External Equity Financing Shocks, Financial Flows, and Asset Prices*

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Abstract

We study the impact of aggregate shocks to the cost of equity issuance on asset prices. We document that an empirical proxy of equity issuance cost shocks captures systematic risk in economy. Exposure to this shock helps price the cross section of stock returns including book-to-market, size, investment, debt growth, and issuance portfolios. We then propose a dynamic investment-based model that features an aggregate shock to the firms' cost of external equity issuance, and a collateral constraint. Our central finding is that time-varying external financing costs are important for the model to quantitatively capture the joint dynamics of firms' real quantities, financing flows, and asset prices. Furthermore, the model also replicates the failure of the unconditional CAPM in pricing the cross-sectional expected returns.

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1 Introduction

The impact of the recent financial crisis in 2007-2008 on the economy suggests that shocks in the financial sector can be an important source of business cycle fluctuations. In this paper, we study the asset pricing implications of financial shocks–that is, aggregate perturbations that originate directly in the financial sector– on asset prices in the cross section of U.S. nonfinancial publicly traded firms. Specifically, we study the joint behavior of asset prices, real quantities, and financing flows (debt and equity), in response to a particular form of financing shocks: an aggregate shock to the cost of firms' external equity financing.

We construct an empirical measure of the aggregate shock to the cost of equity issuance. Building on previous studies (e.g. Eisfeldt and Muir, 2013), we use firm-level cross sectional data to recover a proxy for this shock in the data. Specifically, we compute the fraction of U.S. firms that issue equity each year, and we extract the time-series of the innovations in this variable using a vector autoregressive (VAR) model that includes aggregate productivity as a state variable to control for the effect of demand shocks on firms' equity issuance cost and decisions. We refer to the innovations in the VAR as an (equity) issuance cost shock (ICS), which we interpret as an aggregate disturbance originated in the financial sector. A positive realization of the aggregate issuance cost shock is associated with an increase in the firms' equity issuance beyond what aggregate market conditions as captured by aggregate productivity would predict. As such, this positive realization of the aggregate issuance cost shock reveals, at least partially, a low (marginal) cost of equity issuance, and vice versa. Our measure captures the systematic (aggregate) component of issuance costs.

Our approach is consistent with the view that external equity is costly (e.g., Fazzari et al. 1988; Altinkilic and Hansen 2000), and that these costs vary over time (McLean and Zhao, 2013, and references therein).[1] The costs of external equity include both direct costs, for example, flotation costs, as well as indirect costs, for example, adverse selection costs (Myers and Majluf 1984), agency costs (Jensen and Mecklin 1976), and other costs that we discuss below. Hennessy and Whited (2007) show that the estimated marginal equity flotation costs start from 5.0% of capital for small firms and 15.1% of capital for large firms, and the indirect costs of external equity can be substantial. Bustamante (2013) estimates firms' average costs of external financing to be 12.7% of firms' capital stock. Furthermore, Erel, Julio, Kim, and Weisbach (2012) show that firms' access to external equity markets changes with macroeconomic conditions. The large size of these costs and its variation over time can have an important impact on both firms' performance, firms' investment and financing decisions. Because the

[1]For example, changes in information symmetries between firms and investors can vary over business cycles. It is natural to expect that these asymmetric information costs are higher in recessions and lower in expansions.

impact of changes in these cost affects firms differently depending on the firm's current and future needs for external funding, these shocks should affect asset prices and risk premiums in the cross section.

We document several empirical links between equity issuance cost shocks, systematic risk, and average stock returns in the cross section. We show that the ICS is a source of systematic risk. Controlling for the aggregate market factor, we document that firms' exposure to ICS helps explain cross sectional variation in the average returns of portfolios sorted by book-to-market, investment, size, debt growth, and equity issuance. In addition, we document that investors require a higher risk premium for holding assets that are more positively exposed to the ICS (that is, assets that do poorly when it is more costly to issue equity). Augmenting the standard capital asset pricing model (CAPM) with ICS shocks, we show that the two-factor model significantly outperforms the CAPM in pricing the cross section of stock returns of several portfolios sorts.

To understand the economic mechanism driving the empirical findings, we propose a dynamic investment-based model that captures the quantitative effects of equity issuance cost shocks on real quantities, financing flows, and asset prices of nonfinancial firms. The key features of the model are: (i) an aggregate disturbance in the cost of equity issuance; and (ii) a (standard) collateral constraint, which restricts the amount of debt that firms can issue. The collateral constraint captures the fact that lenders typically impose a constraint requiring that the fire sale value of capital be sufficient to pay off the loan. The issuance cost shocks represent the stochastic changes that affect the (marginal) cost of equity issuance of firms. In the model, the issuance cost shock acts as a source of aggregate economic fluctuations that is independent of aggregate productivity shocks, and it affects investor's marginal utility (positive price of risk), consistent with the empirical evidence. That is, the initial disruption is assumed to arise in the financial sector of the economy with no initial disruptions in the nonfinancial sector, which is the sector of the economy that we model here.[2] After a negative issuance cost shock caused by a disruption in the financial sector, fewer funds can be channeled from equity holders to firms. This leads to insufficient external financing available to firms; as a result, firms cut investment which in turn affects firms' dividends and market value of equity.

The variation in expected stock returns in the cross section arise endogenously in the model due to the interaction between firm productivity, investment, equity issuance cost shocks, and the collateral constraint. The economic mechanism emphasizes that the firms' ability (or inability) to substitute between different marginal sources of external financing during

[2]Most of the existing literature in macroeconomics has focussed on the amplification mechanism generated by financial frictions (Bernanke and Gertler 1989, Kiyotaki and Moore 1997, Bernanke, Gertler, and Gilchrist 1999). In those models, financial frictions serve to exacerbate the negative shocks from the nonfinancial sectors, but not to cause economic fluctuations.

bad economic times is an important determinant of equilibrium risk premiums. The exact underlying economic mechanism operates as follows. Firms with high idiosyncratic productivity are expanding firms with high investment demand. When a negative issuance cost shock hits the economy, it becomes more difficult for all firms in the economy to raise external equity financing because of its higher marginal cost. However, high productivity firms can still finance investment through debt because their collateral value (capital) is increasing. Thus, because high productivity firms can substitute equity financing for debt financing, the high productivity firms are still able to increase their future dividend payout and hence their continuation value still rises. As a result of their relatively high market value in periods in which it is costly to raise external equity, these firms act as a hedge against the issuance cost shocks. These firms therefore have relatively lower risk and hence lower expected returns in equilibrium.

Compared with firms with high idiosyncratic productivity, the firms with low idiosyncratic productivity are relatively more affected by the negative issuance cost shock. These firms are experiencing a decrease in their profitability, and want to downsize, and hence the capital stock of these firms is shrinking. Because their collateral value falls, and more important, equity financing is particularly costly (they would otherwise raise external equity to pay off debt if equity market is free of cost), thus low productivity firms de-leverage. Their dividend payout falls below the steady state level for a long time, and their continuation value falls. As a result of their relatively low market value in periods in which it is costly to raise external equity, these firms have a relatively high positive covariance with aggregate issuance shock and hence higher expected returns in equilibrium. In the model, high productivity firms are growth firms, investing firms, large cap firms, high debt growth firms, and high equity issuance firms, thus the model generates cross sectional return spreads in book-to-market, investment, size, debt growth, and equity issuance that are consistent with the data. To the best of our knowledge, our model is among the first to emphasize the channel that the inflexible substitution between two marginal sources of external financing generates cross sectional dispersion in firms' risk.

The model matches the aggregate-level asset pricing and quantity moments, and key properties of the firm-level investment rates, financing flows in debt and equity, and financial leverage ratios. We then show that the model successfully replicates the observed level of the value premium, the investment spread, the size premium, the debt growth return spread, and the issuance spread in the data with reasonable parameter values. Through several comparative static exercises, we show that the existence of external equity costs being driven by (priced) aggregate issuance shocks is crucial for the good quantitative fit of the model. When equity financing is cost free, the model generates a too volatile equity issuance-to-book-equity ratio (100.2% in the frictionless equity financing model versus 32% in the baseline model with equity financing costs and 35% in the data) and the value premium/investment spread/size premium/debt growth spread/equity issuance spread that are too small and even slightly negative. Similarly, when equity financing *is* costly but the costs are not driven by aggregate issuance shock (that is, are time invariant), the model implied *gross* equity issuance frequency are off by an order of magnitude compared to the data. This result is intuitive. Without external equity financing costs, firms issue more equity on the margin. Firms also take the advantage of this cost-free marginal source of financing to smooth their payouts in response to the shocks, thus significantly reducing the dispersion in risk in the cross section. On the debt financing margin, when we significantly tighten collateral constraint or increase the debt adjustment cost in presence of aggregate issuance cost shocks, all return spreads become tiny or negative. This is because when all firms have limited debt capacity, the ability of productive firms to substitute equity for debt financing to smooth negative aggregate shocks are limited. This in turn substantially reduces the risk dispersion. Taken together, the results of our analysis suggest that the time-variation in the availability of external funds can have a significant impact on asset prices in financial markets.

Notably, the model provides a novel mechanism for the value premium that is different from the existing literature. In standard investment-based asset pricing models (e.g., Zhang 2005, Cooper 2006, Belo, Lin, and Bazdresch 2014, etc), the value premium is mainly driven by operating leverage effect. Intriguingly, in the model, when we shut down the fixed operating cost, the value premium remains positive and sizeable (albeit smaller), 2.6% compared to 6.7% in the baseline model and 7.1% in the data. This is because even without fixed operating cost, the financial frictions, that is the inflexibility in adjusting the marginal sources of financing still gives rise to a sizable risk dispersion between value and growth firms, leading to the value premium.

The model also replicates the failure of the unconditional CAPM model in explaining the cross sectional variation in the expected returns of several portfolio sorts. In the model, it is the exposure to issuance cost shocks that drive the cross sectional difference in average portfolio returns, in addition to the aggregate productivity shock. In the data, using standard time-series regressions, the sensitivity of the returns of firms with different characteristics to the aggregate stock market factor (market risk) is weakly correlated with its average stock returns. As such, the CAPM generates pricing errors that are close to the return spreads themselves. The model is consistent with these asset pricing results, thus providing an explanation for the failure of the CAPM in the data. According to the model, the aggregate stock market is mostly driven by the standard aggregate productivity shock, and thus it is weakly correlated with issuance cost shocks, which are the main drivers of the return spreads in the cross section.

Related literature This paper is closely related to the literature that examines the impact of financial frictions on corporate investment, e.g., Gomes (2001), Hennessy and Whited (2005, 2007), DeMarzo, Fishman, He, and Wang (2011), Bolton, Chen, and Wang (2011), Bolton, Chen, and Yang (2013), etc. Our paper is particularly related to Bolton, Chen, and Wang (2013) who study firms' external financing decisions and payout decisions in a dynamic q-theoretic framework where external financing conditions are stochastic. In Bolton, Chen, and Wang, firms time market optimally and issue equity in good times. We differ from Bolton, Chen, and Wang in that we focus on the impact of the time varying external equity issuance cost on both asset prices and firms' financing and investment decisions.

Our work is related to the literature that studies asset prices in production economies.[3] This literature has primarily focused on aggregate shocks that originate in the real sector, e.g., aggregate productivity shocks or investment-specific shocks, or shocks on monetary and fiscal policies. For example, Jermann (1997), Zhang (2005), Kaltenbrunner and Lochstoer (2010), Favilukis and Lin (2013), etc., study the asset pricing implications of aggregate productivity shocks. Papanikolaou (2011) focuses on investment-specific shocks. Gilchrist and Leahy (2002) study the relationship between monetary policy and asset prices. Kung, Croce, Nguyen, and Schmid (2012) explore the market price of fiscal policy risk. Our paper differs in that we explore the relation between financing flows and the cross sectional variation of stock returns when firms face financial shocks to equity issuance.

The theoretical analysis is also related to the recent macroeconomic literature on the impact of financial shocks on aggregate quantities, e.g., Jermann and Quadrini (2011), Khan and Thomas (2014), etc. Different from the shocks to credit supply studied by these authors, we focus on aggregate shocks to the cost of external equity issuance and the implications for asset pricing. The financial frictions in our model are similar in spirit to Bernanke and Gertler (1989), Kiyotaki and Moore (1997), Bernanke, Gertler, and Gilchrist (1999), etc. The difference is that disturbance in the financial sector acts as a source of the business cycle fluctuations in our model (as in Jermann and Quadrini and Khan and Thomas) as opposed to propagating shocks that originate in other sectors of the economy.

Lastly, our paper also relates to the empirical corporate finance literature that explores the relations between external financing and macroeconomic conditions, e.g., Ritter (1984), Lucas and McDonald (1990), Choe, Maulis, and Nanda (1993), Erel, Julio, Kim, and Weisbach (2012), Kahle and Stulz (2013), etc. Our paper adds on to this literature by identifying an aggregate shock to external equity issuance and show that this shock has substantial impact on both of the risk premiums and financing flows.

The paper proceeds as follows. Section 2 shows the empirical links between issuance costs

[3]See, for example, Cochrane (1991, 1996), Boldrin, Christiano, and Fisher (2001), Liu, Whited, and Zhang (2009), Livdan, Sapriza, and Zhang (2009), Belo (2010), Kogan and Papanikolaou (2012), Lin (2012), Yang (2013), Belo, Lin, and Bazdresch (2014), etc.

shocks, systematic risk, and average stock returns in the data. Section 3 presents a dynamic investment-based model with collateral constraints and equity issuance cost shocks. Section 4 presents the calibration and model solution. Section 5 presents the main results. Section 6 provides a detailed analysis of the economic mechanisms driving the results. Finally, Section 7 concludes.

2 Empirical findings

In this section, we propose an empirical proxy of an aggregate measure of equity issuance cost shocks. Then, we show that this measure captures systematic risk in the economy and it is priced due to its effect on investors' marginal utility. In particular, together with the market factor, we document that firms' exposure to equity issuance cost shocks helps explain cross sectional variation in the average returns of several portfolio sorts, and that investors require a higher risk premium for holding asset that are more positively exposed to the aggregate issuance cost shocks. We also show that equity issuance cost shocks are correlated with future consumption, consistent with the hypothesis that the issuance cost shocks affect investors' marginal utility.

2.1 Data

Monthly stock returns are from the Center for Research in Security Prices (CRSP), and accounting information is from the CRSP/Compustat Merged Annual Industrial Files. The sample is from 1971 to 2011 and includes firms with common shares (shrcd=10 and 11) and firms traded on NYSE, AMEX, and NASDAQ (exchcd=$1, 2$, and 3).[4] We omit firms whose primary standard industry classification (SIC) is between 4900 and 4999 (regulated firms) or between 6000 and 6999 (financial firms). We remove observations with negative total asset or negative sale or negative book equity.

We use standard portfolios as test assets. The portfolios are 10 book-to-market portfolios, 10 investment portfolios, 10 size (market equity) portfolios, 10 debt growth portfolios, and 6 equity issuance portfolios (as in Fama and French 2008, we allocate the zero issuance portfolios to one bin and allocate the other issuance portfolios across the other five portfolios). The first three set of portfolios are standard in the literature. The last two portfolios are related to the financing side of the firm and hence constitute an interesting set of portfolios to investigate the link between the financial shocks and stock returns. The appendix explains the construction of these portfolios.

[4]Our sample ends in 2011 due to the availability of total factor productivity (TFP) in constructing equity issuance shocks. The sample starts in 1971 due to the availability of the data items required to construct net equity issuance at the firm-level (Compustat items SSTK and PRSTKC).

The stock market factor and the risk-free returns are obtained from Ken French's website. Portfolio-level quantities such as investment rate, debt growth, equity issuance, etc., are computed as the medians of all the firms in a portfolio in every given year. Utilization-adjusted total-factor productivity (TFP) is from John Fernald/Kuni Natsuki (available at John Fernald's webpage at the Federal Reserve Bank of San Francisco).[5] Portfolio returns are annualized to match the frequency of the issuance cost shocks.

2.2 Identification of aggregate equity issuance cost shocks

External equity is costly.[6] Measuring the total -direct plus indirect (unobserved)- cost of equity issuance is a difficult task because there is no available data on the indirect costs. These indirect costs include the traditional impact of asymmetric information and agency frictions on equity valuation, but also the possible effect of changes in investor sentiment, time varying aggregate liquidity, etc, on the investors' marginal willingness to supply new equity capital to firms at a given price, thus affecting how much capital firms can raise in the market at each point in time. Because the indirect costs can be substantial (Hennessy and Whited, 2007, Erel, Julio, Kim, and Weisbach, 2012, Bustamante 2013) while the direct costs are relatively small (Altinkilic and Hansen, 2000) we have to rely on a proxy variable that is correlated with the time varying issuance costs in the data in order to characterize the link between the issuance costs shocks and asset prices.

We construct a proxy of the aggregate equity issuance cost using information on the proportion of firms issuing external equity in the cross section of Compustat firms. More specifically, we define that a firm issues equity if its net equity issuance in a given year is positive. Following Eisfeldt and Muir (2013), the net equity issuance is computed as Item SSTK (sale of common and preferred stock) - Item PRSTKC (purchase of common and preferred stock) - Item DV(cash dividend) in Compustat Annual files. (When cash dividend is missing, we replace it with zero.) The time series of the percentage of firms issuing equity is constructed from 1971 to 2011. The top left panel in Figure 1 shows the time series of this series. We note that the average fraction of firms issuing equity is large, about 37%. This is because this measure includes granting of employee stock options as a form of workers compensation. Because this form of compensation is also a costly form of finance by firms, we include these observations in the main analysis.[7] Nevertheless, in the internet appendix, we show that our main results are

[5] We have also experimented with TFP without adjusting utilization. The results stay unchanged.

[6] See, for example, Jensen and Meckling (1976), Myers and Majluf (1984), Stulz (1988, 1990), Fazzari et al. (1988), Altinkilic and Hansen (2000), Erel, Julio, Kim, and Weisbach (2012), among many others.

[7] Indeed, this form of compensation is costly because if workers are risk averse, a compensation in the form of stock option is valued less by the worker than by an external investor because of lack of diversification. The differential value that the worker assigns to the stock options relative to the value assigned by outside investors

robust to excluding from this measure most of the equity issuance events that are due to the granting of employee stock options.

[Insert Figure 1 here]

By measuring the percentage of firms issuing equity in the cross section, we focus on the extensive margin (number of firms) and not so much on the intensive margin (dollar amount raised) adjustment of external equity issuance. This approach is motivated by the findings in Covas and Den Haan (2011) who show that external finance for the largest firms (especially those at the top 1% of the size distribution) is not representative of the financing behavior of the rest of the firms in the economy because their issuance is either acyclical or countercyclial, in contrast with the behavior of almost all of the other firms in Compustat, for which debt and equity issuance is procyclical. Because the dollar amount of issuance of the very large firms has an unusually large influence on the aggregate series, it completely dominates any intensive margin (that is based on dollar amount raised) measure of equity issuance activity in the economy.

To extract the innovations in the equity issuance cost proxy, which we refer to as the equity issuance cost shock (ICS), we estimate a first order vector autoregressive (VAR) model using log TFP and the percentage of firms issuing equity as the two state variables, denoted x_t and s_t, respectively. We include aggregate TFP in the VAR because it is the standard source of economic fluctuations in most macroeconomic models, and thus drives firms' demand for external funds. As such, including the TFP in the VAR allows us to control for variation in equity issuance activity that is driven by changes due to normal economic fluctuations, hence helping us to identify the equity issuance cost component of observed equity issuance waves (or contractions).

As shown in Figure 1, the fraction of firms issuing equity in the sample of Compustat firms exhibits a positive trend. As such, we first apply the one-sided Hodrick-Prescott filter (HP filter, Hodrick and Prescott, 1997) to detrend this variable, as well as the TFP variable (in level).[8][9] Then, we estimate the following VAR system using a rolling regression with an expanding window. Specifically, we first estimate the system from 1971 to 1976, and then extract the shock in 1977 using the parameters estimated in the previous (expanding) period.

is an indirect cost of issuing equity which we want to capture in our measure. See, for example, Babenko, Lemmon and Tserlukevich (2011).

[8]We use a one-sided HP filter to mitigate any look ahead bias in the asset pricing tests and aggregate consumption growth predictability results reported below.

[9]We have also tried different filters for the percentage of firms issuing equity before estimating the VAR system. The results appear to be overall robust to several different ways of filtering data. For example, using simply the growth rate of the variables as a proxy for the innovation produces similar results to those reported here.

This approach allows us to mitigate any look ahead bias in extracting the shocks (as such, all asset pricing tests are performed for the 1977 to 2011 period). The VAR system is specified as follows:

$$\begin{pmatrix} x_{t+1} \\ s_{t+1} \end{pmatrix} = A \begin{pmatrix} x_t \\ s_t \end{pmatrix} + \begin{pmatrix} u_{t+1} \\ v_{t+1} \end{pmatrix},$$

in which u_{t+1} and v_{t+1} are two normally distributed random variables with standard deviations σ_x and σ_s respectively. We use the estimated time series of v_{t+1} as our empirical measure of ICS. A high realization of ICS (v_{t+1} is high) is associated with an equity issuance wave by firms, which we interpret as driven (at least partially) by a reduction in the cost of external equity issuance, and vice versa. The variable u_{t+1} is used as the measure of TFP innovations.

For practical purposes, we interpret the ICS as an aggregate disturbance originated in the financial sector, and which affects the cost of external equity issuance of the firms in the nonfinancial sector. But its useful to interpret this issuance cost shock in a broad manner. This shock captures differences over time in the amount that firms can raise by issuing new equity (for the same amount of share issued, in some periods the firm will be able to raise more capital, and in some periods will be able to raise less, and this difference is labeled as a shock). In essence, this issuance cost shock creates a wedge between the fundamental value of the equity for managers and the value outside investors are willing to pay for equity. As discussed above, this wedge can arise due to agency frictions or asymmetric information frictions that have a systematic aggregate impact of the value investors are willing to pay for new equity. Similarly, the wedge may capture time variation in investors' willingness to supply more (less) capital to firms (for example, due to changes in investor sentiment), thus making it less (more) costly for firms to raise new capital.

Naturally, there are many different variables affecting firms' issuing decision that are not fully controlled by aggregate TFP in the VAR. We focus on this simple measure primarily because of two reasons. First, this simple approach relies on only two state variables thus allowing us to replicate the construction of these shocks inside the theoretical model below. Because in the theoretical model we observe both the true issuance cost shock and the proxy for this shock using the VAR, we can thus investigate the conditions under which the VAR shock measure proposed here is a good proxy for the true underlying shock that we are trying to infer in the data.

Second, we have experimented controlling for many other variables proposed in the literature that are important for explaining equity issuance by firms, and obtained very similar results to those obtained using this simple measure. In particular, we investigate how the results change once we control for a measure of time varying aggregate liquidity (Pastor and Stambaugh, 2003), and time varying risk premiums (using the aggregate dividend-price ratio as a control variable). In addition, the main results appear to be robust to the inclusion of other primitive macroeconomic shocks such as investment-specific shocks (Papanikolaou 2011), and credit shocks (Jermann and Quadrini, 2012), etc. We have also estimated the issuance cost shock using the market excess returns as the control instead of TFP shocks, and the main results remain unchanged. Additional robustness check includes varying the cutoff values of net issuance and trying alternative measures of equity issuance used in the literature, e.g., Loughran and Ritter (1995), Fama and French (2008), Boudoukh, Michaely, Richardson, and Roberts (2007), etc. The online appendix reports the results of these robustness checks.

2.3 Properties of issuance cost shocks

In this section we report the properties of the issuance cost shocks, and the empirical links between these shocks and systematic risk in the cross section.

2.3.1 Summary statistics

Several important estimates are reported in Table 1. The time series of the equity issuance cost shock (ICS) and TFP shock are reported in the bottom left panel in Figure 1.

[Insert Table 1 here]

The ICS is more volatile than the TFP shock. The standard deviation of the ICS is 4.7% per year, versus 1.1% for the TFP shock. In addition, the two shocks have a low contemporaneous correlation. As reported in Panel B of Table 1, the correlation of the ICS with the TFP shock is only -14%.

We also investigate the correlation between the ICS and other macroeconomic variables. The contemporaneous correlation between the ICS and aggregate output (ΔGDP), and aggregate per capita nondurables consumption (ΔC) is relatively low, 8% and 17%, respectively. Interestingly, the correlation between the ICS and a proxy of investment specific technology shocks (ISTS, measured as the real quality-adjusted investment price growth) is also low, 6%. As a result, we can conclude that the ICS captures aggregate fluctuations that are, at least partially, distinct from investment-specific technology shocks (see, for example, Papanikolaou, 2011).

2.3.2 External finance costs, systematic risk, and risk premiums

ICS captures systematic risk in the economy. In particular, firms' exposure to ICS helps understand cross sectional variation in risk premiums across several portfolio sorts. To establish this link, we investigate a two-factor model using the stock market factor (MKT) and ICS as the two factors. We also investigate the ability of the simple one factor (MKT) capital asset pricing model (CAPM), which we use as a benchmark to evaluate the performance of the two factor model.

To investigate the sensitivity of the portfolio returns of several portfolio sorts to the ICS, we run the following time series regression:

$$r^e_{it} = a_i + \beta^{\mathrm{M}}_i \times \mathrm{MKT}_t + \beta^{\mathrm{I}}_i \times \mathrm{ICS}_t + e_{it}, \tag{1}$$

in which r^e_{it} is the portfolio i excess return. This model decomposes the excess return of each portfolio i into three components: (i) the systematic risk due to exposure to the market risk ($\beta^{\mathrm{M}}_i \times \mathrm{MKT}_t$); (ii) the systematic risk due to exposure to equity issuance cost shocks ($\beta^{\mathrm{I}}_i \times \mathrm{ICS}_t$); and (iii) the idiosyncratic risk $e_{i,t}$. a_i is the constant term which can be nonzero since issuance cost shocks are not excess returns (except when testing the CAPM, in which case the MKT factor is the only factor and the regression intercept is a measure of abnormal return or pricing error). Among these three parts, i) and ii) are nondiversifiable and hence can generate risk premiums.

The extent to which different exposures to ICS translates into differences in risk premiums in the cross section depends on the impact of the ICS on investors' marginal utility. We use the generalized method of moments (GMM) to estimate the impact of ICS and TFP shock on investors marginal utility. To that end, we specify the following pricing kernel (investors' marginal utility):

$$M_t = 1 - b_{\mathrm{M}} \times \mathrm{MKT}_t - b_{\mathrm{I}} \times \mathrm{ICS}_t, \tag{2}$$

which states that investors' marginal utility is driven by the two aggregate shocks, the market, and the ICS. We then estimate the price of risk parameters (b_{M} and b_{I}) by GMM using the following standard asset pricing moment condition:

$$E_T \left[r^e_{it} \left(1 - b_{\mathrm{M}} \times \mathrm{MKT}_t - b_{\mathrm{I}} \times \mathrm{ICS}_t \right) \right] = 0. \tag{3}$$

To help in the interpretation, we can manipulate the previous pricing equation and write it as:

$$E_T \left[r^e_{it} \right] = \alpha_i + b_M \mathrm{Cov}(\mathrm{MKT}_t, r^e_{it}) + b_I \mathrm{Cov}(\mathrm{ICS}_t, r^e_{it}), \tag{4}$$

in which α_i (alpha) captures the pricing error associated portfolio i. From equation (3), this pricing error should be zero for all assets. As test assets, we use the following standard portfolio sorts: (i) ten book-to-market portfolios; (ii) ten investment-rate portfolios; (iii) ten size portfolios, (iv) ten debt growth portfolios; and (v) six equity issuance portfolios. Panel A in Table 2 reports the average returns, Sharpe ratios (average return-to-return volatility ratio), CAPM alphas (α), and CAPM and two-factor model factor loadings (implied by the estimation of equation (1)) of the high (H), low (L), and spread (H-L) portfolios in each sort. Figure 2 reports the predicted (implied from equation (4)) versus realized average returns when all portfolio sorts are pooled together in the GMM estimation of equation (3). We report the pricing errors for both the two factor model, and the CAPM (in which case b_I in equation (4) is set to zero.

[Insert Table 2 here]
[Insert Figure 2]

As reported in Panel A of Table 2, the high book-to-market portfolio (value firms, H) outperforms the low book-to-market portfolio (growth firms, L) by about 7.1% per annum. This return spread cannot be explained by CAPM as the abnormal return (α) of the high-minus-low portfolio is 7.4% per annum and is statistically significant. The two-factor model improves the fit of the CAPM in explaining the returns of these portfolios (note that in Panel A we do not report the time series intercept from the two-factor model regression because this intercept is not meaningful - the intercept does not have to be zero since the ICS factor is not an excess return). As reported in Panel B of Table 2, when the ICS factor is added to the market factor in the two-factor asset pricing model, the mean absolute pricing error decreases significantly relative to the MAE of the CAPM. The MAE of the two-factor model is only 0.8% per year, whereas the MAE of the CAPM is 1.7% per year.

To help us understand the source of the improved performance of the two-factor model relative to the CAPM in explaining the variation in the average returns of the book-to-market portfolios, the lower panels in Panel A in Table 2 report the estimates from the time-series regressions of the two-factor model. The loadings (betas) on the issuance cost shocks are increasing across the book-to-market portfolios. That is, firms with low book-to-market ratios (growth firms) load less (have a negative covariance) on the issuance cost shocks than firms with high book-to-market ratios (value firms). In addition, Panel B in Table 2 shows that the estimated price of risk (b_I) of the issuance cost shock is positive. That is, periods in which it is particularly costly to issue equity (low ICS), are periods associated with high marginal utility.

The previous results suggest a potential novel risk explanation for the value premium. The issuance cost shock is a source of systematic risk, and growth firms provide a hedge against these shocks. Controlling for the market factor, these firms tend to have relatively higher returns when the ICS is low (high equity issuance costs), which are high marginal utility states (bad economic times). Analogously, value firms are risky firms because these firms have a high exposure (high covariance) to the ICS. Controlling for the market factor, the value firms have relatively lower returns at times when the ICS is also low (bad economic times). We investigate this risk explanation, both qualitatively and quantitatively, in the theoretical model below.

The two-factor model also improves the fit of the CAPM in explaining the average returns of the ten portfolios sorted on firms' investment rate, size, debt growth, and the six portfolios sorted on equity issuance. The results are also reported in Table 2. The table show that firms with low investment rates, large size, low debt growth rates, and low equity issuance have lower average returns than firms with high investment rates, small size, high debt growth rates, and high equity issuance. Except across the size portfolios, the CAPM cannot explain the cross-sectional variation in the returns of these portfolios (large α). Adding the ICS factor substantially improves the fit of the CAPM. As reported in Panel B of Table 2, the MAE of the two-factor model is significantly lower than that of the CAPM. Figure 2 shows the pricing errors of the CAPM versus the two-factor model and shows that the pricing errors of the two-factor model are considerably smaller.

The better fit of the two-factor model relative to the CAPM on the previous portfolios follows from the fact that firms with low investment rates, small size, low debt growth, and low equity issuance (which are firms with high average returns) have significantly higher exposure (betas) to ICS. Because the price of risk of the ICS shock is estimated to be positive across all these portfolio sorts (The sign of b_I is positive and significant across all portfolios), this result suggest that these firms are risky because they provide low returns with the ICS is low, that is, when it is costly to issue equity and investors' marginal utility is high.[10]

2.3.3 External finance costs and aggregate consumption

The previous section shows that ICS is a source of systematic risk because these shocks affect investors' marginal utility of consumption. This evidence is based on asset price data. Here, we provide further support for the link between ICS and marginal utility by looking directly at the relationship between ICS and aggregate consumption. Although the correlation between ICS and contemporaneous consumption growth is relatively small (17%, see Panel B in Table 1), the correlation with future aggregate consumption can be high. With recursive preferences, (see, for example, Epstein and Zin, 1986, Bansal and Yaron, 2004), aggregate shocks that affect future consumption affect the current marginal utility of the investor, and hence they affect the pricing kernel. With this class of preferences, the exact impact of the ICS shocks on current marginal utility depends on the relative size of risk aversion and the inverse of elasticity of intertemporal substitution. When risk aversion is higher than the inverse of the intertemporal elasticity of

[10]Note that the fact that the market price of risk is estimated to be insignificant in the cross sectional tests follows from the fact that the market factor is not important for explaining cross sectional variation in average stock returns. However, it does *not* mean that the market factor is not important for asset prices. As we show in the theoretical model below, the market factor is important to get the level of the risk premium right.

substitution (as in most calibrations of the long run risk models, see Bansal and Yaron, 2004), a decrease in expected future consumption (low ICS) is associated with an increase in marginal utility, and hence with a positive price of risk for the ICS shock.

To investigate the relationship between ICS and future consumption, we run a standard predictive regression of future consumption using the lagged issuance cost shock (ICS) and TFP shock (TFPS) as the two regressors. This regression generates the following result:

$$\Delta \mathrm{C}_{t+1} = a + \underset{(1.91)}{0.07} \times \mathrm{ICS}_t + \underset{(2.66)}{0.87} \times \mathrm{TFPS}_t + e_{it}, \; R^2 = 30.1\% \tag{5}$$

in which, ΔC is the per capita real growth of nondurables consumption, the t-statistics are reported in parenthesis below the corresponding point estimate and are corrected for autocorrelations and heteroskedasticity per Newey and West (1987), with lag equal to one year, and R^2 is the regression R-squared.

The regression in equation (5) shows that the ICS forecast future consumption with a positive slope. That is, a negative innovation in the ICS (an increase in the cost of equity issuance), is associated with lower future consumption, even after controlling for the current aggregate productivity shock. If, as in standard calibrations of long run risk models, the risk aversion of the representative consumer is higher than the inverse of the intertemporal elasticity of substitution, then the positive slope on ICS implies that ICS is negatively correlated with marginal utility (marginal utility high when cost of issuance is high, that is, a low ICS), consistent with the positive price of risk of ICS estimated in the previous section using asset price data only.

2.3.4 Portfolio characteristics

The differential exposure of the firms across portfolios naturally reflects differences in the characteristics of these firms. To understand these differences, we report selected characteristics of the firms in the book-to-market, investment, size, debt growth, and issuance portfolios. The characteristics include investment rate in physical capital (IK), net equity–issuance-to-book equity ratio (Equity/BE), debt growth (ΔDebt), the frequency of debt issuance (Debt Freq.), financial leverage (LEV), and firm-level total factor productivity. The appendix gives the definition of these characteristics. We construct the time series of the characteristics for each portfolio by computing the median of the characteristics across all firms within each portfolio in any given year, and report the time series mean of each characteristics for each portfolio.

[Insert Table 6 here]

Table 6, column Data, reports the portfolio characteristics of the high minus low (H-L) portfolio. Across the book-to-market portfolios, growth (L) firms are more productive and invest more than value (H) firms. On the intensive external financing margin, growth firms issue (both debt and equity) more than value firms. At the extensive margin, growth firms also issue more frequently than value firms. Finally growth firms are less levered than value firms. In the ten investment portfolios, high investment firms are productive and issue (both debt and equity) more than value firms at both of the intensive and extensive margin. High investment firms also take less financial leverage than low investment firms. In the size portfolios, big firms are productive and invest more in capital. Big firms issue more debt but less equity than small firms. Big firms also take on less financial leverage than small firms. In the ten debt growth portfolios, high debt growth firms are more productive and issue more debt but less equity than low debt growth firms at both of the intensive and extensive margin. High debt growth firms also take slightly more financial leverage than low debt growth firms. Lastly, in the equity issuance portfolios, high equity issuance firms are more productive and invest more and take less financial leverage than low issuance firms. We use these portfolio characteristics to evaluate the theoretical model below.

3 Model

The results from the empirical section show that the equity issuance cost shocks capture systematic risk in the economy, and that these shocks are priced. In this section, we present a dynamic capital structure investment-based model to help understand the economic mechanism linking these shocks to differential firm performance and risk premiums in the cross section. We then calibrate the model to the data to evaluate the extent to which the model can quantitatively (not just qualitatively) explain the empirical links.

The model features a continuum of heterogeneous firms facing time-varying costs of issuing equity (which we interpret as an aggregate financial shock). The firms are also subject to a collateral constraint on the amount that firms can borrow. Firms choose optimal levels of physical capital investment, external equity, and debt each period to maximize the market value of equity.

3.1 Technology

Firms use physical capital (K_t) to produce a homogeneous good (Y_t). To save on notation, we omit firm index j whenever possible. The production function is given by

$$Y_t = Z_t X_t^{1-\theta} K_t^{\theta}, \tag{6}$$

where X_t represents aggregate productivity and Z_t represents firm-specific productivity. The production function exhibits decreasing returns to scale. The curvature parameter satisfies $0 < \theta < 1$ (low θ means high curvature in the production technology). Decreasing returns to scale capture the idea that firms grow by taking on more investment opportunities. Because better opportunities are taken first, an increase in productive scale causes output to increase by a smaller proportion. Alternatively, decreasing returns to scale can be motivated by limited managerial or organizational resources that result in problems of managing large, multi-unit firms such as increasing costs of coordination (e.g., Lucas 1978).

Aggregate productivity follows a random walk process with a drift

$$\Delta x_{t+1} = \mu_x + \sigma_x \varepsilon^x_{t+1}, \tag{7}$$

in which $x_{t+1} = \log(X_{t+1})$, Δ is the first-difference operator, ε^x_{t+1} is an i.i.d. standard normal shock, and μ_x and σ_x are the average growth rate and conditional volatility of aggregate productivity, respectively.

Firm-specific productivity follows the AR(1) process

$$z_{t+1} = \bar{z}(1-\rho_z) + \rho_z z_t + \sigma_z \varepsilon^z_{t+1}, \tag{8}$$

in which $z_{t+1} = \log(Z_{t+1})$, ε^z_{t+1} is an i.i.d. standard normal shock that is uncorrelated across all firms in the economy and independent of ε^x_{t+1}, and $\bar{z}$, ρ_z, and σ_z are the mean, autocorrelation, and conditional volatility of firm-specific productivity, respectively.

Physical capital accumulation is given by

$$K_{t+1} = (1-\delta)K_t + I_t, \tag{9}$$

where I_t represents investment and δ denotes the capital depreciation rate.

Following Hayashi (1982) and Zhang (2005), we assume that capital investment entails convex adjustment costs, denoted as G_t, which are given by:

$$G_t = \begin{cases} \frac{c_k^+}{2}\left(\frac{I_t}{K_t}\right)^2 K_t, & I_t \geq 0 \\ \frac{c_k^-}{2}\left(\frac{I_t}{K_t}\right)^2 K_t, & I_t < 0, \end{cases} \tag{10}$$

where c_k^+ and c_k^- determine the upward and downward speed of adjustment, respectively. The capital adjustment costs include planning and installation costs, learning the use of new equipment, or the fact that production is temporarily interrupted. For example, a factory may need to close for a few days while a capital refit is occurring. We allow the capital adjustment costs to be asymmetric to capture costly reversibility of capital, that is, the fact that reducing the capital stock may be more costly than expanding. The costly reversibility can arise because of resale losses due to transaction costs or the market for lemons phenomenon.

The firm also incurs fixed operating costs of production that are independent of firm size, which are captured by $F_t = fX_t$, with $f > 0$. We scale the fixed operating costs by aggregate productivity to allow for growth in the economy.

3.2 Collateral constraint

Firms use equity and debt to finance investment. At the beginning of time t, firms can issue an amount of debt, denoted as B_t, which must be repaid at the beginning of period $t+1$. The firm's ability to borrow is bounded by the limited enforceability as firms can default on their obligations. Following Hennessy and Whited (2005), we assume that the only asset available for liquidation is the physical capital K_{t+1}. In particular, we require that the liquidation value of capital is greater than or equal to the debt payment. It follows that the collateral constraint is given by

$$B_{t+1} \leq \varphi K_{t+1}. \tag{11}$$

The variable $0 < \varphi < 1$ affects the tightness of the collateral constraint, and therefore, the borrowing capacity of the firm. Due to collateral constraint, the interest rate, denoted by r_f, is the riskfree rate which is also constant due to the specification of the stochastic discount rate which will be discussed in section 3.4.

Firms also incur adjustment costs, denoted by Φ_t when changing the amount of debt outstanding,

$$\Phi_t = \frac{c_b}{2}\left(\frac{\Delta B_t}{B_t}\right)^2 B_t, \tag{12}$$

where $\Delta B_t = B_t - B_{t-1}$. Debt adjustment costs capture the fact that adjusting capital structure is costly. The convexity in the adjustment cost function implies a persistent debt growth process, consistent with the data. It also allows us to generate a persistent leverage process, which is also consistent with the empirical evidence (Leary and Roberts, 2005).

3.3 Costly external equity financing

Taxable corporate profits are equal to output less fixed production costs, capital depreciation and interest expenses: $Y_t - F_t - \delta K_t - r_f B_t$. It follows that the firm's budget constraint can be written as

$$E_t = (1-\tau)(Y_t - F_t) + \tau\delta K_t + \tau r_f B_t - I_t - G_t + B_{t+1} - (1+r_f)B_t - \Phi_t, \tag{13}$$

where τ is the corporate tax rate, $\tau\delta K_t$ is the depreciation tax shield and $\tau r_f B_t$ is the interest tax shield, and E_t is the firm's payout.

When the sum of investment, capital and debt adjustment costs exceed the sum of after tax operating profits and debt financing, firms can take external funds by means of seasoned equity offerings. External equity H_t is given by

$$H_t = \max\left(-E_t, 0\right). \tag{14}$$

External equity is costly. As is discussed in Hennessy and Whited (2007), the main costs of external equity involve flotation costs and adverse selection costs. For example, Altinkilic and Hansen (2000) provide detailed evidence regarding flotation costs. Myers and Majluf (1984) and Krasker (1986) show that the cost of external equity is increasing in asymmetric information in equity markets. Furthermore, changes in information symmetries between firms and investors can vary over business cycles. It is easy to imagine that these asymmetric information costs are higher in recessions and lower in expansions. We do not explicitly model asymmetric information in our model. Rather, we attempt to capture the effect of adverse selection costs and underwriting fees in a reduced-form fashion. More specifically, we parameterize the equity issuance costs as:[11]

$$\Psi\left(H_t\right) = \left(\eta_0 X_t + \eta_1 H_t\right)\exp\left[-\eta_2 \xi_t\right]\mathbf{1}_{\{H_t>0\}}, \tag{15}$$

in which ξ_t is captures the time-varying cost of external equity financing. This cost follows an AR(1) process,

$$\xi_{t+1} = \rho_\xi \xi_t + \sigma_\xi \varepsilon_{t+1}^{\xi}, \tag{16}$$

with ρ_ξ and σ_ξ are the first-order autocorrelation coefficient and conditional volatility of the ξ_{t+1} and ε_{t+1}^{ξ} is an i.i.d. standard normal shock that is independent of ε_{t+1}^{x} and ε_{t+1}^{z}.

The key feature of the formulation of external equity costs different from the existing literature is that external equity costs are subject to an aggregate disturbance independent of aggregate shocks to productivity. We interpret this shock as perturbations of external financing that are not driven by firms' capital demand originated from the real sector; rather this shock directly originates from the financial sector. More specifically, a high realization of ξ_t implies low costs of external equity financing, vice versa.

Finally, firms do not incur costs when paying dividends or repurchasing shares. The effective

[11]Note that aggregate productivity, X_t, is included because there is positive growth in the economy; this term cancels out in the stationary representation of the model. We have also experimented various formulations of equity issuance costs including a combination of fixed costs, linear costs, and convex costs. We find the simple linear cost structure works well in capturing the properties of equity issuance such as persistence and volatility.

cash flow D_t distributed to shareholders is given by

$$D_t = E_t - \Psi_t. \tag{17}$$

3.4 Firm's problem

We specify the stochastic discount factor as

$$M_{t,t+1} = \frac{1}{1+r_f} \frac{e^{-\gamma_x \Delta x_{t+1} - \gamma_\xi \Delta \xi_{t+1}}}{\mathbb{E}_t \left[e^{-\gamma_x \Delta x_{t+1} - \gamma_\xi \Delta \xi_{t+1}} \right]}, \tag{18}$$

where r_f is the risk-free rate. We discuss the sign of the price of risk parameters (γ_x and γ_ξ) in the calibration section below. The risk-free rate is set to be constant. This allows us to focus on risk premia as the main driver of the results in the model as well as to avoid parameter proliferation.

Firms solve the maximization problem by choosing capital investment and debt optimally:

$$V_t = \max_{I_t, B_{t+1}} D_t + \mathbb{E}_t[M_{t,t+1} V_{t+1}], \tag{19}$$

subject to firms' capital accumulation equation (Eq. 9), collateral constraint (Eq. 15), budget constraint (Eq. 13), and cash flow equation (Eq. 17).

3.5 Optimality conditions

Let q_t and μ_t be the Lagrangian multiplier associated Eqs. (9) and (17). The first-order conditions with respect to I_t, K_{t+1}, and B_{t+1} are, respectively,[12]

$$q_t = \left(1 + \Psi'(H_t)\mathbf{1}_{\{H_t>0\}}\right) \left[1 + \frac{\partial G_t}{\partial I_t} \right], \tag{20}$$

$$q_t - \mu_t \varphi = \mathbb{E}_t M_{t,t+1} \left\{ \left((1 + \Psi'(H_{t+1})\, \mathbf{1}_{\{H_t>0\}} \right) \left[\frac{\partial E_{t+1}}{\partial K_{t+1}} + (1-\delta) \left(1 + \frac{\partial G_{t+1}}{\partial I_{t+1}} \right) \right] \right\}, \tag{21}$$

$$\text{and } \mu_t - \mathbb{E}_t \left[M_{t,t+1} \left(1 + \Psi'(H_{t+1}) \mathbf{1}_{\{H_{t+1}>0\}} \right) \frac{\partial E_{t+1}}{\partial B_{t+1}} \right] = \left(1 + \Psi'(H_t) \mathbf{1}_{\{H_t>0\}} \right) \frac{\partial E_t}{\partial B_{t+1}}, \tag{22}$$

where $\Psi'(H_t)$ is the partial derivative of $\Psi(H_t)$ with respect to H_t and $\mathbf{1}_{\{\}}$ is the indicator function.

Eq. (20) is the optimality condition for investment that equates the marginal cost of investing in capital, $\left(1 + \Psi'(H_t)\mathbf{1}_{\{H_t>0\}}\right) \left[1 + \frac{\partial G_t}{\partial I_t} \right]$, with its marginal benefit q_t. Here q_t is

[12] These first-order conditions are taken in the differentiable regions of the relevant variables.

known as the marginal q of investment. However it differs from the standard q–theory of investment (e.g., Hayashi 1983) in that the marginal cost of investment is the marginal capital adjustment cost $\left(1+\frac{\partial G_t}{\partial I_t}\right)$ augmented by the marginal cost of issuance $\left(1+\Psi'(H_t)\mathbf{1}_{\{H_t>0\}}\right)$. When firms take external equity financing, i.e., $H_t > 0$, the marginal cost of investment is $(1+\eta_1 \exp[-\eta_2\xi_t])\left[1+\frac{\partial G_t}{\partial I_t}\right]$, larger than that implied by the standard q-theory without financial frictions, all else equal. More important, in contrast to the standard models, because marginal issuance cost depends on the fluctuations of aggregate issuance shock ξ_t, the variations of marginal cost of investment is not only driven by shocks from the real sector, e.g., aggregate productivity shocks, but by the perturbations in the financial sector as well. In particular, the marginal cost of investment is inversely related to the realization of ξ_t. When firms use retained earnings to finance investment, i.e., $H_t = 0$, marginal cost of investment reduces to that implied by the standard models since $\Psi'(H_t)\mathbf{1}_{\{H_t>0\}}$ would be zero.

Eqs. (21) and (22) are the Euler equations that describe the optimality conditions for capital and debt. Intuitively, Eq. (21) states that to generate one additional unit capital at the beginning of next period, K_{t+1}, the firm must pay the price of capital, $q_t - \mu_t\varphi$. Different from the standard model where the price of capital simply equals the marginal q of investment, here the price of capital also depends on $\mu_t\varphi$. When the collateral constraint binds, $\mu_t \geq 0$ measures the tightness of the constraint. One additional unit of capital K_{t+1} will relax the constraint and reduce the effective marginal cost of investment by $\mu_t\varphi$ where φ is the fraction of K_{t+1} that can be liquidated. The next-period marginal benefit of this additional unit of capital depends on the marginal benefit of investing in real technology $\frac{\partial E_{t+1}}{\partial K_{t+1}} + (1-\delta)\left(1+\frac{\partial G_{t+1}}{\partial I_{t+1}}\right)$ and the reduction of the future marginal cost of issuance $1+\Psi'\left(H_{t+1}\right)\mathbf{1}_{\{H_{t+1}>0\}}$ due to the increase in the retained earnings caused by one additional unit of capital K_{t+1}.

Eq. (22) states that to raise one additional unit of debt at the beginning of next period, (B_{t+1}), the firm must pay the shadow price of debt μ_t plus the next-period interest expense of repaying this additional debt net of the reduction in the marginal debt adjustment cost $-\mathbb{E}_t\left[M_{t,t+1}\left(1+\Psi'(H_{t+1})\mathbf{1}_{\{H_{t+1}>0\}}\right)\frac{\partial E_{t+1}}{\partial B_{t+1}}\right] = \mathbb{E}_t\left[M_{t,t+1}\left(1+\Psi'(H_{t+1})\mathbf{1}_{\{H_{t+1}>0\}}\right)\left((1+r_f(1-\tau)) - abs(\frac{\partial \Phi_{t+1}}{\partial B_{t+1}})\right)\right]$.[13] This marginal cost is increasing the marginal issuance cost $\Psi'(H_{t+1})\mathbf{1}_{\{H_{t+1}>0\}}$ because firms may need to take on costly external equity financing to repay the debt due next period. The marginal benefit of debt $\left(1+\Psi'(H_t)\mathbf{1}_{\{H_t>0\}}\right)\frac{\partial E_t}{\partial B_{t+1}}$ is the benefit of one additional unit of debt financing to be used in production, $\frac{\partial E_t}{\partial B_{t+1}}$, augmented by the reduction in the marginal issuance cost $\left(1+\Psi'(H_t)\mathbf{1}_{\{H_t>0\}}\right)$ due to the substitution of debt financing for equity financing at the margin.

[13]Note $\frac{\partial E_{t+1}}{\partial B_{t+1}} = -\left(1+r_f(1-\tau)\right) + abs(\frac{\partial \Phi_{t+1}}{\partial B_{t+1}})$ is mostly negative with reasonable parameter values of c_b.

3.6 Equilibrium risk and return

In the model, risk and expected stock returns are determined endogenously along with the firm's optimal investment and financing decisions. To make the link explicit, we can evaluate the value function in equation (19) at the optimum and obtain

$$V_t = D_t + \mathbb{E}_t \left[M_{t,t+1} V_{t+1}\right] \tag{23}$$

$$\Rightarrow \quad 1 = \mathbb{E}_t \left[M_{t,t+1} R^s_{t+1}\right] \tag{24}$$

in which equation (23) is the Bellman equation for the value function, and the Euler equation (24) follows from the standard formula for stock return $R^s_{t+1} = V_{t+1}/\left[V_t - D_t\right]$. Substituting the stochastic discount from Eq. (18) into Eq. (24), and some algebra, yields the following equilibrium asset pricing equation:[14]

$$\mathbb{E}_t \left[r^e_{t+1}\right] = \lambda_x \times \beta^x + \lambda_\xi \times \beta^\xi \tag{25}$$

in which $r^e_{t+1} = R^s_{t+1} - R_f$ is the stock excess return, $R_f \equiv 1 + r_f = \mathbb{E}_t \left[M_{t,t+1}\right]^{-1}$ is the gross risk-free rate, $\lambda_x = \gamma_x Var(\Delta x_{t+1})$ and $\lambda_\xi = \gamma_\xi Var(\Delta \xi_{t+1})$ are the price of risk of the aggregate productivity shock and aggregate issuance cost shock, respectively, and $\beta^x = Cov\left(r^e_{t+1}, \Delta x_{t+1}\right)/Var(\Delta x_{t+1})$ and $\beta^\xi = Cov\left(r^e_{t+1}, \Delta \xi_{t+1}\right)$ are the sensitivity (betas) of the firm's excess stock returns with respect to the two aggregate shocks in the economy.

According to equation (25), the equilibrium risk premiums in the model are determined by the endogenous covariances of the firm's excess stock returns with the two aggregate shocks (quantity of risk) and its corresponding prices of risk. The sign of the price of risk of the two aggregate shocks is determined by the two factor loading parameters (γ_x and γ_ξ) in the stochastic discount factor in Eq. (18). The pre-specified sign of the loadings imply a positive price of risk for both the aggregate productivity shock and the equity issuance cost shock. Thus, all else equal, assets with returns that have a high positive covariance with the aggregate productivity shock are risky and offer high average returns in equilibrium. Similarly, all else equal, assets with returns that have a high positive covariance with the aggregate equity issuance cost shock are risky and offer high average returns in equilibrium.

[14] This derivation is standard. Equation (24) implies $\mathbb{E}_t \left[M_{t,t+1}\left(R^s_{t+1} - R_f\right)\right] = 0$ because $\mathbb{E}_t \left[M_{t,t+1}\right] R_f = 1$. Using a first-order log-linear approximation of the SDF $M_{t,t+1}$ defined in Eq. (18), and applying the formula for covariance $Cov(X, Y) = \mathbb{E}[XY] - \mathbb{E}[X]\mathbb{E}[Y]$ to the previous equation, plus some algebra, yields equation (25).

4 Model solution

This section presents the model solution. The model is solved at a monthly frequency. Because all the firm-level accounting variables in the data are only available at an annual frequency, we time-aggregate the simulated accounting data to make the model-implied moments comparable with those in the data.

Table 3 reports the parameter values used in the baseline calibration of the model. The model is calibrated using parameter values reported in previous studies, whenever possible, or by matching the selected moments in the data reported in Table 4. To evaluate the model fit, the table reports the target moments in both the data and the model. To generate the model's implied moments, we simulate $3,600$ firms for $1,000$ monthly periods. We drop the first 400 months to neutralize the impact of the initial condition. The remaining 600 months of simulated data are treated as those from the economy's stationary distribution. We then simulate 100 artificial samples and report the cross-sample average results as model moments. Because we do not explicitly target the cross section of return spreads (and abnormal returns) in the baseline calibration, we use these moments to evaluate the model in Section 6.

[Insert Table 3 here]
[Insert Table 4 here]

*Firm's technology: general parameters***.** We set the curvature of the production function θ is 0.75, close to the value estimated by Cooper and Ejarque (2001) and Hennessy and Whited (2007). The capital depreciation rate δ is set to be 1% per month, as in Bloom (2009). The fixed operating cost f is set to match the average book-to-market equity ratio (BM) of 0.62 as closely as possible, subject to the requirement that the endogenous firm value in the model be positive. Thus, we set $f = 0.04$, which allows us to obtain an average aggregate BM of 0.58. We set corporate tax rate to be 0.35 consistent with Hennessy and Whited (2005, 2007). We set the liquidation cost parameter $\varphi = 0.75$, consistent with the estimates in Ramey and Shapiro (2001) and Hennessy and Whited (2005).

Firm's technology: adjustment costs. We calibrate the capital and debt adjustment cost parameters to match several cross-sectional and time-series moments of firms' investment rates and debt growth rates. The convex capital adjustment costs are set to be $c_k^+ = 0, c_k^- = 39$.[15] Table 4 shows that this calibration of the model matches reasonably well the volatility, autocorrelation, interquartile range, and kurtosis of firm-level investment rates. We calibrate the debt adjustment cost $c_b = 2.8$ to match the volatility of the aggregate debt growth rates. It also implies a financial leverage ratio at 0.38, consistent with the data (0.38). The implied

[15] The upward capital adjustment cost is set to zero to match the autocorrelation of investment rate.

volatility and autocorrelation of financial leverage are 8% and 0.62, close to the data moments at 14% and 0.62, respectively. We set the equity issuance cost parameters $\eta_0 = 0.002, \eta_1 = 0.1$ and $\eta_2 = -10$ which imply the average equity issuance frequency at 34%, close to the data moment at 37%. It also implies the fixed cost of equity issuance is less than 1% of the amount of issuance, and the variable equity issuance cost less than 10% of issuance proceeds, consistent with the estimate in Altinkilic and Hansen (2000) and the estimates in Hennessy and Whited (2007). The issuance cost sensitivity parameter η_2 is calibrated to match the volatility of firm level net issuance to book equity ratio (32% in the model and 35% in the data).

Stochastic processes. In the model, the aggregate productivity shock is essentially a profitability shock. We set the conditional volatility of the aggregate productivity shock to be $\sigma_x = 0.055$ to match the volatility of aggregate profits (0.14 in the data and 0.12 the model). In the data, we measure aggregate profits using data from the National Income and Product Accounts (NIPA). Given the volatility of the aggregate productivity shock, we set the conditional volatility of the aggregate issuance cost shock to be $\sigma_\xi = 0.035$ and the persistence of the aggregate issuance cost shock to be $\rho_\xi = 0.98$ so that the implied volatility aggregate equity-issuance-to-capital ratio is 0.05, close to the data moments at 0.04.

To calibrate the persistence and conditional volatility of the firm-specific productivity shock, we set the values as $\rho_z = 0.97$ and $\sigma_z = 0.15$ which implies the firm level return volatility 0.35, consistent with Campbell et al (2001). The long-run average level of firm-specific productivity, $\bar{z}$, is a scaling variable. We set $\bar{z} = -3.4$, which implies that the average detrended long-run debt in the economy is 10. To calibrate the stochastic discount factor, we set the real risk-free to be $r_f = 1.65\%$ per annum. We set the loading of the stochastic discount factor on the aggregate productivity shock to be $\gamma_x = 9.25$, and the loading of the stochastic discount factor aggregate issuance shock to be $\gamma_\xi = 7$ by matching the average aggregate stock market return and the Sharpe ratio as close as possible. This implies a market excess return of 5.59% and Sharpe ratio at 0.49, reasonably close to 5.63% and 0.35, respectively, in the data. We conduct comparative statics in Section 6 to evaluate the impact of the stochastic discount factor loading parameters on the model's performance.

5 Main results

We replicate the portfolio sorts and asset pricing tests performed in the empirical section using the artificial data obtained from the simulation of the model. Furthermore, we also show that the model replicates the financing flows of the test portfolios.

5.1 The cross section of stock returns

Panel A in Table 5 reports the average value-weighted excess returns, Sharpe ratios, and the CAPM and two-factor model (MKT + ISC) factor loadings (obtained by estimating Eq. (1)) of the low (H), high (H), and high minus low (H-L) for each portfolio sort in the model.

Book-to-market portfolios The calibration of the baseline model generates a pattern of average excess returns across the book-to-market portfolios that is similar to the pattern in the data. Growth (L) firms earn subsequently lower returns on average than value (H) firms. The size of the value premium (H-L) is comparable with the data. In the model, the value premium is 6.7% per annum, which is close to the 7% per annum in the data reported in Table 2.

[Insert Table 5 here]

Table 5 also shows that the Sharpe ratios of the book-to-market portfolios are increasing in firms' current book-to-market ratios, consistent with the data. The Sharpe ratio of the portfolio of value firms is about three times larger (in the real data is two times larger) than the Sharpe ratio of the growth firms. Panel A reports the factor loadings of the book-to-market portfolios with the market excess returns and the issuance shock as the two factors. The loadings on market portfolios are decreasing in book-to-market ratio, consistent with the data but opposite to the direction to capture the value premium, while the loadings on the issuance shock is increasing in book-to-market ratio. Moreover, the loadings of growth firms are negative suggesting that growth firms are a hedge against issuance cost shocks while the loadings of value firms are positive, consistent with the data. The difference in the issuance cost shock betas is sizable which explains why the value premium is mostly driven by the issuance cost shock. We note, however, that the size of the ICS betas are smaller than in the data.

Investment portfolios In the model the high investment firms earn subsequently lower returns on average than low investment firms, consistent with the data. The size of the investment spread is comparable with the data. In the model, the investment spread is 6.8% per annum, which is slightly higher than 5.2% per annum in the data reported in Table 5. The model also replicates the pattern that the Sharpe ratios of the investment portfolios are decreasing in investment rates.

Panel A in Table 5 reports the factor loadings of the investment portfolios with the market portfolio and the issuance cost shock as the two factors. The loadings on market portfolios are increasing in investment rates, while the loadings on the issuance shock are decreasing in investment rates. Moreover, the loadings of low investment firms (positive loadings) is two times as large (in absolute value) as the loadings of the high investment firms (negative loadings); this difference is responsible for the sizable investment return spread in the model.

Size portfolios Big firms earn subsequently lower returns on average than small firms, consistent with the data. The size of the size spread is comparable with the data. In the model, the size spread is 5.8% per annum, which is slightly higher than 4.6% per annum in the data reported in Table 5. The model also replicates the pattern that the Sharpe ratios of the size portfolios are decreasing in size. In the time series regressions, the loadings on market portfolios are increasing in size, opposite to the direction to explain the size portfolio returns, while the loadings on the issuance shock are decreasing in size. Moreover, the loadings of small firms (positive loadings) is close to three times as large (in absolute value) as the loadings of the big firms (negative loadings); this difference is responsible for the size spread in the model.

Debt growth portfolios The model also generates sizable spreads on debt growth portfolios. High debt growth firms earn subsequently lower returns on average than low debt growth firms, consistent with the data. In the model, the debt growth spread is 6.6% per annum, which is somewhat higher than 3.0% per annum debt growth spread in the data reported in Table 5. The model also replicates the pattern that the Sharpe ratios of the debt growth portfolios are decreasing in debt growth and the loadings on market portfolios and on the issuance shock. More specifically, the loadings of low debt growth firms (positive loadings) is two times as large (in absolute value) as the loadings of the high debt growth firms (negative loadings).

Equity issuance portfolios Lastly, the model also generates sizable spread on equity issuance portfolios. High equity issuance firms earn subsequently lower returns on average than low equity issuance firms, consistent with the data. In the model, the equity issuance spread is 3.1% per annum, which is slightly smaller than 4.6% per annum equity issuance spread in the data reported in Table 5. The model also replicates the pattern that the Sharpe ratios of the equity issuance portfolios are decreasing in equity issuance and the loadings on market portfolios and on the issuance shock. More specifically, the loadings of low equity issuance firms (positive loadings) is two times as large (in absolute value) as the loadings of the high equity issuance firms (negative loadings).

5.2 Asset pricing tests

Panel A in Table 5 reports abnormal returns of the CAPM (α), and Panel B replicates the GMM estimation of the factor risk prices and pricing errors for both the CAPM and two-factor model.

Book-to-market portfolios The baseline model matches well the failure of the unconditional CAPM in explaining the average returns of the book-to-market portfolios. The pricing error of the value premium is large, 7.6% per annum, which is more than 8.9 standard errors from zero and slightly larger than the value premium itself (6.7% per annum). As in the data, the CAPM fails in the model because the growth firms have relatively higher market betas (b), and hence higher risk according to the CAPM, but relatively lower average returns. The model generates large and statistically significant mean absolute pricing error that is close to the data (3.7% per annum in the model versus 3.4% in the data).

Other portfolios The analysis of the asset pricing test results across the portfolios sorted on investment rate, size, debt growth, and equity issuance (reported in Table 5) is qualitatively similar to the analysis across the ten book-to-market portfolios, so here we briefly state the main results. As in the data, the unconditional CAPM in the model is unable to fully explain the investment, size, debt growth and equity issuance return spreads. The pricing errors of the investment, size, debt growth, and equity issuance portfolios are 7.6%, 8.4%, 7.6%, and 3.3% per annum, close to the data moments of 9.3%, 3.7%, 2.7%, and 7.8% per annum. When all portfolios are considered together, the bottom left and right panels in Figure 2 shows the failure of the CAPM and the better performance of the two-factor model in a clear manner.

The significant magnitude of the CAPM pricing errors in the model, especially for the ten book-to-market portfolios, is an improvement over the standard neoclassical investment-based model in which aggregate productivity is the only source of aggregate risk. Zhang (2005) shows that the standard neoclassical model can generate a sizeable value premium. As shown in Belo and Lin (2012), however, the value premium is completely explained in that model by variation in market betas, a pattern that does not appear to be consistent with the data, at least during our sample period. As a result, the model-implied CAPM pricing errors in the standard investment-based model with one aggregate shock are counterfactually too small and indistinguishable from zero. Belo, Lin, and Bazdresch (2014) show that an aggregate shock to adjustment costs in labor hiring and investment help explain the failure of CAPM in an investment-based asset pricing model. However, the aggregate adjustment cost shock in Belo, Lin, and Bazdresch (2014) is different from the issuance cost shock. The aggregate issuance shocks are shocks originated from the financial sector that affect the supply of capital, while the adjustment costs shock is from real sector which affects the efficiency of hiring or investment decisions.

5.3 Real investment, financing flows, and capital structure

The model also replicates the patterns of real investment, equity and debt financing flows, and financial leverage of book-to-market portfolios, investment portfolios, size portfolios, debt growth, and equity issuance portfolios. Table 6 reports the model implied financing flows and financial leverage across firms in each portfolio sort, which we compare with the results in the data (column Data).

Book-to-market portfolios Growth firms are more productive and issue more equity than value firms and the fraction of firms in the growth portfolios issue equity is significantly higher than that of the value portfolio. On the debt financing side, growth firms also issue more debt than value firms. These patterns are consistent with the data. Furthermore, growth firms also take on less financial leverage than value firms, consistent with the data as well.

Investment portfolios Low investment firms are less productive than high investment firms, consistent with the data. Similarly, the model replicates the patterns of financial flows of investment portfolios. High investment firms issue more equity and debt than low investment firms and the fraction of high investment firms issuing both debt and equity is also much higher than low investment firms. Low investment firms take on more financial leverage than high investment firms.

Size portfolios Table 6 also reports the model implied characteristics of size, debt growth and equity issuance portfolios. Small firms are less productive and invest less and issue less debt (both the debt issuance and the fraction of debt issuance) than big firms (small firms are de-leveraging). On equity financing side, small firms issue more equity and the fraction of small firms issuing equity is much higher than big firms. There is no significant pattern in financial leverage across firm size.

Debt growth and issuance portfolios High debt growth firms are more productive than low debt growth firms. They invest more and issue more debt than low debt growth firms. High debt growth firms also take on less financial leverage than low debt growth firms. High equity issuance firms are more productive and invest more and issue more equity than low equity issuance firms. High issuance firms also issue slightly more debt and take on less financial leverage than low debt growth firms. All these patterns are consistent with the data.

6 Inspecting the mechanism

In this section we perform several analyses to understand the economic forces driving the overall good fit of the model.

6.1 The driver of the cross section of stock returns

The theoretical model proposed in Section 3 implies that risk premiums in the economy are determined by Eq. (25). To understand the return spreads, we must thus understand the endogenous sensitivity of the returns of the book-to-market, investment, size, debt growth, and equity issuance portfolios to the two aggregate risk factors (quantity of risk), as well as the role of the corresponding prices of risk. To facilitate the exposition, most of the analysis in this section focuses on the ten book-to-market portfolios.

To be consistent with the empirical model in Eq. (1), we implement the exact same procedure as the section 2 and construct a two-factor model composed of a market factor, r_t^m, and model implied issuance shock factor, ICS_t (to make the comparison with the empirical results meaningful, this ICS is constructed using the same VAR regression as in the data; not the exogenous issuance shock ξ), using the simulated data. Given that market factor is most driven by the TFP shock (the TFP shock alone can explain more than 75% variation in the market returns), this factor model is in spirit similar to Eq. (25).

6.1.1 Quantity of risk

The value premium is driven by the differential exposure of the returns of the book-to-market portfolios to the aggregate issuance shock, and not so much by differential exposure to the market factor (aggregate productivity shock). To show this result, we compute the sensitivity (betas) of the returns of the book-to-market portfolios with respect to the two factors in the economy by running the following time-series regression in the simulated data:

$$r_{it}^e = a_i + \beta_i^m \times r_t^m + \beta_i^{ICS} \times ICS_t + e_{it}, \tag{26}$$

in which r_{it}^e is the monthly excess return of the i^{th} book-to-market portfolio, r_t^m is the market excess returns, and ICS_t is the aggregate issuance shock. Figure 3 plots the sensitivity of the returns of each portfolio to the two factors. To highlight the cross-sectional dispersion in the exposure to the shocks, we report the portfolio sensitivity to each factor relative to the average (across portfolios) sensitivity.

[Insert Figure 3 Here]

The top two panels in Figure 3 documents an important feature of the model. The sensitivity of the returns of the book-to-market portfolios to the market factor (aggregate productivity shock) is almost flat across the portfolios. In contrast, the dispersion in the sensitivity to the aggregate issuance shock is large, and it is monotonically increasing across the book-to-market portfolios. In particular, the sensitivity of the value firms to the issuance shock is more than two times larger than the sensitivity of the growth firms. Furthermore, the sensitivities of growth firms are negative implying that growth firms are a hedge against aggregate issuance cost shocks. This differential exposure is the fundamental difference in the quantity of risk of the book-to-market portfolios in the model, and explain why the growth firms have lower average returns in equilibrium.

The rest eight panels in Figure 3 document the feature of the model for the investment, size, high debt growth and equity issuance portfolios. The sensitivity to the market factor is flat across the portfolios while the dispersion in the sensitivity to the aggregate issuance shock is large, and it is monotonically decreasing across the investment, size, debt growth and equity issuance portfolios with high investment, large cap, high debt growth and high equity issuance firms having negative betas implying that these firms are hedge against aggregate issuance cost shock.

The previous analysis also helps understand why the CAPM is unable to explain the cross-sectional variation in the average returns of the book-to-market (and investment) portfolios. In the baseline model, almost all of the variation of the aggregate stock market return is driven by shocks to aggregate productivity. Across panels, a multivariate time-series regression of the aggregate stock market return on the two risk factors has an average regression $R^2 \approx 90\%$, a univariate regression on the aggregate productivity shock has an average regression $R^2 \approx 75\%$, but a univariate regression on the aggregate issuance shock has an average regression $R^2 \approx 25\%$ (results not tabulated). Thus, because the aggregate stock market return is mostly driven by the aggregate productivity shock, the market factor alone fails to capture the differential exposure of the book-to-market, investment, size, debt growth and equity issuance portfolios to the issuance cost shock.

6.1.2 Price of risk

According to Eq. (25), the impact of the differential firms' exposure to the aggregate shocks on equilibrium risk premiums depends on the price of risk of these shocks. To evaluate the importance of the price of risk of the two aggregate risk factors on the model's results, we perform comparative statics with respect to the loadings (γ_x and γ_ξ) of the stochastic discount factor on the two aggregate shocks.

Table 7 reports selected model-implied moments from several alternative specifications of the model, which we compare against the moments in the data (specification 0) and in the baseline calibration of the model (specification 1). In specifications 5 and 6, we specify the stochastic discount factor to have a low loading on the issuance shock ($\gamma_\xi = 3$ versus $\gamma_\xi = 7$ in the baseline model) and a low loading on the aggregate productivity shock ($\gamma_x = 4.5$ versus $\gamma_x = 9$ in the baseline model), respectively. In these two specifications, we keep all the other model parameters equal to the baseline specification.

[Insert Table 7 Here]

Specification 5 in Table 7 shows that decreasing the size of the loading of the stochastic discount factor on the aggregate issuance shock has a trivial effect on the properties of firms' investment rates. The interesting effects are reflected in the moments of asset prices. Here, the value premium drops substantially (6.7% in the baseline model to 3.3% here), whereas the investment, size, debt growth and equity issuance spreads decreases by a large margin as well. This analysis shows that a sufficiently large and positive price of risk for the issuance shock is crucial for the model to generate positive and sizeable return spreads.

Specification 6 in Table 7 shows that the effect on asset prices is again substantial when the factor loading on aggregate productivity shock is set to 4.5 (the benchmark calibration is 9). The risk premium in the aggregate stock market is significantly reduced (from 5.6% in the benchmark model to 3.9% here). Furthermore the value premium, investment, debt growth and equity issuance spreads drop by $2 - 3\%$. The size spread remains comparable to the baseline calibration. This result thus confirms that the aggregate productivity shock drives the aggregate market premium and also somewhat contributes the cross sectional variations in the portfolio returns.

6.1.3 Intuition

Why do the returns of firms with currently high book-to-market ratio (analogously, low investment rates, small size, low debt growth, and low equity issuance) have higher positive covariance with the aggregate issuance shock in equilibrium? Given the positive price of risk of this shock, understanding this endogenous covariance is essential to understanding these return spreads.

To illustrate the economic mechanism behind the previous analysis, Figures 4 and 5 show impulse responses of selected endogenous variables in the baseline calibration of the model to a one standard deviation negative aggregate issuance cost shock (an increase in the marginal equity financing cost), and to a one standard deviation negative aggregate productivity shock, respectively. We report the responses of each variable relative to its (time-detrended) long-run average level. Because all firms in the economy are ex ante identical, we generate cross-sectional heterogeneity by examining the response of two firms in which their respective firm-specific productivity level is set one standard deviation above and below the long-run average level of firm productivity (we label these two firms as high and low productivity firms, respectively); furthermore, their productivity levels gradually mean revert to the average level following Eq. (8).[16] The high and low productivity firms correspond roughly to the growth (high investment/large cap/high debt growth/high equity issuance) and value (low investment/small cap/low debt growth/low equity issuance) firms in the model. Even though the difference in productivity is not the only difference across these firms, it is clearly an important state

[16] The long-run average level is determined by setting all shocks to the long-run average level, i.e., $z = -3.4$, $\xi = 0$, and $\Delta x = 0$.

variable. This is because idiosyncratic productivity is the endogenous source of heterogeneity in the model.

[Insert Figure 4 Here]

Figure 4 shows that after a negative issuance shock, the high productivity firms increase their investment while the low productivity firms decrease their investment. Due to the increase in the marginal cost of external equity financing, external equity market freezes upon impact for both high and low productivity firms for the first one and six months, respectively. However, the increase in investment and adjustment costs of high productivity firms are financed by an increase in debt growth. This happens because high productivity firms accumulate more capital which allows them to pledge for more debt. While for low productivity firms, the debt growth falls substantially because their capital decreases causing them to have less capital to be collateralized. The dividends of the high productivity firms increase slightly upon impact and then fall immediately below the steady state level for a few periods of time but increases above the steady state and stays for a long period of time; the dividends of low productivity firms also increase on impact, but then the dividends fall below the steady level for an extended period of time of more than twenty months. As a result of the response of firms' profits and dividends over time, the continuation value (the present value of all future dividends at time $t+1$) of the high productivity firm increases substantially on impact, but the continuation value of the low productivity firm decreases (relative to its long-run average level) on impact. Because current dividends represent a small fraction of total firm value, the properties of firm-level stock returns are mostly determined by the change in the continuation value, the standard capital gains component of stock returns. As such, the returns of the high productivity/low book-to-market (high investment/large cap/high debt and equity issuance) firms have a negative covariance with the issuance shock while the returns of the low productivity/high book-to-market (low investment/small cap/low debt and equity issuance) firms have positive covariance with the issuance shock. Because the stochastic discount factor (marginal utility) is increasing in this shock due to its positive price of risk, the differential covariance implies that, all else equal, high book-to-market firms have higher risk than low book-to-market firms because the returns of the low book-to-market (growth) firms are a hedge against the issuance shock.

[Insert Figure 5 Here]

We now turn to the analysis of firms' responses to a negative aggregate productivity shock. Figure 5 shows that firms' responses to this shock also go in the right direction for explaining the cross sectional return spread in the data. After a negative aggregate productivity shock, the high productivity firm increases its investment, whereas the low productivity firm slightly decreases investment on impact (relative to the average long-run level). In contrast to the impulse responses after the negative aggregate issuance cost shock, high productivity firms use both equity and debt to finance the increase in investment and capital adjustment; low productivity firms decrease their investment and de-leverage, and do not take external equity issuance. The dividends of high productivity firms fall substantially because of the need to finance investment. The dividends of the low productivity firms also decrease on impact because of its lower output, but this decrease is substantially smaller. After impact, the dividends and sales of the high productivity firm increase to above the steady state level sharply. In turn, the continuation value of the high productivity firm increases on impact, but the continuation value of the low productivity firm decreases. Thus, the returns of the high productivity/low book-to-market firms have a negative covariance with the aggregate productivity shock while the returns of the low productivity/high book-to-market firms have a positive covariance with the aggregate productivity shocks. Because marginal utility is increasing in this shock due to its positive price of risk, this higher covariance implies that, all else equal, high book-to-market firms have higher risk than low book-to-market firms. This analysis shows that aggregate productivity shocks also contribute to the risk dispersion across book-to-market firms. However, quantitatively this effect is much smaller than that of the aggregate issuance cost shock.

6.2 The role of equity issuance costs

The existence of time-varying external equity issuance costs is important for the overall good fit of the model. To show this importance, we compute the model-implied moments from an alternative calibration of the issuance cost function, which we report in Table 7. In specification 3, we shut down issuance cost completely ($\eta_0 = \eta_1 = 0$). In terms of quantities, specification 3 in Table 7 shows that by removing issuance costs, the model generates an equity issuance-to-book-equity ratio and a firm-level investment rate being too volatile (the volatilities are 0.29/0.21 in the baseline model, respectively, compared to 1.02/0.26 here).

We now turn to the analysis of the effects of equity issuance costs on asset prices. Removing equity issuance costs in the issuance cost significantly reduces the value premium, the investment, size, debt growth and equity issuance return spreads relative to the baseline model. For example, the value premium, the investment, size, debt growth and equity issuance return spreads are $-1\%/1.4\%/-0.1\%/1.1\%/0.1\%$ without issuance cost. These values are all considerably smaller than the those observed in the data (7%/5.2%/4.6%/3%/4.6%) and in the baseline model (6.7%/6.8%/5.8%/6.6%/3.1%).

Another interesting comparative statics is the specification 2 where we shut down the stochastic shock on the cost of external equity financing ($\eta_2 = 0$). Removing the aggregate shocks on equity issuance costs significantly reduces the return spreads relative to the baseline model. The value premium, the investment, size, debt growth and equity issuance return spreads are $-2\%/-0.8\%/-1.8\%/-1.1\%/0.5\%$ without issuance cost shocks, respectively, considerably smaller than 6.7%/6.8%/5.8%/6.6%/3.1% in the baseline model. Taken together, equity issuance costs driven by the aggregate issuance shocks play a key role in determining both real quantities and asset prices.

6.3 The role of substitution between equity and debt financing

The time-variation in the availability of external funds play a crucial role in generating risk dispersion across productive and unproductive firms. In particular, the flexibility of productive firms in switching between marginal sources of financing make them less risky. To understand this result, specification 6 tightens the collateral constraint (the resale of value of capital is set to 0.05 whereas the baseline is 0.75). Specification 7 raises the debt adjustment costs seven times larger the baseline calibration. In both of these two specifications, financial leverage almost drops to zero. All the returns spreads decrease substantially. This happens because tightening collateral constraint or increasing debt adjustment lowers the debt capacity of all the firms. This limits the flexibility of productive firms' ability to substitute debt for equity financing when facing negative aggregate issuance cost shocks, which in turn reduces the risk dispersion across firms.

Finally we shut down the fixed operating cost ($f = 0$) in specification 8. Surprisingly value premium remains sizable at 2.6%. This finding is different from Belo, Lin, and Bazdresch (2014) who show that operating leverage is the key driver of the value premium in an investment-based model with two aggregate shocks: aggregate productivity shocks and adjustment cost shocks. The difference from Belo, Lin, and Bazdresch (2014) is that here in the model with external financing frictions, fixed operating cost affects the marginal cost of issuance, making it no longer a pure operating leverage effect. Thus financing frictions also contribute significantly to the value premium.

6.4 Internal validation

We can use the alternative calibrations of the model to internally validate our proxy for issuance cost shock based on the VAR. Because in the model we observe both the true issuance cost shock and the VAR proxy (by replicating the empirical VAR in the simulated data), we can investigate the conditions under which (if any) the proxy and the true shock are strongly positively correlated.

To examine this question, Table 7 reports the model implied correlation between the true ICS and the VAR proxy of the ICS across the different calibrations of the model. This correlation is reported in column Correl (ICS_t,ξ_t). Several interesting things are worth noting. First, the correlation between the true shock and its proxy in the benchmark model at annual frequency is 31% (the correlation is significantly higher at monthly frequency at which the model is solved, around 50% on average across simulations). Although this correlation is not perfect, it's significantly positive.[17] This sizeable and positive correlation crucially depends on the existence of both time-varying and positive issuance costs. In specifications 2, when we shut down the time variation in the issuance costs (but keep the effect of ICS on marginal utility), the implied correlation between the true shock and its VAR proxy is essentially zero. That is, under this specification, the empirical VAR proxy variable is not a good proxy for the underlying issuance cost shock, even though the ICS affects the investors' marginal utility (and hence asset prices). Similarly, in specification 3, when we shut down the issuance costs entirely (but again, keep the effect of ICS on marginal utility), the implied correlation between the true shock and its proxy is also zero. Taken together, the existence in the model of time-varying and issuance cost shocks that affect firms' cash flows is crucial to rationalize the use of the VAR proxy of ICS. We can only use the fraction of firms issuing equity in the cross section to extract the issuance cost shock with a VAR controlling for aggregate TFP when the ICS are present, even if the ICS is correlated with investors' marginal utility.

6.5 Discussion: credit shocks to collateral constraint

So far, we have studied the impact of the aggregate external equity issuance cost shock on real quantities, financing flows and asset prices. Here, we briefly discuss the impact of an aggregate shock on debt financing costs on asset prices when we allow the liquidation value of capital to be time-varying.[18] In the model, the collateral constraint captures the idea that the lender can fully observe whether or not the borrower is fulfilling his or her contractual obligations. But, the lender does not have tools available to enforce the contractual obligations. For instance, even if the bank knows that firms (borrowers) are not exerting effort or are diverting funds, it may be difficult to prove in court. In the model, the parameter that determines the fire sale value of liquidated capital (i.e., the tightness of collateral constraint), φ, is set to constant. A recent literature on the impact of macroeconomic quantities of credit shocks highlights the role of stochastic tightness of collateral constraint in generating recessions in DSGE models (for example, Jermann and Quadrini, 2011; Khan and Thomas, 2013). We have also experimented

[17]The imperfect correlation is also (partly) due to the substantial nonlinearity in the issuance cost in the model while the empirical procedure to extract issuance cost shocks is linear.

[18]Empirically we have also tried extracting shocks on debt issuance like we do in estimating ICS using the cross sectional Compustat firms. However we find that the shocks on debt issuance do not appear to help price the cross sectional stock returns.

with a stochastic φ_t. More specifically, we assume φ_t follows an AR(1) process

$$\log \varphi_{t+1} = \left(1 - \rho_\varphi\right) \log \bar{\varphi} + \rho_\varphi \log \varphi_t + +\sigma_\varphi \varepsilon^\varphi_{t+1},$$

with $\bar{\varphi}$, ρ_φ, and σ_φ are the mean, first-order autocorrelation coefficient and conditional volatility of the $\log \varphi_{t+1}$ and $\varepsilon^\varphi_{t+1}$ is an i.i.d. standard normal shock that is independent of ε^x_{t+1} and ε^z_{t+1}. We find that such an aggregate shock on collateral constraint does not generate significant cross sectional variations in expected stock returns (Results available upon request). The reason is that φ_{t+1} affects investment decisions only if the collateral constraint binds. However the collateral constraint only binds occasionally in the model, because firms can reduce debt and investment to avoid hitting the binding constraint. Given that shocks on constraint only affect investment decision occasionally, it does not affect dividend/continuation values of firms significantly.

7 Conclusion

We show that aggregate shocks to the cost of external equity financing have significant impact on real quantities, financing flows, and asset prices in the cross section of nonfinancial public traded firms. An empirical proxy of an aggregate shock to the cost of equity issuance prices the cross section of stock returns including book-to-market, investment, size, debt growth and issuance portfolios. We propose an investment-based asset pricing model featuring aggregate shocks to the cost of firms' external equity issuance and collateral constraint to interpret the links in the data. We show that time varying costly equity issuance is important for the model to quantitatively capture the joint dynamics of firms' real quantities, financing flows, and asset prices. We also offer an novel explanation for the failure of the unconditional CAPM model in pricing the cross-section of expected stock returns.

Our results have implications for asset pricing, corporate finance, and macroeconomics literature. Our findings suggest that financial shocks, in particular, equity issuance cost shocks, can have a significant impact on asset prices, helping us to understand the observed differences in risk premiums in the cross section. Going forward, our analysis suggest that incorporating aggregate shocks to the cost of external equity financing in current DSGE models may be important for an accurate understanding of aggregate quantity dynamics, time-varying risk premiums, and financing flows over the business cycle.

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A-1 Making the model stationary

It is easy to verify that all variables grow with X_t on the balanced growth path. Define

$$\begin{aligned}&\{V_t, D_t, E_t, Y_t, K_t, B_t, I_t, H_t, G_t, \Phi_t, \Psi_t, F_t\} = \\ &\{v_tX_t, d_tX_t, e_tX_t, y_tX_t, k_tX_{t-1}, b_tX_{t-1}, i_tX_t, h_tX_t, g_tX_t, \phi_tX_t, \psi_tX_t, fX_t\}\end{aligned} \tag{27}$$

where $\{v_t, d_t, e_t, y_t, k_t, b_t, i_t, h_t, g_t, \phi_t, \psi_t, f\}$ are detrended stationary variables.

The stationary optimization problem can be written as follows:

$$v(\Delta x_t, z_t, \xi_t, k_t, b_t) = \max_{i_t, b_{t+1}, n_t} d_t + \mathbb{E}_t \left[M_{t,t+1} \frac{X_{t+1}}{X_t} v(x_{t+1}, z_{t+1}, \xi_{t+1}, k_{t+1}, b_{t+1}) \right] \tag{28}$$

$$s.t. \quad d_t = e_t - \psi_t \tag{29}$$

$$h_t = \max(-e_t, 0) \tag{30}$$

$$e_t = (1-\tau)(y_t - f) + \tau\delta k_t \frac{X_{t-1}}{X_t} + \tau r_f b_t \frac{X_{t-1}}{X_t} \tag{31}$$

$$-i_t - g_t + b_{t+1} - (1+r_f) b_t \frac{X_{t-1}}{X_t} - \phi_t \tag{32}$$

$$k_{t+1} = (1-\delta) k_t \frac{X_{t-1}}{X_t} + i_t \tag{33}$$

$$b_{t+1} \leq \varphi k_{t+1} \tag{34}$$

where the stationary output and various adjustment costs are given as follows:

$$
\begin{aligned}
y_t &= Z_t \left(\frac{X_t}{X_{t-1}}\right)^{-\theta} k_t^{\theta}, && (35)\\
g_t &= \begin{cases} \frac{c_k^+}{2}\left(\frac{i_t}{k_t}\right)^2 k_t \frac{X_t}{X_{t-1}}, & i_t \geq 0 \\ \frac{c_k^-}{2}\left(\frac{i_t}{k_t}\right)^2 k_t \frac{X_t}{X_{t-1}}, & i_t < 0 \end{cases}, && (36)\\
\phi_t &= \frac{c_d}{2}\left(\frac{\Delta b_t}{b_t}\right)^2 b_t \frac{X_t}{X_{t-1}}, && (37)\\
\psi_t &= \left[\eta_0 + \eta_1 \exp\left[-\eta_2\left(\xi_t/\bar{\xi}\right)\right] h_t\right] \mathbf{1}_{\{h_t>0\}}, && (38)
\end{aligned}
$$

where $\Delta b_t = b_{t+1} - b_t \frac{X_{t-1}}{X_t}$.

Finally, the stock return is given as follows:

$$
R_{t+1} = \frac{V_{t+1}}{V_t - D_t} = \frac{v_{t+1}\frac{X_{t+1}}{X_t}}{v_t - d_t}. \tag{39}
$$

A-2 Numerical algorithm

To solve the model numerically, we use the value function iteration procedure to solve the firm's maximization problem. The value function and the optimal decision rule are solved on a grid in a discrete state space. We specify a grid of 30 points for capital and debt, respectively, with upper bounds $\bar{k}$ and $\bar{b}$ that are large enough to be nonbinding. The grids for capital and debt are constructed recursively, following McGrattan (1999), that is, $k_i = k_{i-1} + c_{k1}\exp(c_{k2}(i-2))$, where $i = 1,...,30$ is the index of grids points and c_{k1} and c_{k2} are two constants chosen to provide the desired number of grid points and two upper bounds $\bar{k}$ and $\bar{b}$, given two pre-specified lower bounds $\underline{k}$ and $\underline{b}$. The advantage of this recursive construction is that more grid points are assigned around $\underline{k}$ and $\underline{b}$, where the value function has most of its curvature.

The aggregate productivity shock ε_t^x is an i.i.d. standard normal shock. We discretize ε_t^x into 5 grid points using Gauss-Hermite quadrature. The state variables ξ and z have continuous support in the theoretical model, but they have to be transformed into discrete state space for the numerical implementation. The popular method of Tauchen and Hussey (1991) does not work well when the persistence level is above 0.9. Because both the aggregate adjustment cost wedge and idiosyncratic productivity processes are highly persistent, we use the method described in Rouwenhorst (1995) for a quadrature of the Gaussian shocks. We use 5 grid points for the ξ process and 7 grid points for the z process. In all cases, the results are robust to finer grids as well. Once the discrete state space is available, the conditional expectation can be carried out simply as a matrix multiplication. Cubic spline interpolation is used extensively to obtain optimal investment and hiring that do not lie directly on the grid points. Finally, we use a simple discrete global search routine in maximizing the firm's problem.

A-3 Data and portfolio construction

We use annual Compustat and monthly CRSP to create our sample. In particular, we keep only common stocks (CRSP item SHRCD = 10 or 11) and stocks traded in NYSE or AMEX or NASDAQ (CRSP item EXCHCD = 1 or 2 or 3). We remove utility and financial firms (SIC code between 4900 and 4999 or between 6000 and 6999) from our sample. We follow Shumway (1997) to adjust for delisting and we define book equity following Fama and French (1992).

IK is computed as investment (Compustat data item CAPX (capital expenditures) minus SPPE (sales of property, plant, and equipment)) over the physical capital stock (Compustat data item PPENT (net property plant and equipment)). BM is the book equity over market equity ratio, where both book equity and market equity value follow the definitions in Fama and French (1992). LEV is computed as book value of liabilities over the market value of equity.

We use 46 stock portfolios as our test assets. They include 10 book-to-market portfolios as in Fama and French (1993), 10 physical investment portfolios, 10 size portfolios, 10 debt growth portfolios, and 6 gross equity issuance portfolios. The returns of book-to-market portfolios and size portfolios formed by sorting firms using their market equity are from Kenneth French's website. We form the other portfolios following the standard procedure described in Fama and French (1993). At the end of June of year t, we sort all stocks in our sample by a sorting variable (e.g. investment rate) in year $t-1$. Portfolio breakpoints are set as 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80% and 90% of the cross-sectional distribution of the sorting variable. Then, we categorize stocks into 10 portfolios based on their sorting variable relative to these breakpoints. From July of year t to June of year $t+1$, we compute monthly portfolio returns as the value-weighted stock returns across all the firms in the portfolio using market equity in the end of previous month as the weights. In addition, we compute portfolio characteristics (e.g. market-to-book ratio) using their median values across all firms in the portfolio. We repeat this procedure every year. Specifically:

Physical investment portfolios: We define a firm's investment in physical capital (IK_t) as

$$\mathrm{IK}_t = \frac{CAPX_t - SPPE_t}{0.5 \times (PPENT_{t-1} + PPENT_t)},$$

where CAPX, SPPE, and PPENT are from annual Compustat. CAPX is capital expenditures; SPPE is sale of property; and PPENT is total net value of property, plant and equipment of a firm. If SPPE is missing, we set it to be zero. We remove firms with fiscal year end (annual

Compustat item FYR) not in December. We set portfolio breakpoints based on stocks traded on all three exchanges.

Debt growth portfolios: We define debt growth (ΔDebt_t) as

$$\Delta\text{Debt}_t = \frac{DLTT_t + DLC_t - DLTT_{t-1} - DLC_{t-1}}{0.5 \times (DLTT_t + DLC_t + DLTT_{t-1} + DLC_{t-1})},$$

where DLTT is the annual Compustat item for total long-term debt and DLC is the annual Compustat item for total debt in current liability. So the sum of these two items measures total book value of debt for a firm. We remove firms with fiscal year end (annual Compustat item FYR) not in December. We set portfolio breakpoints based on stocks traded on all three exchanges.

Gross equity issuance portfolios: We define gross equity issuance as

$$\text{Issue}_t = \frac{SSTK_t}{0.5 \times (BE_{t-1} + BE_t)},$$

where SSTK is the annual Compustat item for sale of common and preferred stock and BE denotes book equity. If a firm's fiscal year end (annual Compustat item FYR) is before June, we set its calendar year one year after its fiscal year. In addition, we remove firms with negative book equity or negative total asset (annual Compustat item AT) or negative sale (annual Compustat item SALE). We set portfolio breakpoints based on stocks traded on all three exchanges. We notice that there are large portion of firms do not issue ($Issue_t = 0$) for most of the years. Hence, we follow Fama and French (2008) to split firms into zero issuance ($Issue_t = 0$) and positive issuance ($Issue_t = 0$) and then we split positive issuance firms into five portfolios sorted by gross equity issuance ($Issue_t$). Deviating from Fama and French (2008), we use gross equity issuance rather than net equity issuance (gross equity issuance minus repurchase) as sorting variable. Therefore, we have no negative issuance portfolio.

Table 1 : Properties of issuance cost shocks

This table reports the results from the VAR(1) estimates of the issuance cost shock (ICS) and TFP shock, as well as the correlation of these variables with macroeconomic variables: the growth rate of aggregate GDP (ΔGDP), per capita nondurables consumption (ΔC), and a proxy of investment-specific technological shocks (ISTS real quality-adjusted investment price growth). ICS is the innovation to percentage issuance in the VAR (the proxy for the equity issuance cost shock). TFP is the innovation to TFP in the VAR. The raw data is annual from 1971 to 2011, the VAR shock data and corresponding statistics is from 1977 to 2011. The data for the ISTS is from 1971 to 2008.

Panel A: Summary statistics

Description	Parameter	Value	
Mean level of the percentage of firms issuing equity		38.76	
Standard dev. of the percentage of firms issuing equity		12.63	
Standard dev. of TFP shock	σ_x	1.05	
Standard dev. of the issuance cost shock (ICS)	σ_s	4.70	
Matrix for the shocks process	A	0.68	−0.01
		−0.24	0.52

Panel B: Correlation matrix

	ΔGDP	ΔC	ISTS	ICS
ΔC	0.75			
ISTS	0.44	0.14		
ICS	0.08	0.17	0.06	
TFP	0.25	0.37	0.18	−0.14

Table 2 : Issuance cost shocks and systematic risk in the cross section

Panel A in this table reports the portfolio average returns, Sharpe ratios (average return-to-return standard deviation ratio), the CAPM abnormal returns (α), and two factor-model factor loading using several portfolio sorts as test assets. Each sort is based on 10 or 6 portfolios (or all portfolio together - All), and we report portfolios 1 (Low, L), and 10 or 6 (High, H) for each sort. H-L stands for the high-minus-low portfolio. E[r^e] is the average annualized ($\times$1200) portfolio excess stock return; $\sigma[r^e]$ are the annualized standard deviation of the portfolio excess returns; $[t]$ are heteroscedasticity and autocorrelation consistent t-statistics (Newey-West). α are the portfolio CAPM average abnormal returns, obtained as the intercept from monthly CAPM regression, reported in annual percentage ($\times$1200); MKT and ICS (issuance cost shock) are the portfolio market and issuance cost shock betas, respectively, obtained from a the time series regression of the portfolio excess returns on the market and the ICS factors. Panel B reports the estimates (and the corresponding t-statistics below each estimate) of the loadings b_{M} and b_{I} in the stochastic discount factor $M_{t+1} = 1 - b_{\mathrm{M}} \times \mathrm{MKT}_t - b_{\mathrm{I}} \times \mathrm{ICS}_t$ in which MKT_t is the (demeaned) market return, and $\mathrm{ICS}_t$is the (demeaned) issuance cost shock. Estimation is by the generalized method of moments (GMM) using the moment condition $E_T\left[r^e_{it} M_{t+1}\right] = 0$, and it is performed separately across each portfolio sort, and using all portfolio sorts together (All). The table reports both 1$^{\text{st}}$ stage and 2$^{\text{nd}}$ stage GMM estimates. MAE is the mean absolute pricing errors across the corresponding portfolios. The sample is from July 1977 to June 2011.

Panel A: Time series regressions

	10 BM			10 IK			10 Size			10 ΔDebt			6 Issue.		
	L	H	H-L	L	H	H-L	L	H	H-L	L	H	H-L	L	H	H-L
	Average returns and Sharpe ratios														
E[r^e]	5.76	12.85	7.09	7.99	2.79	−5.20	10.96	6.40	−4.55	5.77	2.97	−2.80	8.41	3.77	−4.63
[t]	1.89	4.98	2.05	3.40	0.87	−1.88	2.79	2.38	−0.88	1.89	0.89	−1.68	4.46	1.52	−2.67
SR	0.27	0.53	0.31	0.41	0.09	−0.21	0.41	0.37	−0.20	0.26	0.13	−0.26	0.61	0.16	−0.33
	Abnormal returns and factor loadings														
α	−2.49	4.94	7.43	1.17	−8.17	−9.34	3.02	−0.69	−3.71	−2.94	−5.98	−3.05	2.89	−4.93	−7.82
[t]	−1.63	2.05	1.97	0.57	−2.62	−2.48	0.66	−0.79	−0.69	−1.49	−2.41	−1.86	3.87	−2.30	−3.69
MKT	1.14	1.09	−0.05	0.94	1.52	0.57	1.10	0.98	−0.12	1.20	1.24	0.03	0.76	1.20	0.44
[t]	17.79	6.22	−0.22	9.59	4.96	1.67	6.01	23.36	−0.53	11.37	10.84	0.42	16.98	7.43	2.91
R^2	0.81	0.58	0.00	0.68	0.61	0.15	0.48	0.94	0.01	0.83	0.81	0.00	0.86	0.75	0.28
MKT	1.18	1.01	−0.17	0.87	1.54	0.67	0.99	1.01	0.02	1.20	1.25	0.05	0.76	1.21	0.45
[t]	17.70	9.33	−1.13	13.78	4.76	1.98	6.57	28.14	0.09	11.57	10.25	0.57	16.70	6.88	2.78
ICS	−0.67	1.34	2.01	1.30	−0.36	−1.67	1.80	−0.46	−2.26	0.14	−0.16	−0.30	0.04	−0.16	−0.20
[t]	−1.97	2.12	2.17	4.37	−0.75	−3.14	3.42	−2.93	−3.33	0.57	−0.54	−1.04	0.27	−0.34	−0.54
R^2	0.83	0.65	0.17	0.78	0.61	0.25	0.57	0.95	0.21	0.83	0.81	0.02	0.86	0.75	0.29

Table 2 : Issuance cost shocks and systematic risk in the cross section (cont.)

Panel B: Cross sectional analysis

	10 BM		10 IK		10 Size		10 ΔDebt		6 Issue.		All	
	CAPM	2F	CAPM	2F	CAPM	2F	CAPM	2F	CAPM	2F	CAPM	2F
	1st stage GMM											
b_M	3.47	1.79	2.18	0.19	3.47	2.38	2.38	−0.14	2.35	1.69	2.83	1.12
[t]	3.14	1.10	1.43	0.09	3.55	1.37	1.95	−0.06	2.38	1.29	1.04	0.55
b_I		16.62		24.83		9.09		34.69		11.10		19.18
[t]		1.90		3.85		0.83		2.02		0.80		2.70
MAE	1.74	0.78	3.20	1.79	0.84	0.57	2.35	1.28	1.67	1.64	2.24	1.27
	2nd stage GMM											
b_M	4.83	1.85	4.96	0.79	3.62	2.71	4.38	−0.05	3.04	1.89	3.14	1.66
[t]	9.69	2.17	4.91	1.01	6.91	2.97	6.79	−0.06	4.51	1.54	2.95	0.86
b_I		14.96		27.84		8.56		28.79		10.94		16.37
[t]		4.52		4.46		2.18		6.23		1.06		2.05
MAE	3.43	0.80	6.87	2.66	0.79	0.77	4.77	1.58	2.11	1.58	2.05	1.26

Table 3 : Calibration

This table presents the calibrated parameter values of the baseline model.

Parameter	Symbol	Value
Technology		
Returns to scale	θ	0.75
Corporate tax rate	τ	0.35
Rate of depreciation for capital	δ	0.01
Fixed operating cost	f	0.04
Adjustment cost parameters in capital	c_k^+/c_k^-	0/39
Adjustment cost parameters in debt	c_d	2.80
Resale value of capital	φ	0.75
Fixed/linear issuance cost	η_0/η_1	.002/0.1
Parameter of time-varying issuance cost	η_2	10
Stochastic processes		
Average growth rate of aggregate productivity	μ_x	0.01
Conditional volatility of aggregate productivity	σ_x	0.055
Average level of firm-specific productivity	$\bar{z}$	-3.4
Persistence coefficient of firm-specific productivity	ρ_z	0.97
Conditional volatility of firm-specific productivity	σ_z	0.15
Persistence coefficient of issuance disturbance	ρ_ξ	0.98
Conditional volatility of issuance disturbance	σ_ξ	0.035
Real risk-free rate (%)	r_f	1.65/12
Loading of the SDF on aggregate productivity shock	γ_x	9.25
Loading of the SDF on the issuance cost shock	γ_ξ	7

Table 4 : Target moments

This table presents the selected target moments used for the calibration of the baseline model. We compare the moments in the data with moments of simulated data. The model-implied moments are the mean value of the corresponding moments across simulations. The time series of the firm-level moments are computed using pooled (across all firms and years) data. The real data are from 1977 to 2011. The data moment for marginal issuance cost is from Hennessy and Whited (2007). The reported statistics for the model are obtained from 100 samples of simulated data, each with 3,600 firms and 600 monthly observations.

Moments	Data	Model
Asset prices		
Aggregate stock market excess return (%)	5.63	5.59
Sharpe ratio of stock market returns	0.35	0.49
Real risk-free rate (%)	1.65	1.65
Average aggregate book/market	0.58	0.62
Real quantities: Aggregate-level		
Standard dev. of profits	0.14	0.12
Standard dev. of net issuance-to-capital ratio	0.04	0.05
Standard dev. of debt growth rate	0.08	0.08
Average frequency of net issuance	0.37	0.34
Marginal issuance cost	$.084 - .12$	0.1
Real quantities: Firm-level		
Standard dev. of net issuance/book	0.35	0.32
Standard dev. of investment rate	0.19	0.17
Autocorrelation of investment rate	0.29	0.39
Interquatile range of investment rate	0.16	0.18
Skewness of investment rate	1.23	1.99
Kurtosis of investment rate	8.25	9.45
Standard dev. of financial leverage ratio	0.14	0.08
Autocorrelation of financial leverage ratio	0.65	0.62

Table 5 : Asset pricing tests in the model

Panel A in this table reports the portfolio average returns, Sharpe ratios (average return-to-return standard deviation ratio), the CAPM abnormal returns (α), and two factor-model factor loading using several portfolio sorts as test assets and data simulated by the model. Each sort is based on 10 or 6 portfolios (or all portfolio together - All), and we report portfolios 1 (Low, L), and 10 or 6 (High, H) for each sort. H-L stands for the high-minus-low portfolio. $\mathrm{E}[\mathrm{r}^e]$ is the average annualized ($\times 1200$) portfolio excess stock return; $\sigma[r^e]$ are the annualized standard deviation of the portfolio excess returns; $[t]$ are heteroscedasticity and autocorrelation consistent t-statistics (Newey-West). α are the portfolio CAPM average abnormal returns, obtained as the intercept from monthly CAPM regression, reported in annual percentage ($\times 1200$); MKT and ICS (issuance cost shock) are the portfolio market and issuance cost shock betas, respectively, obtained from a the time series regression of the portfolio excess returns on the market and the ICS factors. Panel B reports the estimates (and the corresponding t-statistics below each estimate) of the loadings b_{M} and b_{I} in the stochastic discount factor $M_{t+1} = 1 - b_{\mathrm{M}} \times \mathrm{MKT}_t - b_{\mathrm{I}} \times \mathrm{ICS}_t$ in which MKT_t is the (demeaned) market return, and $\mathrm{ICS}_t$is the (demeaned) issuance cost shock. Estimation is by the generalized method of moments (GMM) using the moment condition $E_T\left[r^e_{it} M_{t+1}\right] = 0$, and it is performed separately across each portfolio sort, and using all portfolio sorts together (All). The table reports both 1st stage and 2nd stage GMM estimates. MAE is the mean absolute pricing errors across the corresponding portfolios. The reported statistics for the model are obtained from 100 samples of simulated data, each with 3,600 firms and 600 monthly observations.

Panel A: Time series regressions

	10 BM			10 IK			10 Size			10 ΔDebt			6 Issue.		
	L	H	H-L	L	H	H-L	L	H	H-L	L	H	H-L	L	H	H-L
	Average returns and Sharpe ratios														
$\mathrm{E}[\mathrm{r}^e]$	2.84	9.56	6.72	9.03	2.23	−6.80	8.20	2.43	−5.77	8.90	2.33	−6.57	6.37	3.31	−3.06
[t]	1.69	5.80	7.76	5.42	1.40	−7.90	6.30	1.43	−4.46	5.50	1.43	−7.50	3.73	2.01	−4.55
SR	0.24	0.83	1.15	0.81	0.20	−1.17	0.91	0.20	−0.67	0.79	0.21	−1.12	0.54	0.29	−0.69
	Abnormal returns and factor loadings														
α	−3.35	4.26	7.61	3.62	−4.02	−7.64	3.99	−4.40	−8.39	3.67	−3.98	−7.65	0.69	−2.63	−3.33
[t]	−7.63	8.19	8.89	7.38	−8.65	−8.84	8.61	−9.44	−9.98	7.61	−8.76	−9.13	1.57	−5.94	−4.67
MKT	1.13	0.94	−0.18	0.96	1.14	0.18	0.73	1.25	0.51	0.93	1.15	0.21	1.01	1.08	0.07
[t]	46.79	33.09	−2.82	37.04	42.87	2.63	34.67	53.42	10.64	37.38	44.22	3.59	79.61	52.71	1.38
R^2	0.96	0.92	0.15	0.93	0.96	0.15	0.91	0.97	0.61	0.93	0.96	0.19	0.96	0.96	0.07
MKT	1.03	0.83	−0.30	0.85	1.04	0.31	0.65	1.13	0.49	0.82	1.05	0.34	0.89	1.00	0.18
[t]	14.71	13.83	−3.16	14.17	14.68	2.97	10.99	14.70	5.91	13.94	14.87	3.52	14.56	13.85	1.53
ICS	−0.07	0.11	0.21	0.10	−0.09	−0.22	0.13	−0.08	−0.20	0.11	−0.08	−0.22	0.05	−0.05	−0.11
[t]	−1.15	1.99	2.71	1.88	−1.33	−2.92	2.66	−1.18	−3.18	1.87	−1.30	−2.97	0.89	−0.71	−2.02
R^2	0.82	0.78	0.33	0.79	0.82	0.35	0.74	0.83	0.56	0.79	0.82	0.38	0.81	0.82	0.22

Table 5 : Asset pricing tests in the model (cont.)

Panel B: Cross sectional analysis

	10 BM		10 IK		10 Size		10 ΔDebt		6 Issue.		All	
	CAPM	2F	CAPM	2F	CAPM	2F	CAPM	2F	CAPM	2F	CAPM	2F
	1[st] stage GMM											
b_M	4.15	4.06	4.06	4.11	4.13	4.08	4.05	4.14	4.49	4.19	4.17	4.12
[t]	6.70	2.59	6.57	2.55	6.57	2.54	7.02	3.21	5.72	2.39	2.97	2.55
b_I		22.17		22.84		22.72		18.15		24.34		22.74
[t]		5.27		5.29		5.24		4.43		4.50		5.15
MAE	2.04	0.38	2.17	0.50	2.09	0.31	0.90	0.26	2.60	0.29	1.95	0.38
	2[nd] stage GMM											
b_M	6.73	3.55	6.72	3.27	7.05	3.85	5.50	3.43	8.67	3.39	12.99	2.82
[t]	13.09	3.37	13.39	2.78	12.84	2.76	11.07	3.30	13.07	2.70	11.27	3.93
b_I		18.07		18.74		21.73		16.00		20.18		16.65
[t]		6.32		5.90		6.09		6.20		5.71		9.72
MAE	3.68	0.87	3.93	1.32	4.16	0.43	2.14	1.08	5.37	1.33	12.99	2.07

Table 6 : Investment, financial flows, and productivity in the data versus model

This table reports the portfolio characteristics of several portfolio sorts in the model and in the real data (column "Data"). Each sort is based on 10 or 6 portfolios, and we report the characteristics for portfolios 1 (Low, L), and 10 or 6 (High, H) for each sort. H-L stands for the high-minus-low portfolio. IK is investment rate; Equity/BE is the market-equity-to-book-equity ratio; Equity Freq. is the fraction of firms with positive net equity issuance in the portfolios; ΔDebt is the growth rate of debt; Debt Freq. is the fraction of firms in the portfolio that issue debt; Lev is the financial leverage ratio; TFP is firms' total factor productivity (TFP), a measure of productivity (in the model, TFP=log(Z), and in the real data the firm-level TFP is from Tuzel and Imrohoroglu, 2013). All variables except TFP are report in percentage. The reported statistics for the model are obtained from 100 samples of simulated data, each with 3,600 firms and 600 monthly observations.

	10 Book-to-Market				10 Investment				10 Size			
Characteristic	L	H	H-L	Data	L	H	H-L	Data	L	H	H-L	Data
IK	33.74	−5.12	−38.86	−19.14	−5.84	51.81	57.65	74.57	3.13	25.77	22.64	6.22
Equity/BE	8.76	−7.76	−16.52	−2.49	−9.76	30.55	40.31	2.32	6.11	−25.57	−31.68	−5.83
Equity Freq.	57.52	20.94	−36.58	−37.97	13.47	72.27	58.80	26.62	68.59	19.82	−48.77	−15.09
ΔDebt	21.53	−17.54	−39.07	−8.57	−18.15	35.68	53.83	43.17	−10.79	20.21	31.00	7.72
Debt Freq.	86.02	9.00	−77.02	4.76	3.89	98.88	94.99	25.39	20.30	79.53	59.23	22.35
Leverage	34.55	46.16	11.61	57.52	48.93	31.72	−17.21	−31.06	36.87	33.78	−3.09	−18.47
TFP	1.19	0.89	−0.30	−0.23	0.83	1.56	0.73	0.17	0.37	2.74	2.37	0.22

	10 ΔDebt				6 Issuance			
Characteristic	L	H	H-L	Data	L	H	H-L	Data
IK	−5.06	49.68	54.74	12.28	0.26	45.27	45.01	14.60
Equity/BE	−4.57	19.76	24.33	−0.36	−16.44	35.38	51.82	64.42
Equity Freq.	29.21	59.89	30.68	−0.01	1.85	86.02	84.17	63.86
ΔDebt	−19.57	37.74	57.31	271.59	−9.07	25.86	34.93	0.10
Debt Freq.	0.00	99.79	99.79	99.97	25.30	88.03	62.73	−0.73
Leverage	48.15	29.14	−19.01	−12.60	40.65	33.08	−7.57	−20.04
TFP	0.72	1.67	0.95	0.06	1.11	1.21	0.10	0.06

Table 7 : Selected data versus model-implied moments across alternative calibrations

This table presents several comparative statics exercises. The reported statistics for the model are obtained from 100 samples of simulated data, each with 3,600 firms and 600 monthly observations.

	Quantities		Asset Prices											
	Correl.	S.D.		MKT	BM		IK		Size		ΔDebt		Issuance	
Spec.	(ICS,ξ_t)	IK	Lev	r^e	r^e	α	r^e	α	r^e	α	r^e	α	r^e	α
0-Data														
	n.a.	0.19	0.38	5.71	7.07	7.46	5.99	9.06	3.61	2.40	−2.80	−3.05	−4.63	−7.82
1-Benchmark														
	0.31	0.21	0.38	5.59	6.72	7.61	6.80	7.64	5.77	8.39	6.57	7.65	3.06	3.33
2-No stochastic issuance costs ($\eta_2 = 0$)														
	0.01	0.20	0.52	11.02	−1.92	−1.99	−0.81	−1.89	−1.81	1.57	−1.13	−1.53	0.54	−0.87
3-Zero issuance costs ($\eta_0 = \eta_1 = \eta_2 = 0$)														
	0.02	0.26	0.48	10.35	−0.65	−1.97	1.40	−1.26	−0.10	−1.57	1.08	−1.78	0.11	−0.58
4-Small price of risk of aggregate productivity shock ($\gamma_x = 4.5$; benchmark $\gamma_x = 9.25$)														
	0.36	0.18	0.32	3.87	4.63	5.03	4.36	4.66	5.74	6.72	4.43	4.81	0.51	0.36
5-Small price of risk of aggregate issuance cost shock ($\gamma_\xi = 3$; benchmark $\gamma_\xi = 7$)														
	0.21	0.21	0.43	6.57	3.13	4.52	4.17	5.40	4.28	6.88	4.04	5.29	1.86	1.85
6-Tight collateral constraint/Low resale value of physical capital ($\varphi = 0.05$; benchmark $\varphi = 0.75$)														
	0.28	0.24	0.04	5.99	−4.20	−2.82	−3.43	−2.37	−2.96	−1.19	−3.27	−2.13	−0.86	−0.77
7-High debt adjustment cost ($c_d = 28$; benchmark $c_d = 2.8$)														
	0.42	0.25	0.00	6.20	−2.59	0.71	−1.59	0.40	−1.37	1.30	−0.86	0.25	−0.55	0.20
8-Zero fixed operating cost ($f = 0$)														
	0.36	0.20	0.38	5.83	2.57	3.30	4.45	5.15	7.11	8.00	4.58	5.28	1.64	1.68
9-Low physical capital adjustment costs ($c_k^- = 6$; benchmark $c_k^- = 39$)														
	0.28	0.24	0.39	−0.71	0.40	0.04	3.35	3.02	12.30	11.82	4.07	3.74	2.94	2.69

Figure 1 : Equity issuance, aggregate TFP, and shocks

This figure reports the time series of the fraction of equity issuers in the cross section (top left Panel), the time series of aggregate TFP growth (adjusted for capacity utilization) (top right Panel), and the time series of the equity issuance cost shock (ICS) and TFP shock (obtained as the residuals from the VAR(1) system). Shaded bars are NBER recession years. The data is annual from 1971 to 2011.

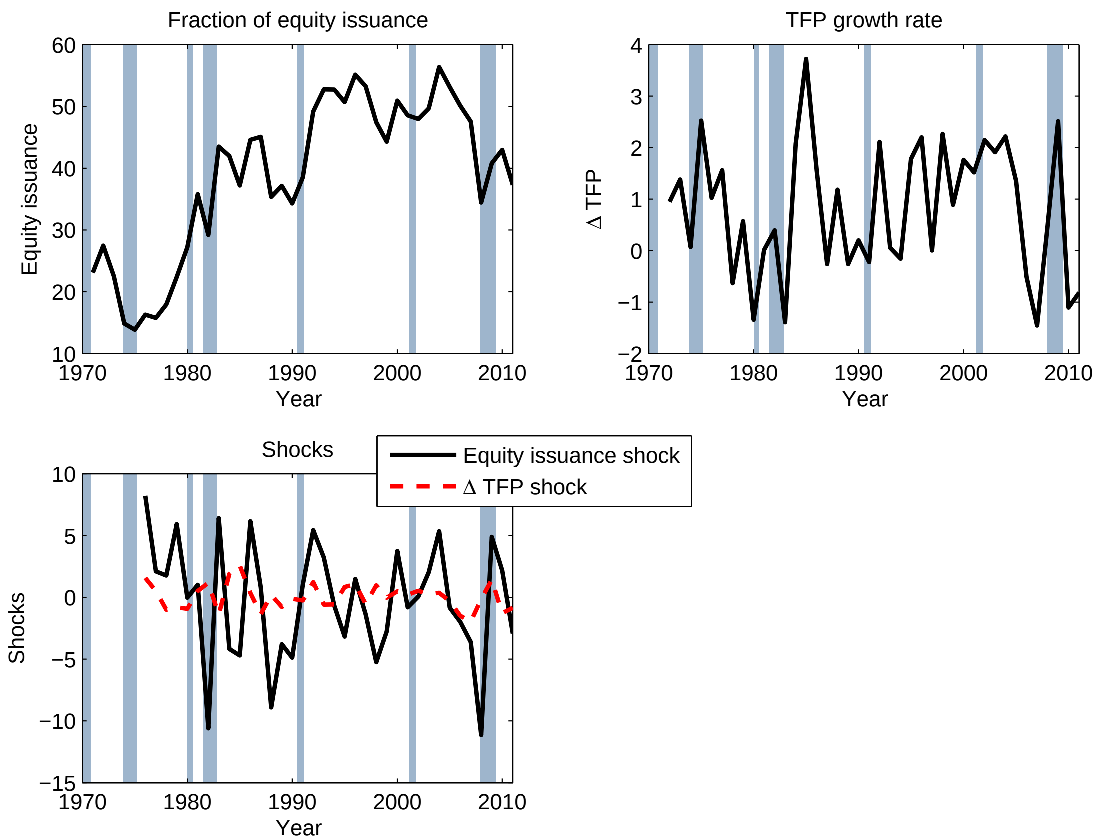

Figure 2 : Pricing errors

This figure reports the predicted versus realized average stock returns of several portfolio sorts in the real data (top panels) and in data simulated in the model (bottom panels). In the left panel, the predicted returns use the CAPM as the pricing model, and in the right panels, the predicted returns use a two factor model (Market and ICS) as the pricing model. The real data is annual from 1976 to 2011. The reported statistics for the model are obtained as averages from 100 samples of simulated data, each with 3,600 firms and 600 monthly observations.

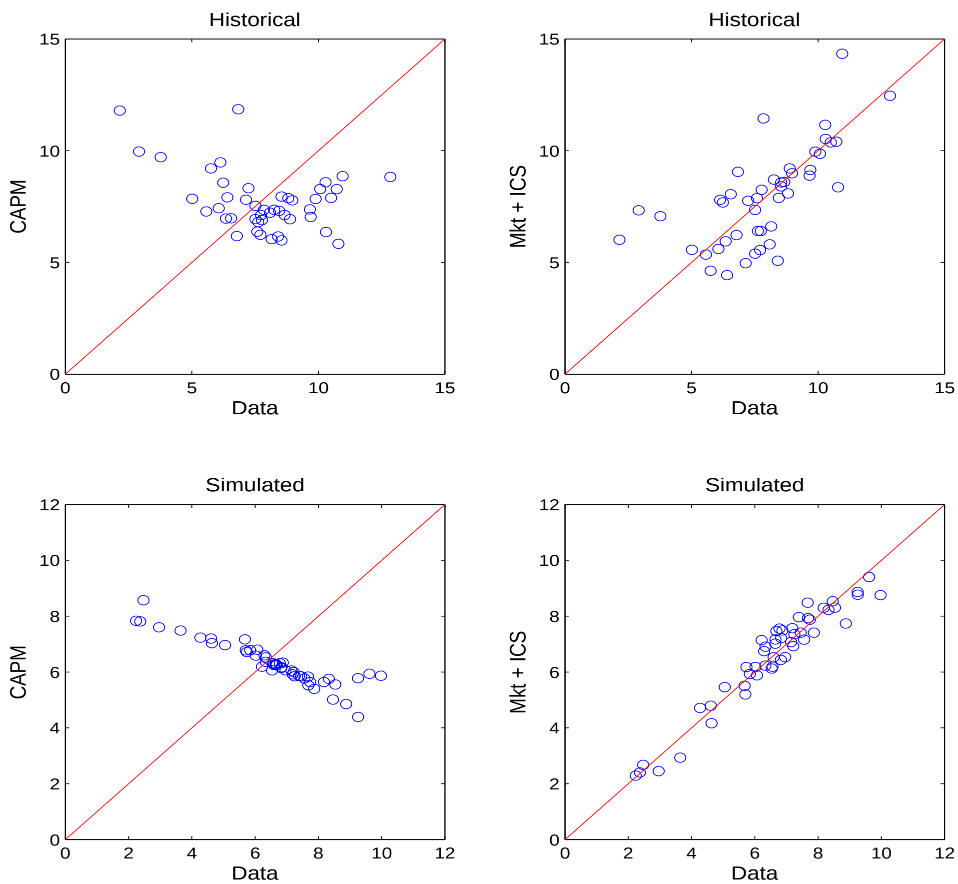

Figure 3 : Market and equity issuance cost shock betas

This figure reports the risk exposures of the ten book-to-market, ten investment portfolios, ten size portfolios, ten debt growth portfolios, and 5 issuance portfolio using data simulated from the model. It reports the slope coefficients from the following time-series regressions $r_{it}^e = a_i + \beta_i^m \times r_t^m + \beta_i^\xi \times \Delta\xi_t + e_{it}$, in which r_{it}^e is the monthly excess return of the i^{th} portfolio, r_t^m is the market excess returns, and $\Delta\xi_t$ is the aggregate equity issuance cost shock. The slope coefficients for each portfolio are expressed relative to the average of the corresponding slope coefficients across portfolios. The reported statistics for the model are obtained as averages from 100 samples of simulated data, each with 3,600 firms and 600 monthly observations.

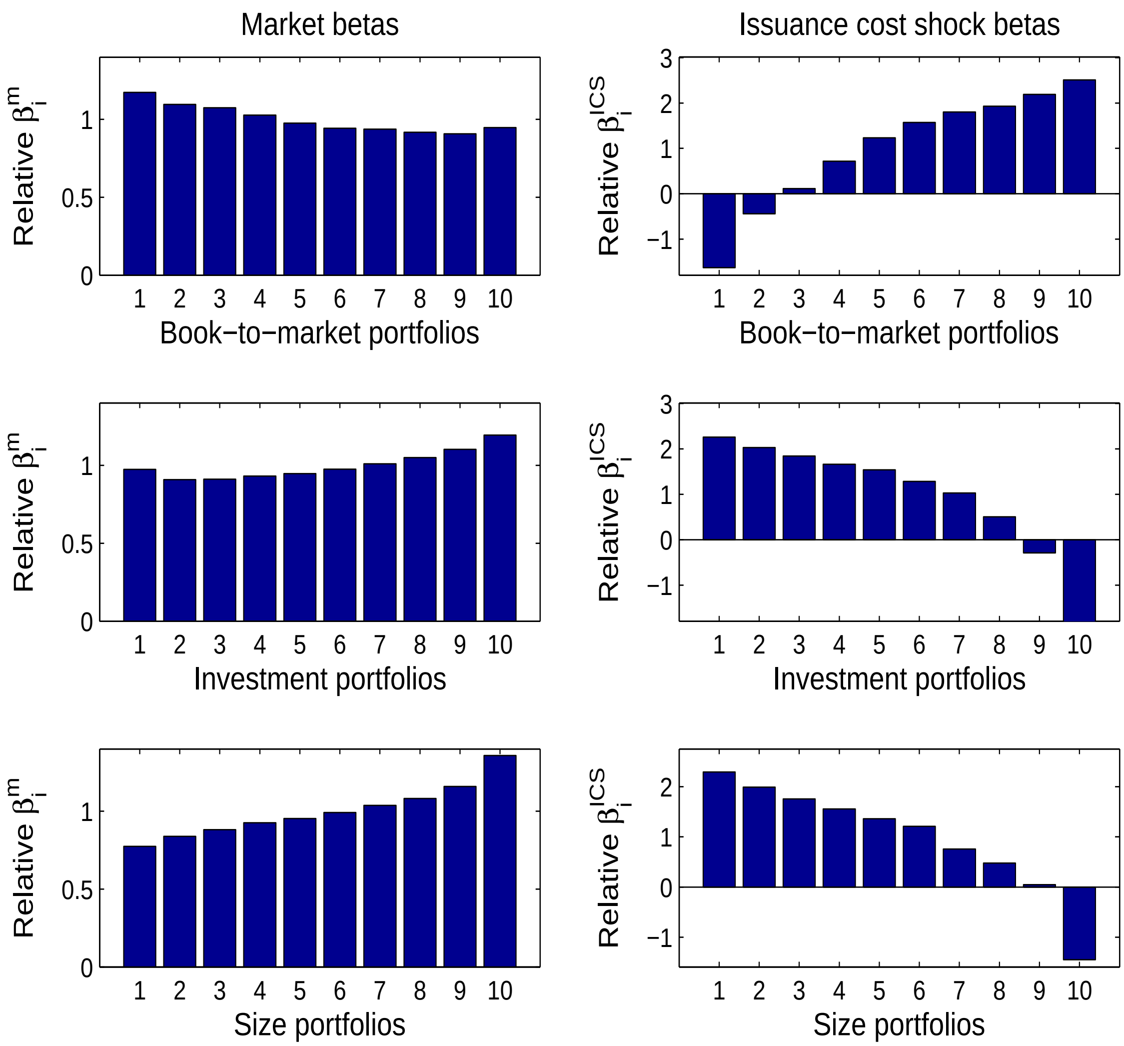

Figure 3 : Market and equity issuance cost shock betas (cont.)

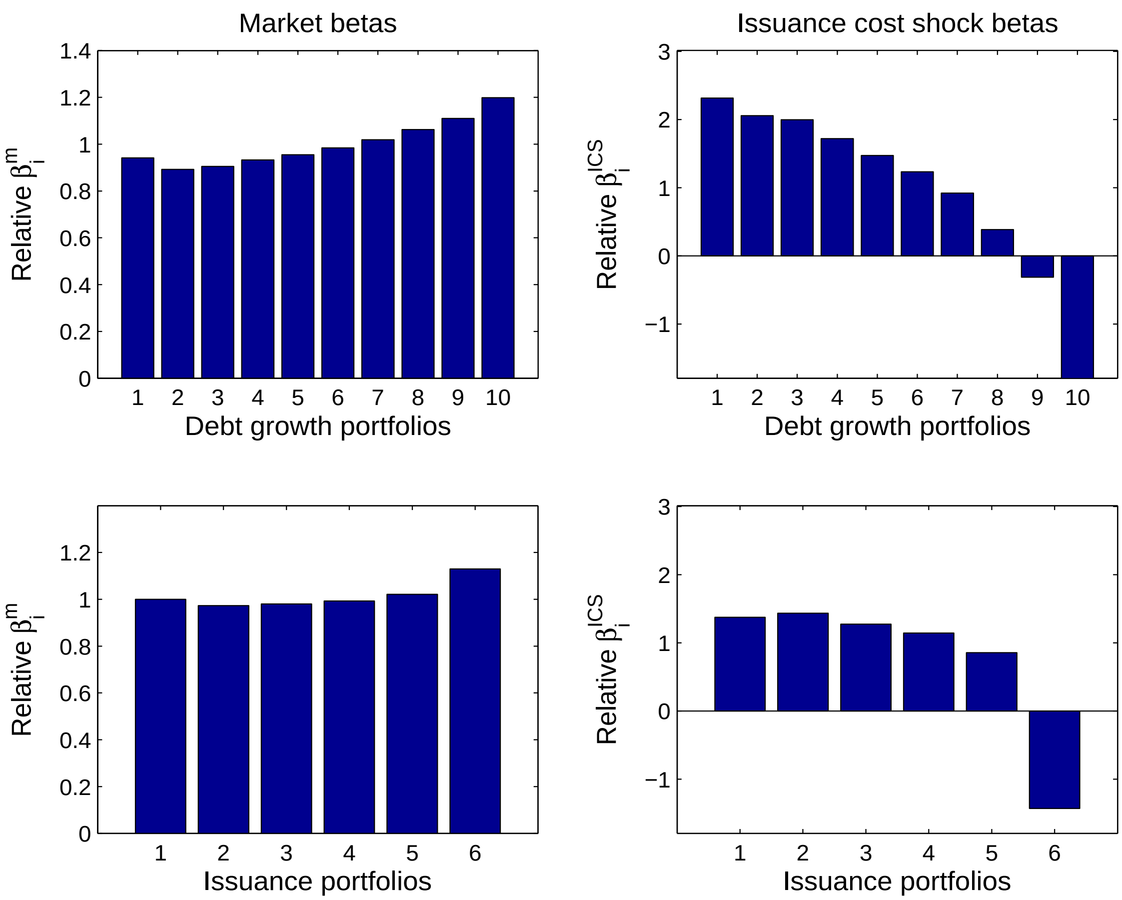

Figure 4 : Impulse response to an aggregate equity issuance cost shock

Impulse responses of selected endogenous variables in the baseline calibration of the model to a one standard deviation negative aggregate equity issuance cost shock (higher cost of issuing equity). The responses are measured in percent deviation relative to the long-run average values (time detrended, when applicable). To generate the response of a high productivity (H) firm, we add a positive one standard deviation firm-specific productivity shock. To generate the response of a low productivity firm (L), we add a negative one standard deviation firm-specific productivity shock. The frequency of the data is monthly. IK is firms' investment rate, ΔB is firms' debt change, SDF is the stochastic discount factor (consumers' marginal utility), Sales is measured as output Y, Profits is after tax corporate profits, Div is firms' dividends, and V is the continuation value of the firm (price of the firm after dividends).

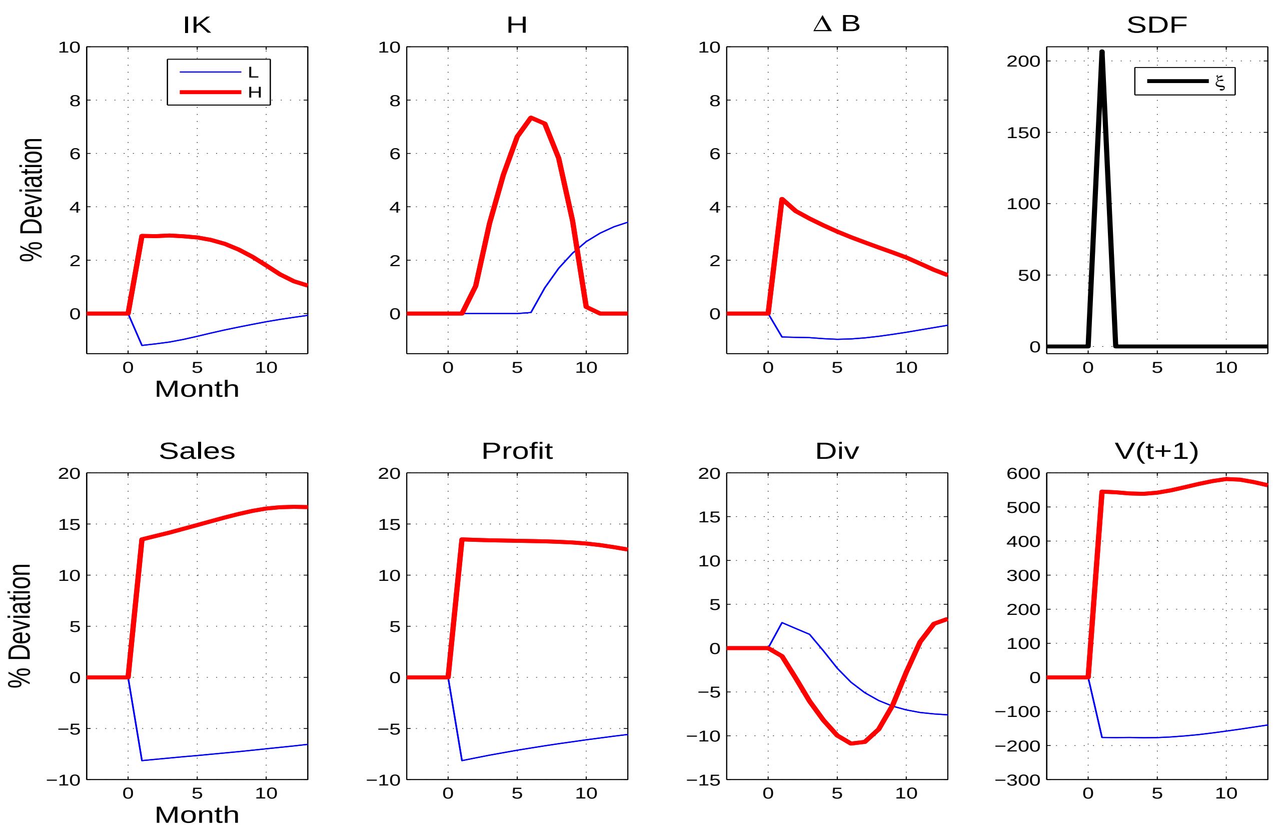

Figure 5 : Impulse response to an aggregate productivity shock

Impulse responses of selected endogenous variables in the baseline calibration of the model to a one standard deviation negative aggregate productivity shock. The responses are measured in percent deviation relative to the long-run average values (time detrended, when applicable). To generate the response of a high productivity (H) firm, we add a positive one standard deviation firm-specific productivity shock. To generate the response of a low productivity firm (L), we add a negative one standard deviation firm-specific productivity shock. The frequency of the data is monthly. IK is firms' investment rate, ΔB is firms' debt change, SDF is the stochastic discount factor (consumers' marginal utility), Sales is measured as output Y, Profits is after tax corporate profits, Div is firms' dividends, and V is the continuation value of the firm (price of the firm after dividends).