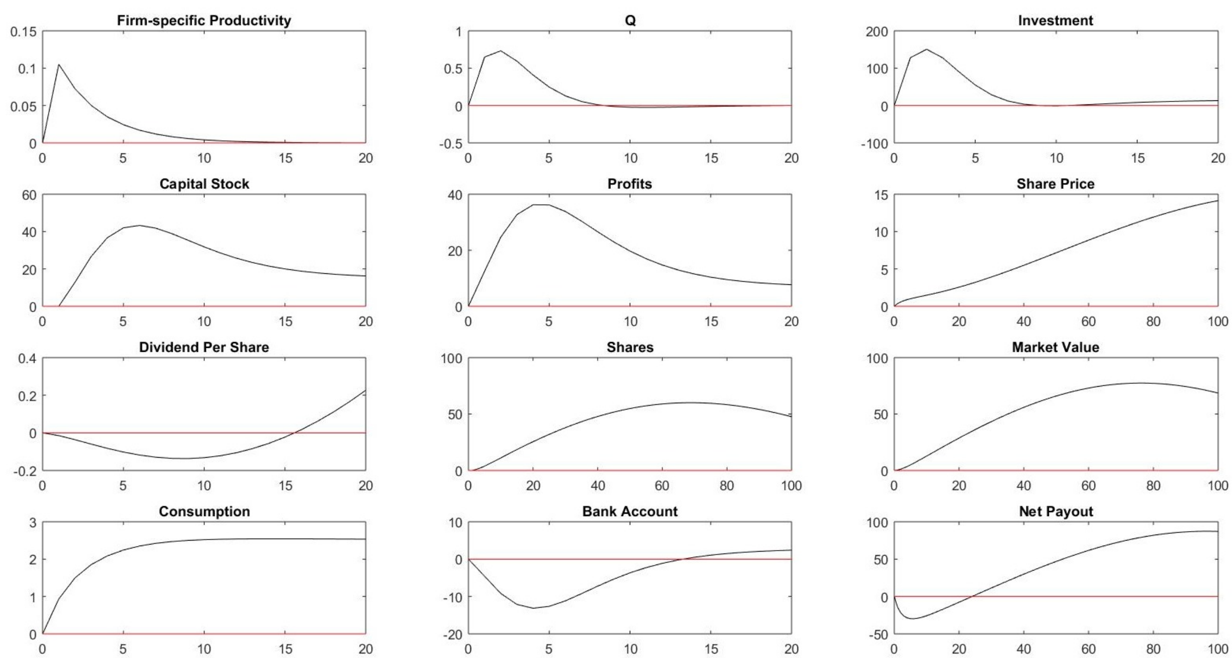


Figure 2: Impulse Responses: Response to Aggregate Shocks with a More Convex Equity Issuance Cost

This figure depicts the impulse responses to a one standard deviation aggregate productivity shock, using an alternative parameterization. The stock issuance cost indicator approximation parameter is changed to $cs = 2$, which makes the stock issuance cost more convex and the firm responses smoother. The purpose of this exercise is to underscore the effect of net payout on the dynamics of market value of the firm in response to a shock.