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

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Abstract

The ability of corporations to raise external equity finance varies with macroeconomic conditions, suggesting that the cost of equity issuance is time-varying. Using cross sectional data on U.S. publicly traded firms, we construct an empirical proxy of an aggregate shock to the cost of equity issuance, which we interpret as a financial shock. We show that this shock captures systematic risk, and that exposure to this shock helps price the cross section of stock returns including book-to-market, investment, and size portfolios. We propose a dynamic investment-based model with stochastic equity issuance costs and a collateral constraint to interpret the empirical findings. Our central finding is that time variation in external equity financing costs is important for the model to quantitatively capture the joint dynamics of firms' asset prices, real quantities, and financing flows. In the model, growth firms, high investment firms, and large firms, can substitute more easily debt financing for equity financing when it becomes more costly to raise external equity, hence these firms are less risky in equilibrium. The model also replicates the failure of the unconditional CAPM in pricing the cross section of stock returns.

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1 Introduction

The recent financial crisis in 2007-2008 is fresh evidence that shocks in the financial sector can be an important source of business cycle fluctuations, and that the impact of the financial shocks on the availability of firms' external finance can be substantial. In this paper, we study the impact of an aggregate shock to the cost of firms' external equity finance– a particular form of financial shocks– on asset prices, real quantities, and financing flows in the cross section of U.S. firms. We show both empirically as well as through the lens of an investment-based model with financial frictions, that time-variation in the availability of external equity funds has a significant impact on equilibrium risk premiums in the cross section.

Building on Eisfeldt and Muir (2014), we use firm-level cross sectional data to construct an empirical proxy of the aggregate shock to the cost of equity issuance in the U.S. economy. Different from Eisfeldt and Muir (2014), however, we focus explicitly on the cost of issuing equity, not on the general cost of external (debt and equity) finance, a distinction we show to be empirically important for our results.[1] Specifically, for each year, we compute the fraction of firms issuing equity in the cross section, and we then extract the time-series of the innovations in this fraction using a vector autoregressive (VAR) model that includes aggregate productivity as a state variable to control for the effect of time-varying growth opportunities on firms' equity issuance decisions. We refer to the innovations in the VAR as an (equity) issuance cost shock (ICS). A positive realization of the ICS is associated with an increase in firms' equity issuance beyond what aggregate market conditions, as captured by the level of aggregate productivity, would predict. As such, this positive shock reveals, at least partially, a low (marginal) cost of equity issuance, and vice versa. We also show that our simple procedure to extract issuance cost shocks with a VAR is robust to the inclusion of several other control variables known to explain equity issuance decisions by firms.

Our empirical approach is consistent with the view that external equity is costly and that these costs vary over time, as in, for example, Bolton, Chen, and Wang (2013). The ICS captures the systematic (aggregate) component driving the time-variation of the equity issuance costs. While we do not study the causes of the changes in external equity financing conditions, the source of its time variation could be due to the impact of changes in information asymmetries and agency frictions, changes in investors' sentiment, time-varying aggregate liquidity, time-varying risk aversion of financial intermediaries, among other effects, on investors' willingness to supply equity capital to firms. We review the related literature in Section 2.

Empirically, we show that the ICS captures systematic risk in the economy. Controlling for

[1] When we use a similar approach to extract debt (not equity) issuance cost shocks, we find that firms' differential exposure to these shocks do not appear to capture cross sectional variation in systematic risk in the cross section, which is the focus of our study.

the aggregate market factor, firms' exposure to ICS helps explain cross-sectional variation in the average returns of portfolios sorted by book-to-market (value premium), investment rate (investment spread), and market equity (size spread). 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 (low ICS). Because value firms, low investment firms, and small firms have a relatively higher exposure (covariance) to ICS, these firms are riskier and thus, have higher returns in equilibrium. Augmenting the standard capital asset pricing model (CAPM) with ICS as an additional factor, we show that the two-factor model significantly outperforms the CAPM in pricing the cross section of stock returns of these portfolios.

We propose a dynamic investment-based model with financial frictions to understand the economic mechanism driving the empirical findings. The model features a large cross section of firms that invest in physical capital, issue equity and debt or save using cash, to maximize the value of the firm for existing shareholders. Cross-sectional heterogeneity is driven by idiosyncratic productivity shocks. The key features of the model are: (i) debt issuance is limited by a (standard) collateral constraint; and (ii) equity issuance is costly and this cost is stochastic, varying over time due to an aggregate issuing cost shock. This equity issuance cost shock acts as an additional source of aggregate economic fluctuations (financial shocks) that is independent of aggregate productivity shocks, and affects investor's marginal utility (with a positive price of risk), consistent with the empirical evidence reported here. We interpret a negative issuance cost shock as a disruption in the financial sector, with no initial disruptions in the nonfinancial sector, which is the sector of the economy that we model here.[2] This disruption implies that fewer funds can be channeled from equity holders to firms. This leads to insufficient external financing available to firms, which in turn affects firms' investment, dividends, and market value of equity.

The cross sectional variation in expected stock returns arises endogenously in the model due to the interaction between firms' 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 (equity and debt) during bad economic times is an important determinant of equilibrium risk premiums. Because growth firms, high investment firms, and large firms, can substitute more easily debt financing for equity financing when it becomes more costly to raise external equity, these firms are less risky in equilibrium.

[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.

The exact economic mechanism in the model 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 to raise external equity. However, high productivity firms can still finance investment through debt because their collateral value (capital) is increasing. Thus, because high productivity firms can substitute debt financing for equity financing, the high productivity firms are still able to increase their future dividend payout and hence their continuation value still rises. As a result, these firms are relatively less affected by the ICS and hence their returns covary less with ICS. 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 ICS. These firms are experiencing a decrease in their productivity, 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 it was not costly to access the equity market), the 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, these firms are relatively more affected by the ICS shocks and hence their returns covary more with ICS. These firms therefore have relatively higher risk and hence higher expected returns in equilibrium. In the model, and consistent with the data (see, for example, Imrohoroglu and Tuzel, 2014), the high productivity firms tend to be growth firms, high investment firms, and large firms, thus the model generates cross sectional return spreads in book-to-market, investment, and size portfolios that are similar to those observed in the real 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.

We provide empirical support for the model's economic mechanism. In the data, more productive firms (growth firms, high investment firms, large firms) increase the use of debt financing and reduce the use of equity financing in years when it is more costly to issue equity (years with low realizations of the ICS), but the opposite pattern is true in years when the cost of external equity is low (years with high realizations of the ICS). The less productive firms reduce both debt and equity in years when it is more costly to issue equity. Thus, for more productive firms, we observe a substitution effect between debt and equity financing when the external equity financing cost is high. Consistent with the model, we do not find such substitution effect when aggregate productivity is low. This result is also consistent with the interpretation that the time-varying issuing cost is capturing a dimension of the wealth of the financial market that is distinct from aggregate total factor productivity in the data.

Quantitatively, the model matches aggregate- and cross-sectional moments of asset prices and real quantities with reasonable parameter values, as well as key properties of the firm-level investment rates and debt and equity financing flows. Through several comparative static exercises, we show that the existence of positive and time-varying external equity issuance costs is important for the good quantitative fit of the model. Without external equity finance costs, the model generates an equity issuance-to-book-equity ratio that is too volatile (53% in the frictionless equity financing model versus 46% in the baseline model with equity financing costs, and 41% in the data) and value, investment, and size return spreads that are too small and even slightly negative. Similarly, when external equity financing is costly but time-invariant, the model implies a counterfactually too smooth equity issuance-to-book-equity ratio (31% versus 41% in the data). These results are intuitive. Without external equity financing costs, all firms 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 the collateral constraint or increase the debt adjustment cost, all the cross sectional return spreads become tiny or negative. This result is also intuitive. When all firms have limited debt capacity, the substitution channel between equity and debt financing is essentially turned off because the ability of productive firms to substitute debt for equity financing to smooth negative aggregate shocks is very limited. In turn, this effect makes these firms more similar to the low productive firms in terms of flexibility, substantially reducing the endogenous risk dispersion in the cross section.

We also use the model to validate the ICS VAR proxy that we use in the empirical analysis. Because in the model we observe both the true ICS (which in practice is unobservable) and its empirical VAR proxy, we can use the model to investigate the conditions under which (if any) the VAR proxy of ICS proposed here is a valid proxy for the true underlying ICS that we try to infer in the data. We document that, in the baseline calibration of the model, the correlation between the two variables is significantly positive (46%), supporting the use of this proxy measure of ICS in the empirical work. Consistent with the previous analysis, this high correlation relies crucially on the existence of positive and time-varying equity issuance costs that affects firm's payouts. In the model, when we either shut down the time variation in the equity issuance costs or set the equity issuance costs to zero (keeping the effect of ICS on investors' marginal utility, and hence, still allowing for an effect of ICS on asset prices), the implied correlation between the true shock and its VAR proxy is essentially zero.

Finally, the model also replicates the well documented failure of the unconditional CAPM in explaining the cross sectional variation in the expected returns of the portfolios considered here. The significant magnitude of the CAPM pricing errors in the model represents an improvement relative the standard neoclassical investment-based model in which aggregate productivity is the only source of aggregate risk (e.g., Zhang 2005). More important, different from the existing investment-based literature that highlights the role of either investment shocks (e.g., Kogan and Papanikolaou, 2014a and 2014b) or adjustment cost shocks (e.g., Belo, Lin, and Bazdresch, 2014) in generating the failure of the CAPM, our model provides a novel mechanism that shows the importance of financial shocks in breaking the CAPM. This mechanism is also different from Koijen, Lustig, and Van Nieuwerburgh (2013) who highlight the different exposures between value and growth firms to shocks signaling future economic growth.

The paper proceeds as follows. Section 2 discusses the related literature. Section 3 shows the empirical links between issuance costs shocks, systematic risk, and the cross section of expected stock. Section 4 presents a dynamic investment-based model with financial frictions and time-varying equity issuance costs. Section 5 presents the calibration and model solution. Section 6 shows the ability of the model in replicating the cross sectional facts. Section 7 provides a detailed analysis of the economic mechanisms driving the good fit of the model. Finally, Section 8 concludes. A separate Appendix with additional results and robustness checks is posted online.

2 Related literature

This paper is closely related to the literature that examines the impact of financial frictions on corporate investment and asset prices.[3] In particular, Bolton, Chen, and Wang (2013), who study firms' investment, financing, and cash management decisions in a dynamic q-theoretic framework in which, similar to our model, external financing conditions are stochastic, and Eisfeldt and Muir (2014), who infer the aggregate cost of external (debt and equity, not just equity as in our work) finance by using firms' cross sectional investment, financing, and saving decisions in a dynamic model. Our analysis is complementary to these studies in that we focus on the impact of the time varying external equity issuance cost on the cross section of expected returns, a dimension that is not examined in these studies.

Our empirical work builds on the corporate finance literature which shows empirically that equity issuance is costly, and that these costs vary over time. These equity issuance costs include both direct costs (for example, flotation costs - underwriting, legal and registration fees), and indirect (unobserved) costs due to asymmetric information and managerial incentive problems, among others (see introduction section). These costs are estimated to be substantial. For example, Altinkilic and Hansen (2000) estimate the underwriting fee ranging from 4.37%

[3]See, for example, Gomes (2001), Hennessy and Whited (2005, 2007), Carlson, Fisher, and Giammarino (2006), Bolton, Chen, and Wang (2011), DeMarzo, Fishman, He, and Wang (2012), Bolton, Wang, and Yang (2014), among others.

to 6.32% of the capital raised in their sample. In addition, a few empirical papers also seek to estimate the indirect costs of equity issuance. Asquith and Mullins (1986) find that the announcement of equity offerings reduces stock prices on average by -3% and this price reduction as a fraction of the new equity issue is on average -31%. Furthermore, Choe, Musulis, and Nanda (1993) find that the adverse selection costs measured as negative price reaction to SEO announcement is higher in contractions and lower in expansions, suggesting changes in information symmetries between firms and investors are likely to vary over business cycles. In this paper, we do not explain the sources of the equity issuance costs. Instead, we take the evidence from these previous studies and incorporate these costs in an investment-based model with financial frictions, and we then investigate the implications of time-variation in equity issuance costs to understand cross sectional variation in average stock returns.

Our paper also relates to the corporate finance literature that explores the relation between external financing and macroeconomic conditions. Erel, Julio, Kim, and Weisbach (2012) show that firms' access to external finance markets changes with macroeconomic conditions. Kahle and Stulz (2013) find that net equity issuance falls more substantially than debt issuance during the recent financial crisis suggesting that shocks to the corporate credit supply are not likely to be the cause for the reduction in firms' capital expenditures in 2007-2008. McLean and Zhao (2013) document that both investment and employment are more sensitive to cash flows during recessions. Consistent with our results, McLean and Zhao also find that equity issuance plays a bigger role than debt issuance in causing their finding. Motivated by the findings in Covas and Den Haan (2011), Begenau and Salomao (2013) study the differential financing behavior of small and large firms over the business cycles. We contribute to this literature by proposing a proxy for the aggregate shock to the cost of external equity issuance, and showing that this shock has an important impact on both risk premiums and financing flows in the cross section.

Our theoretical analysis is also closely related to the literature that studies asset prices in production economies. This literature has primarily focused on aggregate shocks that originate in the real sector, for example, aggregate productivity shocks or investment-specific shocks, or shocks on monetary and fiscal policies.[4] Our paper differs in that we explore the relation between financing flows and the cross sectional variation of stock returns when firms face a financial aggregate shock that affects the cost of issuing equity.

Finally, our theoretical analysis is also related to the recent macroeconomic literature which studies the impact of financial shocks (frictions) on aggregate quantities. Different from the

[4]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) and Kogan and Papanikolaou (2014a and 2014b) 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.

shocks to the credit supply highlighted in Jermann and Quadrini (2011) and Khan and Thomas (2014), we focus on aggregate shocks to the cost of external equity issuance and on the implications of these shocks for risk premiums in the cross section. The financial frictions in our model are similar in spirit to Bernanke and Gertler (1989), Kiyotaki and Moore (1997), Bernanke, Gertler, and Gilchrist (1999), among others. 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, 2011, and Khan and Thomas, 2014) as opposed to propagating shocks that originate in other sectors of the economy.

3 Empirical findings

In this section, we construct an empirical proxy of an aggregate shock to the cost of equity issuance in the U.S. economy. We then document the empirical links between equity issuance cost shocks, systematic risk, and average stock returns in the cross section.

3.1 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 2012, and includes firms with common shares (shrcd= 10 and 11) and firms traded on NYSE, AMEX, and NASDAQ (exchcd= $1, 2$, and 3).[5] We omit firms whose primary standard industry classification (SIC) code is between 4900 and 4999 (utility firms) or between 6000 and 6999 (financial firms). We correct for the delisting bias following the approach in Shumway (1997).

We use standard portfolios as test assets. The portfolios are 5 book-to-market portfolios, 5 investment rate portfolios, and 5 size (market equity) portfolios. Appendix A-3 explains the construction of these portfolios. For each portfolio, we report both average equal- and value-weighted returns to provide a comprehensive picture of the link between issuance cost shocks and risk premiums in the overall economy. As discussed in Fama and French (2008), the properties of average equal-weighted returns are dominated by the behavior of very small firms because these firms are plentiful and also have more volatile returns. Similarly, the properties of average value-weighted returns are dominated by the behavior of a small number of very large (albeit important) firms because of the well-known heavy tails of the size distribution in the U.S. stock market. Hence, reporting both average equal- and value-weighted returns allows

[5]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).

us to infer the links between issuance cost shocks and risk premiums for a typical median firm in the economy.

The stock market factor and the risk-free returns are obtained from Ken French's website. Utilization-adjusted total-factor productivity (TFP) data is from John Fernald/Kuni Natsuki (available at John Fernald's webpage at the Federal Reserve Bank of San Francisco).[6] Portfolio returns are annualized (compounding the monthly returns) from January to December, to match the frequency of the issuance cost shock data.

3.2 Estimation of aggregate equity issuance cost shocks

As discussed in Section 2, measuring the total (direct plus indirect) cost of equity issuance is a difficult task in practice because there is no available data on the indirect (hence, unobserved) costs. Because the indirect costs can be substantial, we estimate a proxy variable that should be correlated with the time-variation in the aggregate component of total equity issuance costs in the data.

3.2.1 Construction of ICS

We estimate a proxy of the aggregate equity issuance cost shock using information on the proportion of firms issuing equity in the cross section. Specifically, we first classify a firm as an equity issuer if its net equity issuance in a given year is positive, and we compute for each year the fraction of firms issuing equity in the cross section. Following Eisfeldt and Muir (2014), the net equity issuance is computed as data item SSTK (sale of common and preferred stock) - data item PRSTKC (purchase of common and preferred stock) - data 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 2012. The top left panel in Figure 1 shows the time series of this fraction. We note that the average fraction of firms issuing equity is large, about 38%, which is larger than the typical frequency of seasoned equity offerings (SEOs), which are relatively rare events. This is because this measure, as in Fama and French (2005), includes several forms of equity issuance. For example, it includes granting of stock options to employees as a form of compensation. Because this form of compensation is also a costly form of financing by firms we include these observations in the main analysis.[7]

[6]The results reported here are robust to using TFP without adjusting for capacity utilization (see online appendix).

[7]Indeed, this form of compensation is costly because, all else equal, 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. That is, the undiversified workers require an additional risk premium for holding the own firms' stock (Huddart, 1994). The differential value that the worker assigns to the stock options relative to the value assigned by outside investors is an indirect cost of issuing equity which we want to capture in our

Nevertheless, in the online appendix, we show that our main results are robust to excluding from this measure most of the equity issuance events that are due to exercising of employee stock options.

[Insert Figure 1 here]

To construct a time-series of the innovations in aggregate equity issuance costs in the economy, which we refer to as the equity issuance cost shock (ICS), we then estimate a first order vector autoregressive (VAR) model using the level of TFP and the percentage of firms issuing equity as the two state variables, denoted x_t and s_t, respectively, and extract the residuals (shocks) from this VAR. We include aggregate TFP in the VAR to control for the standard effect of time-varying investment opportunities on firms' issuance decisions. TFP is also the standard source of economic fluctuations in most macroeconomic models, and thus is a natural driver of 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. Thus, 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] Then, we estimate the following VAR system by standard OLS and using a rolling regression with an expanding window:

$$\begin{pmatrix} x_{t+1} \\ s_{t+1} \end{pmatrix} = A_T \begin{pmatrix} x_t \\ s_t \end{pmatrix} + \begin{pmatrix} u_{t+1} \\ v_{t+1} \end{pmatrix}, \ t = 1971, ..., \mathrm{T}$$

in which u_{t+1} and v_{t+1} are the regression residuals, and A_T is a 2×2 matrix with the estimated coefficients. We first estimate the system from 1971 to 1974 (T= 1974), and then extract the out-of-sample shock in 1975 using the parameters (A_{1974}) estimated in the previous (expanding) period. The rolling regressions allows us to mitigate any look ahead bias in the estimated shocks (as such, all asset pricing tests are performed for the 1975 to 2012 period).

We use the estimated time series of the innovations v_{t+1} as our empirical proxy of ICS. A high realization of ICS (v_{t+1} is high) is associated with an equity issuance wave by firms, which

measure. Additionally, firms use this form of workers' compensation to finance investment. Babenko, Lemmon, and Tserlukevich (2011) shows that firms increase investment by \$0.34 for each dollar received from the exercise of stock options.

[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.

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 shocks.

Note that by extracting the ICS from the percentage of firms issuing equity in the cross section, our measure captures the extensive margin (number of firms) and not so much the intensive margin (dollar amount raised) adjustment of external equity issuance. We do so to focus on the time variation of equity issuance costs for a typical firm in the economy. 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.

3.2.2 Interpretation and robustness

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 this equity issuance cost shock has a more broad interpretation. In essence, this issuance cost shock captures a time-varying wedge between the fundamental value of the equity for managers and the value that outside investors are willing to pay for new equity. As discussed earlier, this wedge can arise due to changes in information asymmetries or agency frictions that have a systematic aggregate impact of the investors' valuation of new equity. Similarly, the wedge may arise due to an increase (decrease) in investors' willingness to supply equity capital to firms (for example, due to changes in investor sentiment, risk-aversion of financial intermediaries, or changes in aggregate liquidity), thus making it effectively less (more) costly for firms to raise new capital.

A relevant empirical question for our analysis is the extent to which the ICS captures variation in the cost of issuing equity, or variation in a more general cost of external finance, that is, the cost of issuing both equity and debt. The answer to this question is important because it can shed light on the economic mechanism driving the results and hence, on the class of models that can explain the empirical findings. To investigate this question, we have replicated the construction of ICS but using the cross sectional fraction of firms issuing debt (a firms is classified as a debt issuer if it has a positive change in total outstanding debt), not equity, in the VAR. We then extracted the out-of-sample innovations in the VAR in an analogous way to the extraction of the ICS, and interpreted these innovations as a proxy for an aggregate debt issuance cost shock. We report the results from this analysis in the online appendix. Interestingly, the correlation between the implied equity and debt issuance cost shock is small and even slightly negative (-16%). In addition, in contrast with the empirical analysis of the link between ICS and systematic risk that we report below, the debt issuance cost shock does not seem to price the cross section of stock returns. Taken together, the results from this analysis show the importance of studying separately the effects of time-varying equity issuance costs from the effects of time-varying debt issuance costs, and that the ICS appears to be a more important determinant of equity risk premiums in the cross section.[9]

Naturally, there are many other different factors affecting firms' equity issuance decisions that are not fully controlled by including only aggregate TFP in the VAR. We focus on this simple VAR specification 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, which also has two aggregate shocks. In this way, the theory and the empirical analysis are well aligned and thus, can be directly compared. This fact also allows us to use the theory to validate our empirical proxy of ICS, because in the theoretical model we observe both the true equity issuance cost shock and its VAR proxy.

Second, we have experimented controlling for many other variables which the literature has found to be important for explaining equity issuance by firms, and obtained results very similar to those obtained using this simple measure. In particular, we investigated how the results change once we control for a measure of time varying aggregate liquidity (Pastor and Stambaugh, 2003), time varying risk premiums (using the aggregate dividend-price ratio as a control variable), or other primitive macroeconomic shocks such as investment-specific shocks (Papanikolaou 2011), credit shocks (Jermann and Quadrini, 2012), general external finance shocks (Eisfeldt and Muir, 2014), shocks to market sentiment (Baker and Wurgler, 2002, and 2006), and shocks to the balance sheet of intermediaries (Adrian et al., 2011, and 2014). We have also estimated the issuance cost shock using the market excess returns as the control variable instead of TFP shocks. Additional robustness checks include varying the cutoff values of net issuance requiring it to be larger than a certain fraction of book value of equity (to eliminate issuance events that are trivial in magnitude), and also trying alternative definitions of equity issuance (including gross, instead of net, equity issuance) often used in the literature, as in, for example, Loughran and Ritter (1995), Fama and French (2008), Boudoukh et al. (2007), among others. The online appendix reports the results of these robustness checks.

[9]We note that this analysis focuses on the link between equity/debt issuance cost shocks and asset prices in the cross section. Thus, our analysis is silent on the effects of these shocks on aggregate asset prices and aggregate quantities. It is possible that the debt issuance cost shocks have important implications for these aggregate-level variables, consistent with the analysis in Jermann and Quadrini (2011).

3.3 Properties of ICS

In this section we report the properties of the estimated ICS. Table 1 reports the summary statistics of the fraction of firms issuing equity in the cross section, and of the VAR implied out-of-sample ICS and TFP shocks The time series of these variables are plotted in the top right and 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 3.6% per year, versus 1.5% 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 5%. Despite this low correlation, Figure 1 shows that the ICS tends to be especially low at the outset of two of the NBER recessions (1981 and 2008).

We also investigate the correlation between the ICS and other aggregate shocks, as well as with other macroeconomic and financial variables. Here, as aggregate shocks, we consider a proxy of investment-specific technology shocks (denoted ISTS, measured as the real quality-adjusted investment price growth) from Papanikolaou (2011), a measure of financial shocks from Jermann and Quadrini (2012) (denoted JM), and a proxy for general (debt and equity) external finance shocks from Eisfeldt and Muir (2014) (denoted EM). We examine these measures to show that ICS is not fully spanned by these alternative aggregate shocks. In addition, we examine the correlation of ICS with a proxy for market sentiment (Baker and Wurgler, 2002, and 2006), which, as discussed in the related literature Section 2, may affect the supply of equity capital, thus affecting the firms' effective cost of issuing equity. As a macroeconomic variable we focus on aggregate per capita nondurables consumption (ΔC). Finally, as financial variables, we consider the three Fama and French (1993) factors: the stock market excess return (MKT), the returns of the small-minus-big portfolio (SMB), and the returns of high-minus-low portfolio (HML).

The contemporaneous correlation between the ICS and aggregate consumption is low, 4%. Interestingly, the correlation between the ICS and ISTS, JM and EM is also low. As a result, we can conclude that the ICS captures shocks that are, at least partially, distinct from investment-specific technology shocks, and from the financial shocks studied in Jermann and Quadrini (2012) and Eisfeldt and Muir (2014). The main difference of our financial shock from those in JQ and EM is that our shock determines the cost of issuing equity, while in these related papers the shocks are either to debt financing constraint (JQ) or to the costs of both debt and equity (EM). The ICS is positively correlated with market sentiment (31%). This positive correlation is expected because the measure of market sentiment also includes aggregate equity issuance. Consistent with our interpretation, when it is less costly to issue equity (high ICS), market sentiment may be high ("good times"), an empirical analysis documented in McLean and Zhao (2013). Finally, turning to the analysis of the correlation between ICS and asset returns, we note that ICS is positively correlated with SMB and HML, and it is moderately positively correlated with the market factor.

3.4 ICS, systematic risk, and risk premiums

In this section we show that ICS captures systematic risk in the economy. In particular, firms' differential exposure to ICS helps us to understand the cross sectional variation in the risk premiums of portfolio sorted on book-to-market, investment, and size.

To establish the link between ICS and systematic risk, we consider a two-factor model which includes the stock market factor (MKT) and ICS as the two factors. For comparison, we also consider the standard capital asset pricing model (CAPM), which includes only one factor (MKT). It is well know that the CAPM cannot explain the cross sectional variation in the returns of the portfolios investigated here. We use the failure of the CAPM on these portfolios to motivate the specification of the theoretical model proposed below (which features two aggregate shocks), as well as an additional empirical fact which we use in the evaluation of the model.

The ability of ICS to capture cross-sectional variation in risk premiums depends on two features: (i) the covariance of the portfolio's returns with ICS; and (ii) the impact of the ICS on the stochastic discount factor (investors' marginal utility). We use the generalized method of moments (GMM) to estimate these two effects. To that end, we first specify the following stochastic discount factor:

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

which states that investors' marginal utility is driven by two aggregate shocks, MKT and ICS. We then estimate the risk factor loadings on the two aggregate shocks (b_{M} and b_{I}) by GMM using the standard asset pricing moment condition $E\left[r^e_{it} M_t\right] = 0$, in which r^e_{it} is the excess return on portfolio i (the CAPM corresponds to the restricted case in which $b_{\mathrm{I}} = 0$). To help in the interpretation of the results, this moment condition can be written as:

$$E\left[r^e_{it}\right] = \alpha_i + b_{\mathrm{M}}\mathrm{Cov}(\mathrm{MKT}_t, r^e_{it}) + b_{\mathrm{I}}\mathrm{Cov}(\mathrm{ICS}_t, r^e_{it}), \tag{2}$$

where we added the term α_i (alpha) to capture the pricing error (abnormal return) associated with portfolio i. This pricing error should be zero for all assets if the asset pricing moment condition holds for all assets, that is, if the model of the stochastic discount factor in equation

(1) captures the relevant sources of systematic risk in the economy.

Panel A in Table 2 reports the average excess returns, Sharpe ratios (average return-to-return standard deviation ratio), the univariate covariances of the portfolio returns with the two risk factors, and the CAPM and the two-factor model implied pricing errors (α and $\alpha^{2\mathrm{F}}$, respectively) of the low (L), high (H), and the spread (H-L) portfolios across the three portfolio sorts studied here. Panel B in Table 2 reports the GMM first and second stage estimates of the risk factor loadings, and the corresponding mean absolute pricing errors (MAE). To save space, we focus most of our analysis here on the results for value-weighted returns because the results are overall consistent between value-weighted and equal-weighted returns.

[Insert Table 2 here]

As reported in Panel A of Table 2, value firms (high book-to-market) outperform growth firms (low book-to-market) by about 7.1% per annum, and also have a higher Sharpe ratio, 0.73 versus 0.34, respectively. As is well known, this average return spread (also known as the value premium) cannot be explained by the CAPM. The CAPM implied abnormal return (α) of the high-minus-low book-to-market portfolio is even higher than the average return spread itself, 9.1% per annum, and this value is more than 2 standard errors from zero. The two-factor model performs significantly better than the CAPM in explaining the returns of these portfolios. When the ICS factor is added to the market factor in the two-factor asset pricing model, the abnormal return of the high-minus-low portfolio drops to an insignificant 0.8% per annum. In addition, as reported in Panel B of Table 2, the MAE decreases significantly relative to the MAE of the CAPM (0.6% versus 2.7% per annum, respectively).

To help us understand the source of the improved performance of the two-factor model relative to the CAPM, Panel A in Table 2 also reports the covariances of the portfolio returns with the two risk factors. The covariance of the portfolio returns with the ICS is increasing across the book-to-market portfolios. That is, firms with low book-to-market ratios (growth firms) have a lower covariance with ICS than firms with high book-to-market ratios (value firms). In addition, Panel B in Table 2 shows that the estimated risk factor loadings (b_{I}) on the issuance cost shock is positive ($b_{\mathrm{I}} = 28$). That is, periods in which it is particularly costly to issue equity (low ICS), are periods associated with high marginal utility.

The two-factor model also improves the fit of the CAPM in explaining the average returns of the five portfolios sorted on firms' investment rate and size. Panel A in Table 2 shows that, consistent with previous studies, firms with currently low investment rates and large size have subsequently lower returns on average than firms with currently high investment rates and small size. Except across the size portfolios (when returns are value-weighted), the CAPM cannot explain the cross-sectional variation in the returns of these portfolios (large α of the high-minus low portfolio). Adding the ICS factor substantially improves the fit of the CAPM, making the alpha of the spread portfolio to be economically small and statistically insignificant ($\alpha^{2\text{F}}$). In addition, as reported in Panel B of Table 2, the MAE of the two-factor model is significantly lower than that of the CAPM.

The previous results suggest a potential novel risk explanation for the value premium, as well as the investment and the size return spreads. The issuance cost shock is a source of systematic risk, and value/low investment/small firms have a relatively higher exposure to this shock. Because these firms tend to have relatively lower returns when the ICS is low (high equity issuance costs), which are high marginal utility states (because $b_I > 0$, these are bad economic times), these firms are riskier and thus have higher returns in equilibrium. We formalize and investigate this risk explanation in the theoretical model below.

3.5 ICS and aggregate consumption

The previous sections shows that ICS is a source of systematic risk because this shock affects investors' marginal utility. This evidence is based on the estimation of the stochastic discount factor using asset price data. Here, we provide further support for the link between ICS and investors' marginal utility by looking directly at the relationship between ICS and aggregate consumption, the key determinant of investors' marginal utility in most macroeconomic models.

Although the correlation between ICS and contemporaneous consumption growth is small (4%, see Panel B in Table 1), the correlation with future aggregate consumption can be high. With recursive preferences as in, for example, Epstein and Zin (1986) or Bansal and Yaron (2004), aggregate shocks that affect expected future consumption will affect investors' current marginal utility.

[Insert Table 3 here]

To investigate the relationship between ICS and future consumption, we run a standard long-horizon predictive regression (from one to five years horizon) of cumulated future consumption using the lagged ICS and TFP shock (TFPS) as the two regressors. The regression results reported in Table 3 shows that ICS forecast future consumption with a positive slope. The slope is significant between the two- and four-year horizon. Thus, 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 (Bansal and Yaron, 2004), the risk aversion of the representative investor 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 the positive risk factor loading on ICS ($b_{\mathrm{I}} > 0$) estimated in the previous section using asset price data only.

4 Model

The empirical results show that the ICS captures systematic risk in the economy, and that exposure to these shocks is priced in the cross section. In this section, we present a dynamic investment-based model with financial frictions to help understand the economic mechanism driving the empirical results.

4.1 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

$$Y_t = Z_t X_t^{1-\theta} K_t^{\theta}, \tag{3}$$

in which X_t is aggregate productivity and Z_t is firm-specific productivity. The production function exhibits decreasing returns to scale, that is, $0 < \theta < 1$.

Aggregate productivity follows a random walk process with a drift

$$\Delta x_{t+1} = \mu_x + \sigma_x \varepsilon_{t+1}^{x}, \tag{4}$$

in which $x_{t+1} = \log(X_{t+1})$, Δ is the first-difference operator, ε_{t+1}^{x} 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

$$z_{t+1} = \bar{z}(1-\rho_z) + \rho_z z_t + \sigma_z \varepsilon_{t+1}^{z}, \tag{5}$$

in which $z_{t+1} = \log(Z_{t+1})$, ε_{t+1}^{z} is an i.i.d. standard normal shock that is uncorrelated across all firms in the economy and independent of ε_{t+1}^{x}, 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

$$K_{t+1} = (1-\delta)K_t + I_t, \tag{6}$$

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

We assume that capital investment entails convex asymmetric adjustment costs, denoted as G_t, which are given by:

$$G_t = \begin{cases} \frac{c_k^+}{2}\left(\frac{I_t}{K_t}\right)^2 K_t, & I_t \geq 0 \\ \frac{c_k^-}{2}\left(\frac{I_t}{K_t}\right)^2 K_t, & I_t < 0, \end{cases} \tag{7}$$

where c_k^+ and c_k^- determine the upward and downward speed of adjustment, respectively. The capital adjustment costs includes 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.

4.2 Collateral constraint and retained earnings

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 $t+1$. Firms can also save on cash when B_t takes on negative values.[10] 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

$$B_{t+1} \leq \varphi K_{t+1}. \tag{8}$$

The variable $0 < \varphi < 1$ affects the tightness of the collateral constraint, and therefore, the borrowing capacity of the firm. Due to the collateral constraint, the interest rate, denoted by r_f, is the risk-free rate which is also constant due to the specification of the stochastic discount rate which will be discussed in section 4.4.

The interest rate on corporate savings, r_s, differs from the borrowing risk-free rate, r_f. This is because if the two rates are equal, firms will save all free cash flows and do not distribute cash to shareholders in the presence of financial frictions. Following Hennessy, Levy, and Whited (2007) and Livdan, Sapriza, and Zhang (2009), we assume the saving rate is smaller than the borrowing rate so that firms are not indifferent between savings and cash distributions. That

[10]We treat cash as negative debt for tractability, given the already high dimensional dynamic problem. In principle, negative debt and cash may not be perfect substitutes if their marginal costs are different, as is shown in Acharya, Almeida, and Campello (2007) and Bolton, Chen, and Wang (2014).

is,

$$r_s = r_f - \kappa, \tag{9}$$

where $\kappa > 0$ captures the wedge between borrowing and saving rate. Let

$$r_l = r_f \mathbf{1}_{\{B_t > 0\}} + r_s \mathbf{1}_{\{B_t < 0\}} \tag{10}$$

denote the applicable interest rate to the firm.

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

$$\Phi_t = \frac{c_b}{2} \left(\frac{\Delta B_t}{B_t} \right)^2 |B_t| \, , \tag{11}$$

where $\Delta B_t = B_t - B_{t-1}$ and $B_t \neq 0$.[11] 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, and allows us to generate a persistent leverage process, consistent with the empirical evidence (Leary and Roberts, 2005).[12] Nevertheless, the debt adjustment costs are calibrated to be very low in the baseline model (as we discuss in the calibration Section 5).

4.3 Costly external equity financing

Taxable corporate profits are equal to output less capital depreciation and interest expenses: $Y_t - \delta K_t - r_f B_t \mathbf{1}_{\{B_t \geq 0\}}$. It follows that the firm's budget constraint can be written as

$$E_t = (1 - \tau) \, Y_t + \tau \delta K_t + \tau r_f B_t \mathbf{1}_{\{B_t \geq 0\}} - I_t - G_t + B_{t+1} - (1 + r_l) B_t - \Phi_t, \tag{12}$$

in which τ is the corporate tax rate, $\tau \delta K_t$ is the depreciation tax shield, $\tau r_f B_t \mathbf{1}_{\{B_t \geq 0\}}$ is the interest tax shield, and E_t is the firm's payout.

When the sum of investment, capital, and debt adjustment costs exceeds 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

$$H_t = \max \left(-E_t, 0 \right). \tag{13}$$

As discussed in the related literature Section 2, firms face time-varying external equity financing costs, which involve both direct and indirect costs. We do not explicitly model the

[11] Note that zero debt is never an optimal choice for the firm in the model.

[12] For tractability, the cash holding adjustment costs are the same as debt. We have conducted different experiments with different costs for cash and debt and find that it has a small effect on the main results reported here.

sources of these costs. Rather, we attempt to capture the effect of the costs in a reduced-form fashion. The external equity costs are assumed to be fixed and linear quadratic following Hennessy and Whited (2007), and stochastic, as in Bolton, Chen, and Wang (2013). More specifically, we parameterize the equity issuance costs as:[13]

$$\Psi\left(H_t\right) = \left(\eta_0 X_t + \eta_1 H_t + \eta_2 \frac{H_t^2}{K_t}\right) \exp\left[-\eta_3 \xi_t\right] \mathbf{1}_{\{H_t > 0\}}, \tag{14}$$

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

$$\xi_{t+1} = \rho_\xi \xi_t + \sigma_\xi \varepsilon_{t+1}^{\xi}, \tag{15}$$

in which ρ_ξ and σ_ξ are the first-order autocorrelation coefficient and conditional volatility of 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 assumption of linear and convex issuance costs is also consistent with Myers and Majluf (1984) and Krasker (1986) who show that the (marginal) cost of external equity is increasing in asymmetric information in equity markets.

The key feature of the formulation of external equity costs is that external equity costs are subject to an aggregate disturbance different from 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. Consistent with Bolton, Chen, and Wang (2013), here we treat the time-varying equity issuing costs as exogenous.

Finally, firms do not incur costs when paying dividends or repurchasing shares. The effective cash flow D_t distributed to shareholders is given by

$$D_t = E_t - \Psi_t. \tag{16}$$

4.4 Firm's problem

We specify the stochastic discount factor as a function of the two aggregate shocks in the economy:

$$M_{t,t+1} = \frac{1}{1+r_f} \frac{e^{-\gamma_x \Delta x_{t+1} - \gamma_\xi \Delta \xi_{t+1}}}{\mathbb{E}_t\left[e^{-\gamma_x \Delta x_{t+1} - \gamma_\xi \Delta \xi_{t+1}}\right]}, \tag{17}$$

where r_f is the risk-free rate. The sign of the risk factor loading parameters (γ_x and γ_ξ) is positive, consistent with the evidence reported in the empirical section (we also perform

[13] Note that aggregate productivity, X_t, is included for the fixed cost to ensure the economy is cointegrated along the balanced growth path; this term cancels out in the stationary representation of the model.

comparative statics to these parameters to understand its importance on the model results). 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/cash optimally:

$$V_t = \max_{I_t, K_{t+1}, B_{t+1}} D_t + \mathbb{E}_t[M_{t,t+1}V_{t+1}], \tag{18}$$

subject to firms' capital accumulation equation (Eq. 6), collateral constraint (Eq. 8), budget constraint (Eq. 12), and cash flow equation (Eq. 16).

4.5 Optimality conditions

Let q_t and μ_t be the Lagrangian multiplier associated Eqs. (6) and (16). The first-order conditions with respect to I_t, K_{t+1}, and B_{t+1} are, respectively,[14]

$$q_t = \left(1 + \Psi'(H_t)\mathbf{1}_{\{H_t>0\}}\right)\left[1 + \frac{\partial G_t}{\partial I_t}\right], \tag{19}$$

$$q_t - \mu_t\varphi = \mathbb{E}_t M_{t,t+1}\left\{\left((1 + \Psi'(H_{t+1})\,\mathbf{1}_{\{H_t>0\}}\right)\left[\frac{\partial E_{t+1}}{\partial K_{t+1}} + (1-\delta)\left(1 + \frac{\partial G_{t+1}}{\partial I_{t+1}}\right)\right]\right\}, \tag{20}$$

$$\text{and } \mu_t - \mathbb{E}_t\left[M_{t,t+1}\left(1 + \Psi'(H_{t+1})\mathbf{1}_{\{H_{t+1}>0\}}\right)\frac{\partial E_{t+1}}{\partial B_{t+1}}\right] = \left(1 + \Psi'(H_t)\mathbf{1}_{\{H_t>0\}}\right)\frac{\partial E_t}{\partial B_{t+1}}, \tag{21}$$

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. (19) 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 known as the marginal q of investment. 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, that is, $H_t > 0$, the effective marginal cost of investment is $(1 + \Psi'(H_t))\left[1 + \frac{\partial G_t}{\partial I_t}\right]$, which, all else equal, is larger than that implied by the standard q-theory without financial frictions, $1 + \frac{\partial G_t}{\partial I_t}$. More important, in contrast to the standard models, because the marginal issuance cost depends on the aggregate issuance cost shock ξ_t, the variations of marginal cost of investment is not only driven by shocks from the real sector, for example, aggregate productivity shocks, but also by the perturbations in the financial sector. 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

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

reduces to that implied by the standard models because $\Psi'(H_t)\mathbf{1}_{\{H_t>0\}}$ is zero in this case.

Eqs. (20) and (21) are the Euler equations that describe the optimality conditions for capital and debt. Intuitively, Eq. (20) 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_t 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. (21) 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 $-\mathbb{E}_t\left[M_{t,t+1}\left(1+\Psi'(H_{t+1})\mathbf{1}_{\{H_{t+1}>0\}}\right)\frac{\partial E_{t+1}}{\partial B_{t+1}}\right] = \mathbb{E}_t\left[M_{t,t+1}\left(1+\Psi'(H_{t+1})\mathbf{1}_{\{H_{t+1}>0\}}\right)\left(\left(1+r_f\left(1-\tau\right)\right) - abs(\frac{\partial \Phi_{t+1}}{\partial B_{t+1}})\right)\right]$.[15] 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 current 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. If firms choose to optimally save on cash with B_{t+1} being negative, the marginal cost and benefit of cash holding will be the reverse of those of optimal debt.

4.6 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 (18) at the optimum and obtain

$$V_t = D_t + \mathbb{E}_t\left[M_{t,t+1}V_{t+1}\right] \quad (22)$$

$$\Rightarrow \quad 1 = \mathbb{E}_t\left[M_{t,t+1}R^s_{t+1}\right] \quad (23)$$

[15]Note that $\frac{\partial E_{t+1}}{\partial B_{t+1}} = -\left(1+r_f\left(1-\tau\right)\right) + \text{abs}(\frac{\partial \Phi_{t+1}}{\partial B_{t+1}})$ is mostly negative for reasonable parameter values of the debt adjustment cost parameter c_b.

in which equation (22) is the Bellman equation for the value function, and the Euler equation (23) 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. (17) into Eq. (23), and some algebra, yields the following equilibrium asset pricing equation:[16]

$$\mathbb{E}_t\left[r^e_{t+1}\right] = \gamma_x \times Cov\left(r^e_{t+1}, \Delta x_{t+1}\right) + \gamma_\xi \times Cov\left(r^e_{t+1}, \Delta \xi_{t+1}\right) \tag{24}$$

in which $r^e_{t+1} = R^s_{t+1} - R_f$ is the stock excess return, and $R_f \equiv 1 + r_f = \mathbb{E}_t\left[M_{t,t+1}\right]^{-1}$ is the gross risk-free rate.

According to equation (24), 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 by the loading of the stochastic discount factor on the two risk factors (γ_x and γ_ξ) in Eq. (17). The pre-specified positive sign of the loadings imply that, 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.

5 Model solution

In this section we calibrate the model to the data. All of the endogenous variables in the model are functions of the state variables. Because the functional forms are not available analytically, we solve for these functions numerically. Appendix A-2 provides a description of the solution algorithm (value function iteration) and the numerical implementation of the model.

5.1 Calibration

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 4 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 5. To evaluate the model fit, the table reports the target moments in both the data and the model. To generate the

[16] This derivation is standard. Equation (23) 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. (17), 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 (24).

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 4 here]
[Insert Table 5 here]

Firm's technology: general parameters. We set the curvature of the production function θ to be 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). We set corporate tax rate to be 0.35 consistent with Hennessy and Whited (2005, 2007). We set the liquidation cost parameter $\varphi = 0.85$, following Livdan, Sapriza, and Zhang (2009).

Firm's technology: adjustment costs and issuance 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 $c_k^+ = 0, c_k^- = 40$. The upward capital adjustment cost is set to zero to match the autocorrelation of investment rate. Table 5 shows that this calibration of the model matches reasonably well the volatility, autocorrelation, interquartile range, skewness, and kurtosis of firm-level investment rates. We calibrate the debt adjustment cost $c_b = 1$ to match the volatility of the aggregate debt growth rates. It also implies a financial leverage ratio at 0.31, close to the data (0.38). The implied autocorrelation of financial leverage is 0.56, close to the data moment at 0.61. We set the equity issuance cost parameters $\eta_0 = 0.002, \eta_1 = 0.10, \eta_2 = 0.0004$, and $\eta_3 = 12$ which imply the average equity issuance frequency at 31%, close to the data moment at 38%. 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 estimates in Altinkilic and Hansen (2000) and the estimates in Hennessy and Whited (2007). The convex issuance cost parameter η_2 follows Hennessy and Whited (2007), while the issuance cost sensitivity parameter η_3 is calibrated to match the volatility of firm-level net issuance to book equity ratio (46% in the model and 41% in the data). Finally, we set κ to be 0.005/12 following Livdan, Sapriza, and Zhang (2009).

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 0.15 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 of aggregate equity-issuance-to-capital ratio is 0.04, consistent with the data moments at 0.04.

To calibrate the persistence and conditional volatility of the firm-specific productivity shock, we set the values as $\rho_z = 0.98$ and $\sigma_z = 0.15$ which implies the firm level return volatility 0.33, consistent with Campbell et al. (2001). The long-run average level of firm-specific productivity, $\bar{z}$, is a scaling variable. We set $\bar{z} = -3.7$, which implies that the average detrended long-run debt in the economy is 6. 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 $\gamma_x = 5$, and the loading of the stochastic discount factor aggregate issuance shock to be $\gamma_\xi = 15$ by matching the average aggregate stock market return and the Sharpe ratio as close as possible. This implies a market excess return of 5.87% and Sharpe ratio at 0.37, reasonably close to 5.63% and 0.35, respectively, in the data. We conduct comparative statics in Section 7 to evaluate the impact of these risk factors loading parameters on the model's performance.

5.2 Evaluation of the calibration

Panel B in Table 5 also reports the model implied firm-level correlations between investment, sales (identified as output in the model) growth and financing flows and the data counterparts. Since the benchmark calibration does not target these moments, this exercise serves as a preliminary out of sample analysis of the benchmark calibration. Overall, the cross correlations between investment and financing flows are reasonable and qualitatively consistent with the data. For example, investment rate is positively correlated with net equity issuance and debt growth rate with the correlations at 0.08 and 0.97 in the model, respectively, and 0.07 and 0.29 in the data. Net equity issuance and debt growth are weakly negatively correlated both in the model and the data (-0.01 in the data vs -0.07 in the model), suggesting a weak unconditional substitution effect between the two marginal sources of financing. The model also replicates the positive correlations between investment and debt growth with sales growth in the data. However due to dividend payout being more cyclical than gross equity issuance in the model, net equity issuance is weakly negatively correlated with sales growth. Nevertheless, gross equity issuance and sales growth are positively correlated in the model, consistent with the data (both at 0.19).

6 Model 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. In addition, we compare the model implied financing flows across the test portfolios with those in the data.

Panel A in Table 6 reports the value-weighted average excess returns, Sharpe ratios, the univariate covariances of the portfolio returns with the two risk factors (MKT and ICS), and the CAPM and the two-factor model implied pricing errors (α and α^{2F}, respectively) of the low (L), high (H), and the spread (H-L) portfolios across the book-to-market, investment, and size sorts.[17] Panel B reports the corresponding GMM estimation results of the two asset pricing models in the simulated data.

[Insert Table 6 here]

6.1 ICS, systematic risk, and risk premiums in the model

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 (6.9% per annum in the model versus 7.1% in the real data). The Sharpe ratios of the book-to-market portfolios are also increasing in firms' current book-to-market ratios, consistent with the data. The Sharpe ratio of the portfolio of value firms is about four times larger (in the real data is two times larger) than the Sharpe ratio of the growth firms.

Panel A in Table 6 also reports the covariances of the returns of the book-to-market portfolios with the market factor and the ICS. The covariance with the market is slightly decreasing in book-to-market ratio, consistent with the data but opposite of the direction necessary for the CAPM to capture the value premium. The covariance with the ICS is increasing in the book-to-market ratio. The difference between the covariance with the ICS for value and growth firms is sizable which suggest that the value premium in the model is mostly driven by exposure to the issuance cost shocks. We note, however, that the size of the univariate covariances with ICS are smaller than in the data.

Turning to the analysis of the 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 return spread is comparable with the data (5.2% per annum versus

[17] In the model, the average value- and equal-weighted returns are very similar. Thus, to facilitate the comparison between the model results and the data, we focus our comparison using average value-weighted returns only.

5.9%, respectively), and the Sharpe ratios of these portfolios are decreasing in the investment rates. The difference between the covariance of the returns of the low and high investment rate portfolios with the market factor is small and statistically indistinguishable from zero, but the difference in the covariance with the ICS factor is negative and significant. Thus, similar to the value spread, the investment spread is driven by the differential exposure to the ICS.

Lastly, the model also generates a reasonable size return spread. Consistent with the data (especially for equal-weighted average returns), big firms earn subsequently lower returns on average than small firms (5.3% per annum in the model versus 4.7% per annum in the real data). The difference between the covariance of the returns of the big versus small firms with the market factor is positive but small, while the difference between the covariance of the returns of the big versus small firms with the ICS factor is negative and statistically significant. Thus, consistent with the analysis of the book-to-market and investment portfolios, the size spread is mostly driven by the firms' differential exposures to ICS, not to the market factor.

6.2 ICS and asset pricing tests in the model

The baseline model matches well the failure of the unconditional CAPM in explaining the average returns of the tests asset considered here.

Across book-to-market portfolios, Panel A in Table 6 shows that the CAPM pricing error of the high minus low book-to-market portfolio is large, 6.9% per annum. As in the data, the CAPM fails in the model because the growth firms have (slightly) higher covariance with the market factor, and hence higher risk according to the CAPM, but have relatively lower average returns. In addition, as reported in Panel B, the model generates large and statistically significant CAPM mean absolute pricing errors (MAE) that are close to the data (2.5% per annum in the model versus 2.2% in the data). The two-factor model performs significantly better than the CAPM in explaining the returns of these portfolios. Consistent with the empirical results, when the ICS factor is added to the market factor in the two-factor asset pricing model, the abnormal return of the high-minus-low portfolio drops to an insignificant 0.7% per annum (0.8% per annum in the real data). In addition, the MAE of the two-factor model is significantly lower than the MAE of the CAPM (0.5% versus 2.5% annum, respectively).

The analysis of the asset pricing test results across the investment rate and size portfolios is qualitatively similar to the analysis of book-to-market portfolios. As in the data, the unconditional CAPM in the model is unable to fully explain the spread in the average returns of these portfolios. The CAPM pricing errors of the investment and size spread portfolios are 8.9% and 5.6% per annum, respectively, and the CAPM MAE are 1.6% and 2.1% per annum, respectively. The two-factor model performs significantly better than the CAPM in explaining the returns of these portfolios. Consistent with the empirical results, when the ICS factor is added to the market factor in the two-factor asset pricing model, the abnormal return of the high-minus-low investment and size portfolio drops to an insignificant 1% and 0.6% per annum, respectively (0.1% and 0.3% per annum in the real data). In addition, the MAE of the two-factor model is significantly lower than the MAE of the CAPM across both portfolio sorts (0.5% versus 1.6% annum for investment portfolios, and 0.3% versus 2.1% per annum for size portfolios).

Panel B in Table 6 reports the model implied estimated risk factor loadings (b_{M} and b_{I}) using the GMM. Although the loading on the market factor (b_{M}) is estimated to be negative across the three portfolio sorts, its magnitude is small. The estimated loading on the ICS factor (b_{I}) is uniformly positive and large, and its magnitude is within the range of the estimated values in the real data. When all portfolios are considered together (ALL), the 1$^{\text{st}}$ stage GMM estimate of the ICS risk factor loading is 31 in the model versus 19.2 in the real data when using value-weighted returns, and 28.9 when using equal-weighted returns. In the more efficient 2$^{\text{nd}}$ stage GMM estimates, the ICS risk factor loading is 16 in the model versus 24.1 in the real data in value-weighted returns, and 28 in equal-weighted returns.

6.3 Investment and financing flows across portfolios

The differential exposures to the ICS across the book-to-market, investment, and size portfolios naturally reflects differences in the characteristics of the firms in these portfolios. To understand these differences and evaluate if the model is consistent with them, Table 7 reports for each portfolio sort selected characteristics of the firms in the low (L), high (H), and the spread (H-L) portfolio in both the real data (column "Data") and in the model (column "Model").

[Insert Table 7 here]

We focus on the following firm characteristics that characterize the investment policies, financing flows (equity and debt financing), capital structure, and productivity of the firms in each portfolio at the time of portfolio formation: investment rate in physical capital (IK), gross equity issuance-to-book equity ratio (Gross equity/BE), debt growth (ΔDebt), leverage ratio, and firm-level total factor productivity (TFP). Appendix A-3 describes how these characteristics are computed in the data. We construct the average characteristics for each portfolio by first computing the median of each characteristic across all firms in the portfolio in a given year, and then report the corresponding time series averages.

Table 7, column Data, shows that the qualitative relationship between the characteristics of these firms and its level of risk (average returns) is remarkably consistent across the book-to-market, the investment, and the size portfolios. In general, the low risk firms (growth (L), high investment (H), and big (H) firms) are investing more, issuing more debt and equity, are less levered, and are more productive than the high risk firms (value (H), low investment (L), and small (L) firms). The only difference is that the low risk big firms take on more leverage than the high risk small firms. Table 7, column Model, shows that model perfectly matches the pattern of the characteristics of these portfolios. The only difference is that big firms are issuing less equity in the model, not more as in the data. In any case, this difference in both the data and in the model is very small.

7 Inspecting the mechanism

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

7.1 The driver of the cross section of expected returns

The theoretical model proposed in Section 4 implies that risk premiums in the economy are determined by Eq. (24). To understand the equilibrium return spreads, we must thus understand the endogenous differences in the sensitivity of the returns of the book-to-market, investment, and size portfolios to the two aggregate risk factors (quantity of risk), as well as the role of the corresponding prices of risk.

To be consistent with the empirical asset pricing model defined in Eq. (2), we implement the exact same procedures of the empirical Section 3. Specifically, we construct a two-factor model composed of a market factor, r_t^m, and model implied issuance cost shock factor, ICS_t. To make the comparison with the empirical results meaningful, this ICS factor in the model is constructed using the same VAR regression specification used in the real data, that is, it is not the exogenous (unobserved in the data) issuance cost shock ξ_t. Given that in the model the market factor is mostly driven by TFP shocks, this factor model is similar in spirit to Eq. (24).[18]

7.1.1 Quantity of risk

Consistent with the analysis reported in Section 6.1 and Table 6, the average return spreads in the model are driven by the differential exposure of the returns of the portfolios to the aggregate

[18]Across panels, a multivariate time-series regression of the aggregate stock market return on the two risk factors has an average regression $R^2 \approx 99\%$, a univariate regression on the aggregate productivity shock has an average regression $R^2 \approx 98\%$, but a univariate regression on the aggregate issuance shock has an average regression $R^2 \approx 1\%$ (results not tabulated).

ICS, and not so much by differential exposure to the market factor (aggregate productivity shock). To show this result in a clear manner, we report the covariances of the portfolio returns with respect to the two factors in the economy in the simulated data in Figure 2, and for each set of test assets. To highlight the cross-sectional dispersion in the exposure to the shocks, we report the return covariance with each factor relative to the corresponding covariance of the first portfolio.

[Insert Figure 2 Here]

The top two panels in Figure 2 show that 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 ICS is large, and it is monotonically increasing across the book-to-market portfolios. In particular, the covariance of the value firms to ICS is 20% higher than the covariance of growth firms. 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 remaining four panels in Figure 2 document the same qualitative features of the model for the investment and size portfolios. Again, the covariance of the portfolio returns to the market factor is essentially flat across these portfolios (it is slightly increasing across the size portfolios which is the opposite of what the CAPM needs to generate a size return spread), while the dispersion in the covariances with respect to the aggregate issuance cost shock is large, and it is monotonically decreasing across the investment and size portfolios.

The previous analysis also helps understand why the CAPM is unable to explain the cross-sectional variation in the average returns of these portfolios, as reported in Table 6. As noted, in the baseline model, almost all of the variation of the aggregate stock market return is driven by shocks to aggregate productivity (the TFP shock alone can explain more than 98% variation in the market returns). Thus, the market factor fails to capture the differential exposure of the book-to-market, investment, and size portfolios to the issuance cost shock, which is the driver of the variation in risk in the cross section.

7.1.2 Price of risk

According to Eq. (24), the impact of the firm's differential exposures to the aggregate shocks on equilibrium risk premiums depends on the price of risk of these shocks, which is determined by the loadings of the stochastic discount factor on the aggregate shocks (γ_x and γ_ξ). To evaluate the importance of these parameters for the model's results, we perform comparative statics with respect to these parameters.

Table 8 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 2 and 3, we specify the stochastic discount factor to have a zero loading on the ICS ($\gamma_\xi = 0$ versus $\gamma_\xi = 15$ in the baseline model) and to have a low loading on the aggregate productivity shock ($\gamma_x = 1.5$ versus $\gamma_x = 5$ in the baseline model), respectively. In these two specifications, we keep all the other model parameters equal to the baseline specification.

[Insert Table 8 Here]

Specification 2 in Table 8 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, slightly increasing its volatility from 20% in the benchmark model to 24% here. The most interesting effects are reflected in the moments of asset prices. Here, all the return spreads drops substantially. The value spread decreases from 6.9% in the baseline model to 0% here, the investment spread decreases (in absolute value) from -5.2% in the baseline model to -1.2% here, and the size spread decreases (in absolute value) from -5.3% in the baseline model to -0.5% here. This analysis shows that a sufficiently large and positive risk factor loading for ICS is crucial for the model to generate enough risk dispersion in the cross section, that is, sizeable portfolio return spreads.

Specification 3 in Table 8 shows that decreasing the size of the loading of the stochastic discount factor on aggregate productivity shock has again a relatively small effect on quantities, slightly reducing the volatility of the firms' investment rate from 20% in the benchmark model to 16% here. Again, the effect on the asset prices in the model is substantial. The risk premium in the aggregate stock market is significantly reduced from 5.9% in the benchmark model to 3.4% here. However the value, the investment, and the size return spreads all remain sizable and comparable in magnitude with the corresponding spreads in the benchmark calibration. This result thus confirms that the aggregate productivity shock drives the aggregate market premium but it has a small effect on the cross section of expected returns.

Notably, the economic mechanism in generating the failure of the CAPM is different from the existing literature. For example, Kogan and Papanikolaou (2014a and 2014b), and Belo, Lin, and Bazdresch (2014) show that incorporating an aggregate investment shock to the price of new capital or an aggregate shock to adjustment costs in labor hiring and investment help explain the failure of CAPM in investment-based asset pricing models without financial frictions. However, the investment shocks in Kogan and Papanikaloau (2014a and 2014b) or aggregate adjustment cost shock in Belo, Lin, and Bazdresch (2014) are distinct from the issuance cost shock. The aggregate issuance shocks are shocks originated from the financial sector that affect the supply of capital, while the investment shocks or adjustment cost shocks are disturbance in the real sector which affects the efficiency of investment or hiring decisions.

7.1.3 Intuition

Why do the returns of firms with currently high book-to-market ratio, low investment rates, or small firms, have higher positive covariance with the aggregate issuance cost shock in equilibrium? Given the positive price of risk of this shock, understanding this endogenous covariance is essential to understanding the equilibrium return spreads in the model.

To illustrate the economic mechanism behind the results reported in the previous sections, Figures 3 shows 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 cost of equity financing, bad times). 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. (5).[19] The high and low productivity firms correspond roughly to the growth/high investment/large cap and value/low investment/small cap firms in the model, respectively. Even though the difference in productivity is not the only difference across these firms, it is clearly an important state variable that varies across these portfolio as reported in Table 7. This is because idiosyncratic productivity is the underlying primitive source of heterogeneity in the model.

[Insert Figure 3 Here]

Figure 3 shows that after a negative issuance cost shock, the high productivity firms still wants to increase their investment while the low productivity firms wants to decrease it. Due to the increase in the marginal cost of external equity financing, the external equity market freezes upon impact for both firms for an extended period of more than ten months. The increase in investment and corresponding adjustment costs of the high productivity firms is financed by an increase in debt growth. The high productivity firms can rely on debt financing because they are accumulating more capital which allows them to pledge for more debt. For low productivity firms, the debt growth falls substantially because their capital stock is decreasing causing them to have less capital to be collateralized. The dividends of the high productivity firms falls

[19]The long-run average level is determined by setting all shocks to the long-run average level, i.e., $z = -3.7$, $\xi = 0$, and $\Delta x = 0$.

slightly upon impact and then increase immediately above the long-run average level for a long period of time; the dividends of low productivity firms also falls on impact, but stay below the steady state level for an extended period of time. 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 still increases on impact despite the negative ICS, 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. Because the high productivity firms are less affected by the ICS, the returns of these firms have a relatively lower covariance with ICS, while the returns of the low productivity firms have a relatively higher covariance with ICS. Because the stochastic discount factor (marginal utility) is increasing in this shock, the differential covariance implies that, all else equal, the high productivity (low book-to-market/high investment/large cap) firms have relatively lower risk than low productivity (high book-to-market/low investment/small cap) firms.

7.2 The role of positive and time-varying equity issuance costs

The existence of positive and time-varying external equity issuance costs is important for the overall good fit of the model on both quantities and asset prices. To show this importance, we compute the model-implied moments from an alternative calibration of the issuance cost function, which we report in Table 8. In specification 4, we shut down issuance cost completely ($\eta_0 = \eta_1 = \eta_2 = 0$). In specification 5 we shut down the shock on the cost of external equity financing ($\eta_3 = 0$) (this shock still affects the stochastic discount factor, and hence can affect asset prices).

In terms of the effect on quantities, specification 4 in Table 8 shows that by removing issuance costs, the model generates firm-level equity issuance-to-book-equity ratios and investment rates that are too volatile (the volatilities are 0.46/0.20 in the baseline model, respectively, compared to 0.53/0.30 here). The effect of removing equity issuance costs on asset prices is more substantial. The value, the investment, and the size return spreads reduce significantly relative to the baseline model from $6.9\%/-5.2\%/-5.3\%$ in the baseline model, respectively, to $-0.9\%/-3\%/-1\%$, here.

Turning to the analysis of the impact of stochastic equity issuance costs on the model results, specification 5 shows that removing the aggregate shocks on equity issuance costs generates a smoother equity issuance-to-book-equity ratio (0.43 in the baseline model compared to 0.31 here) and, as in the previous specification, significantly reduces the return spreads relative to the baseline model. The value, the investment, and the size return spreads all drop (in absolute value) from $6.9\%/-5.2\%/-5.3\%$, respectively, in the baseline model, to $-0.5\%/-1\%/0.1\%$, respectively, here.

7.3 The role of substitution between equity and debt financing

The time-variation in the availability of external funds plays a crucial role in generating risk dispersion across productive and unproductive firms. In particular, and consistent with the analysis of the impulse response function in Section 7.1.3, the flexibility of the productive firms in switching between marginal sources of financing during bad economic times makes them less risky. To understand the quantitative importance of this mechanism, specification 6 tightens the collateral constraint by setting the resale of value of capital to $\varphi = 0.05$ instead of $\varphi = 0.85$ in the baseline model. In addition, specification 7 increases the size of the debt adjustment costs by fifty times relative to the baseline calibration, $c_d = 50$ instead of $c_d = 1$ in the baseline model. Both specifications increase the effective cost of using and changing debt, making the substitution from equity financing to debt financing more difficult.

Table 8 shows that in both of these two specifications, financial leverage almost drops to zero and that 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. In turn, this effect makes these firms more similar to the low productive firms in terms of flexibility, substantially reducing the endogenous risk dispersion in the cross section.

Notably, the mechanism for the value premium is different from Belo, Lin, and Bazdresch (2014) who show that operating leverage (as in Zhang, 2005) 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, value firms are particularly constrained when it is costly to issue equity. Thus, financing frictions also contribute significantly to the value premium.

7.4 Empirical support for the model mechanism

As discussed in the previous sections, the economic mechanism in the model hinges on the ability of the more productive firms to substitute debt financing for equity financing when the cost of issuing equity increases. We test this prediction in the real data across the book-to-market, investment, and size portfolios. Table 9 reports the results from this analysis. To construct this table, we first split the sample into low, medium, and high ICS (or TFP) states based on the bottom and top 20$^{\text{th}}$ percentiles of the time series distribution of ICS (or TFP shocks). Then, we compute the time series average of the portfolio-level median realized (that is, after portfolio formation and contemporaneous with the aggregate shocks) gross issuance-to-book equity ratio (equity issuance), and change in debt (debt issuance), for the high (H) and low (L) portfolios in each sort. In addition, we also report the change in cash across the ICS and TFP states for each portfolio sort, to show that the mechanism we highlight here is empirically relevant even in the presence of cash. The portfolio-level gross issuance-to-book equity ratio is detrended using a HP filter to provide a meaningful analysis of this characteristic across different ICS and TFP states in the presence of time trends.

[Insert Table 9 Here]

Table 9 shows that, consistent with the analysis of the impulse response function in Section 7.1.3, the low risk growth, high investment, and large firms do substitute debt for equity financing when ICS is particularly low, that is, when there is a substantial increase in the cost of issuing equity. Specifically, these firms all decrease their equity issuance as ICS moves from high (low cost of issuing equity) to low (high cost of issuing equity). For example, for growth firms (L book-to-market firms), the difference in equity issuance is 4.3% in high ICS years versus 2.7% in low ICS years. At the same time, these growth, high investment, and large firms all increase their total debt levels as ICS moves from high to low, consistent with the fact that these firms are substituting debt financing for equity financing. For example, for growth firms, the difference in debt issuance is −0.5% in high ICS years versus 3.2% in low ICS years. In contrast, the high risk value, low investment, and small firms are still deleveraging even in periods in which the cost of issuing equity is high (low ICS states) with a change in debt of −1.5%, −2.9%, and −0.1% per annum, respectively. Finally, we do not find a strong substitution debt for equity financing effect when aggregate productivity shocks are low, consistent with the interpretation that the ICS captures a dimension of the wealth of the financial market that is distinct from aggregate TFP.

Table 9 also shows that the low risk growth, high investment, and large firms do not reduce their cash holding to finance their operations with internal funds in periods in which it is costly to issue equity. Indeed, in low ICS states (high cost of issuing equity), these firms are all still accumulating cash (9.0%, 1.5%, and 5.7%, respectively), although at a much smaller rate than during high ICS states. This result suggest that the more empirically relevant margins to explain the value, investment, and size spreads are the choice of debt versus equity when ICS is low, whereas the choice between cash and equity does not appear to be as important.[20] This

[20]One potential reason for this finding is that a significant amount of corporate cash is held abroad (see, for example, Harford, Wang, and Zhang, 2014), which makes it difficult for corporations to use cash to smooth

result also helps us understand why external financing cost measures previously used in the literature (Eisfeldt and Muir, 2014, and Jermann and Quadrini, 2011) do not perform so well in asset pricing tests in the cross section, as discussed in the empirical section. Naturally, the cash margin is clearly important on other dimensions (see, for example, the analysis in Bolton, Chen, and Wang, 2013), but the channel to generate large cross sectional risk dispersion appears to be mostly driven by the time-varying ability to switch between equity and debt financing.

7.5 Internal validation of ICS proxy

Finally, we can use the alternative calibrations of the model to validate our proposed empirical proxy for issuance cost shock based on the VAR. Because in the model we observe both the true issuance cost shock (ξ) 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 8 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,ξ). Several interesting conclusions emerge from this exercise. First, the correlation between the true shock (ξ) and its proxy in the benchmark model at annual frequency is 46%. Although this correlation is not perfect, it is significantly positive, thus validating the use of the VAR proxy in the empirical analysis.[21]

The sizeable and positive correlation between the true ICS and the empirical VAR proxy of the ICS relies on the existence of both time-varying (stochastic) and positive equity issuance costs. In specifications 5, when we shut down the time variation in the equity issuance costs (keeping its effect on marginal utility, and hence, still allowing ICS to affect asset prices), 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. Similarly, in specification 4, when we shut down the equity issuance costs entirely (but again, maintaining the effect of ICS on marginal utility), the implied correlation between the true shock and its proxy is also zero. Taken together, the time-varying and positive external equity issuance costs that affect firms' payouts in the model is crucial to validate the use of the VAR proxy of ICS in the empirical analysis.

dividends when ICS is low.

[21] 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.

8 Conclusion

We construct a novel empirical proxy of an aggregate shock to the cost of equity issuance in the U.S. economy. We then show that this shock captures systematic risk and is priced in the cross section: assets that covary more positively with equity issuance cost shocks (value, low investment, and small firms) have higher returns on average. We propose an investment-based model with stochastic equity issuance costs and a collateral constraint to understand the economic forces driving the empirical results. The economic mechanism emphasizes that the firms' ability (or inability) to substitute between different marginal sources of external financing (equity and debt) during bad economic times (periods in which is very costly to issue equity) is an important determinant of equilibrium risk premiums. In the model, growth firms, high investment firms, and large firms, can substitute more easily debt financing for equity financing when it becomes more costly to raise external equity, hence these firms are less risky in equilibrium. Through calibration and simulation, we show that this mechanism is economically important for understanding the cross section of stock returns. In addition, we show this mechanism has empirical support.

The model also offers a novel explanation for the failure of the unconditional CAPM in pricing the cross-section of expected stock returns. Different from existent investment-based models which emphasize the role of investment specific shock or adjustment cost to fail the CAPM, our analysis emphasizes the role of financial shocks.

Our results have implications for asset pricing, corporate finance, and macroeconomics literature. Our findings suggest that time-variation in the aggregate cost of external equity financing has a significant impact on asset prices, real quantities, and financing flows in the cross section. By affecting firms' investment and financing real decisions, these shocks are likely to affect aggregate quantities as well. Thus, 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.

Finally, in our analysis, we treat the aggregate issuance cost shock as exogenous, as the natural first step towards understanding the joint behavior of financial frictions, asset prices, and financial flows in the cross section. To help us better understand the links between the financial sector and the real economy, future research may endogenize the source of the issuance cost shock in a dynamic general equilibrium model with a nontrivial financial intermediary sector.

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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

$$
\begin{aligned}
&\{V_t, D_t, E_t, Y_t, K_t, B_t, I_t, H_t, G_t, \Phi_t, \Psi_t\} = \\
&\{v_t X_t, d_t X_t, e_t X_t, y_t X_t, k_t X_{t-1}, b_t X_{t-1}, i_t X_t, h_t X_t, g_t X_t, \phi_t X_t, \psi_t X_t\} \qquad (25)
\end{aligned}
$$

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

The stationary optimization problem can be written as follows:

$$
\begin{aligned}
v(\Delta x_t, z_t, \xi_t, k_t, b_t) &= \max_{i_t, b_{t+1}, n_t} d_t + \mathbb{E}_t \left[M_{t,t+1} \frac{X_{t+1}}{X_t} v(\Delta x_{t+1}, z_{t+1}, \xi_{t+1}, k_{t+1}, b_{t+1}) \right] && (26) \\
s.t. \quad & d_t = e_t - \psi_t && (27) \\
& h_t = \max(-e_t, 0) && (28) \\
e_t &= (1-\tau) y_t + \tau \delta k_t \frac{X_{t-1}}{X_t} + \tau r_f b_t \frac{X_{t-1}}{X_t} \mathbf{1}_{\{b_t \geq 0\}} && (29) \\
& -i_t - g_t + b_{t+1} - (1 + r_l) b_t \frac{X_{t-1}}{X_t} - \phi_t && (30) \\
& k_{t+1} = (1-\delta) k_t \frac{X_{t-1}}{X_t} + i_t && (31) \\
& b_{t+1} \leq \varphi k_{t+1}, && (32)
\end{aligned}
$$

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

$$
\begin{aligned}
y_t &= Z_t \left(\frac{X_t}{X_{t-1}} \right)^{-\theta} k_t^{\theta}, && (33) \\
g_t &= \begin{cases} \frac{c_k^+}{2} \left(\frac{i_t}{k_t} \right)^2 k_t \frac{X_t}{X_{t-1}}, & i_t \geq 0 \\ \frac{c_k^-}{2} \left(\frac{i_t}{k_t} \right)^2 k_t \frac{X_t}{X_{t-1}}, & i_t < 0 \end{cases}, && (34) \\
\phi_t &= \frac{c_d}{2} \left(\frac{\Delta b_t}{b_t} \right)^2 b_t \frac{X_t}{X_{t-1}}, && (35) \\
\psi_t &= \left[\eta_0 + \eta_1 h_t + \eta_2 \frac{h_t^2}{k_t} \frac{X_t}{X_{t-1}} \right] \exp\left[-\eta_3 \xi_t \right] \mathbf{1}_{\{h_t > 0\}}, && (36)
\end{aligned}
$$

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

Finally, the stock return is given as follows:

$$
R_{t+1} = \frac{V_{t+1}}{V_t - D_t} = \frac{v_{t+1} \frac{X_{t+1}}{X_t}}{v_t - d_t}. \qquad (37)
$$

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 two grids of 50 points for capital and 40 points for 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 $i = 1,...,50$ 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 $\underline{\mathrm{k}}$ and $\underline{\mathrm{b}}$. The advantage of this recursive construction is that more grid points are assigned around $\underline{k}$ and $\underline{\mathrm{b}}$, 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 3 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 issuance cost wedge ξ and idiosyncratic productivity process z 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 5 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 definitions and portfolio construction

We construct the following firm characteristics. Following Belo, Lin and Bazdresch (2014), the firm's investment in physical capital rate (IK_t) is given by $\mathrm{IK}_t = I_t/(0.5 \times (K_{t-1} + K_t))$,in which investment is Compustat data item CAPX (capital expenditures) minus Compustat data item SPPE (sales of property, plant, and equipment), and the physical capital stock (K_t) is given by Compustat data item PPENT (net property plant and equipment). Missing values of SPPE are set to zero. BM is the book- equity-to-market equity ratio, where both book equity and market equity values follow the definitions in Fama and French (1992). Leverage ratio is computed as book value of liabilities over the market value of equity. Gross equity/BE is the gross equity issuance-to-lagged book equity ratio, in which gross equity issuance is given by Compustat item

SSTK (sale of common and preferred stock). Firm-level TFP is the total factor productivity estimated in Imrohoroglu and Tuzel (2014).

We construct the 5 book-to-market portfolios, 5 investment rate portfolios, and 5 size portfolios as follows. Following Fama and French (1993), we sort the portfolios annually. At the end of June of year t, we sort all stocks in our sample by either the firms' book-to-market ratio, size (market equity), or investment rate in year $t-1$. The portfolio breakpoints to allocate firms into portfolios are set as the 20^{th}, 40^{th}, 60^{th}, and 80^{th} percentiles of the cross-sectional distribution of the sorting variable across NYSE firms. The firms are then allocated across the 5 portfolios based on their sorting variable relative to the breakpoints. Then, from July of year t to June of year $t+1$, we compute both equal- and value-weighted monthly portfolio returns across all the firms in the portfolio using market equity in the end of the previous month as the weights. The monthly portfolio returns are then transformed to annual (from January to December) by compounding the monthly returns. Portfolio excess returns are obtain after subtracting the annual risk free rate. For the 5 investment portfolios we also require firms to have December fiscal year end (annual Compustat item FYR), because of the relatively low persistence of the investment-rate relative to book-to-market and size characteristic, in which case the lag between the accounting data and the sorting procedure introduces substantial measurement error in the allocation of firms across the portfolios (see Belo, Lin and Bazdresch (2014) for a discussion of this issue). Relaxing this data requirement and perform the sorting procedure at the monthly frequency using the most up to date accounting data (maintaining at least a four month lag between the accounting data and the portfolio procedure) produces portfolio characteristics that are very similar to those reported here with the annual sort and fiscal yearend restriction.

Table 1 : Properties of issuance cost shocks

Panel A in this table reports the summary statistics –mean, standard deviation (St.Dev.), and first order autocorrelation (AR(1))– of the time series of the fraction of firms issuing equity in the cross section. Given the trend in this variable, its standard deviation and AR(1) is computed based on the one-sided HP filter detrended series. In addition, Panel A reports the summary statistics of the two out-of-sample shocks extracted from the recursive estimation of the VAR(1) system composed of the fraction of firms issuing equity and the level of TFP: issuance cost shock (ICS), measured as the out-of-sample innovation to the percentage of firms issuing equity in the VAR, and TFP shock (TFPS), measured as the out-of-sample innovation in the level of TFP in the VAR. Panel B reports the correlation of the estimated shocks with several macroeconomic and financial variables: a proxy of investment-specific technological shocks, denoted ISTS, measured as the real quality-adjusted investment price growth; a financial shock from Jermann and Quadrini (2012), denoted JQ; an external finance shock from Eisfeldt and Muir (2014), denoted EM; a proxy for changes in market sentiment (Baker and Wurgler (2002, 2006)), denoted SENT; the growth rate of per capita real nondurables consumption, denoted ΔC; and the market (MKT), small-minus-big (SMB) and high-minus-low (HML) factors from Fama and French (1993). The data is annual from 1971 to 2012. The out-sample shocks are estimated recursively with an initial training sample of four years. Thus, the first out of sample shock corresponds to year 5, that is, 1975.

Panel A: Summary statistics

Variable	Mean	St. Dev.	AR(1)
Percentage of firms issuing equity	38.04	3.68	0.54
Issuance cost shock (ICS)	−0.24	3.61	0.10
Total factor productivity shock (TFPS)	0.40	1.59	0.21

Panel B: Correlations

	Aggregate shocks						Asset returns		
	TFPS	ISTS	JQ	EM	SENT	ΔC	MKT	SMB	HML
ICS	0.05	−0.03	−0.07	−0.21	0.31	0.04	0.21	0.42	0.37
TFPS		−0.48	0.34	−0.17	−0.14	−0.06	0.36	0.00	0.03

Table 2 : Issuance cost shocks and systematic risk

This table reports the average equal- and value weighted return characteristics of three sets of portfolio sorts: 5 book-to-market portfolios (5 BM), 5 investment portfolios (5 IK), and 5 size portfolios (5 SZ). For each portfolio sort, the table reports the characteristics of the portfolios 1 (Low, L), and 5 (High, H), and the high-minus-low portfolio (H-L). In addition, the table reports the asset pricing tests on these portfolios using the following two asset pricing models as the benchmarks: the CAPM, in which the return on the market (MKT) is the only pricing factor, and a two factor model, in which the return on the market and the issuance cost shock (ICS) are the two factors. The estimation of the asset pricing models is by the generalized method of moments (GMM) using the standard asset pricing moment condition $E_T\left[r^e_{it+1}M_{t+1}\right]=0$, in which $M_{t+1}=1-b_{\mathrm{M}}\times\mathrm{MKT}_t-b_{\mathrm{I}}\times\mathrm{ICS}_t$ is the model specific stochastic discount factor (SDF), MKT_t is the (demeaned) market return, ICS_t is the (demeaned) ICS, and b_{M} and b_{I} are the corresponding risk factor loadings on the SDF. Panel A reports the following characteristics: [r^e] is the average annual portfolio excess stock return (in percentage and in excess of the risk free rate); SR is the portfolio Sharpe ratio (average return-to-return standard deviation ratio); [t] are heteroscedasticity and autocorrelation consistent t-statistics (Newey-West, with 3 year lag); $\mathrm{Cov}^{\mathrm{MKT}}$ is the univariate covariance between the portfolio excess return and the MKT factor; and $\mathrm{Cov}^{\mathrm{ICS}}$ is the univariate covariance between the portfolio excess return and the ICS factor; α and $\alpha^{2\mathrm{F}}$ are the pricing errors (abnormal returns) implied by the estimation of the CAPM and the 2 factor model, respectively. The pricing errors are inferred from the errors on the moment condition estimated above. Panel B reports the 1$^{\text{st}}$ stage and 2$^{\text{nd}}$ stage GMM estimates of the risk factor loadings in the SDF with the corresponding t-statistic in parenthesis,. The estimation is performed separately across each portfolio sort, and using all portfolio sorts together (All). MAE is the estimation implied mean absolute pricing errors (mean of $|\alpha|$ or $|\alpha^{2\mathrm{F}}|$). The data is annual from 1975 to 2012.

Panel A: Portfolio return characteristics and pricing errors

	Value-weighted returns									Equal-weighted returns								
	5 BM			5 IK			5 SZ			5 BM			5 IK			5 SZ		
	L	H	H-L	L	H	H-L	L	H	H-L	L	H	H-L	L	H	H-L	L	H	H-L
	Portfolio returns and Sharpe ratios																	
E[r^e]	6.82	13.88	7.06	11.87	5.95	−5.92	12.49	7.83	−4.67	6.97	22.22	15.25	18.41	11.32	−7.09	17.19	9.10	−8.09
[t]	2.49	5.69	2.36	5.43	2.16	−2.55	3.22	3.11	−1.01	1.73	4.91	5.93	4.32	2.95	−5.43	3.52	4.22	−1.66
SR	0.34	0.76	0.42	0.66	0.25	−0.38	0.44	0.46	−0.21	0.21	0.65	0.84	0.59	0.36	−0.61	0.48	0.49	−0.32
	Risk factor covariances																	
$\mathrm{Cov}^{\mathrm{MKT}}$	3.11	2.55	−0.56	2.65	3.60	0.95	3.60	2.81	−0.79	4.37	3.85	−0.51	3.76	4.01	0.26	4.19	3.05	−1.14
[t]	4.79	3.72	−1.13	4.10	3.73	1.61	4.00	4.63	−1.30	4.14	2.72	−0.80	3.10	3.70	0.73	3.23	4.17	−1.60
$\mathrm{Cov}^{\mathrm{ICS}}$	0.03	0.30	0.27	0.26	0.07	−0.19	0.41	0.04	−0.37	0.41	0.70	0.29	0.65	0.42	−0.23	0.64	0.16	−0.48
[t]	0.19	1.97	3.09	1.87	0.32	−1.73	2.03	0.30	−4.78	1.65	2.31	2.62	2.53	1.77	−3.41	2.23	0.92	−3.92
	Pricing errors: CAPM and 2 factor model																	
α	−4.40	4.67	9.08	3.46	−5.46	−8.92	0.33	−1.66	−1.99	−10.27	7.01	17.28	2.83	−5.32	−8.15	2.16	−1.84	−3.99
[t]	−2.10	1.97	2.05	1.99	−2.64	−2.47	0.14	−0.66	−0.41	−2.57	2.38	2.51	2.15	−2.38	−2.44	0.86	−0.80	−0.84
$\alpha^{2\mathrm{F}}$	0.00	0.76	0.75	−1.35	−1.27	0.07	−0.48	−0.23	0.25	−1.90	−1.47	0.43	−1.39	−1.60	−0.21	0.20	0.00	−0.20
[t]	0.01	0.85	1.21	−1.31	−1.37	0.46	−0.46	−0.54	0.37	−1.32	−1.30	0.75	−1.25	−1.36	−0.84	0.41	−0.01	−1.04

Table 2 : Issuance cost shocks and systematic risk (cont.)

Panel B: Risk factor loadings

	Value-weighted returns								Equal-weighted returns							
	5 BM		5 IK		5 SZ		ALL		5 BM		5 IK		5 SZ		ALL	
	CAPM	2F	CAPM	2F	CAPM	2F	CAPM	2F	CAPM	2F	CAPM	2F	CAPM	2F	CAPM	2F
	1^{st} stage GMM															
b_M	3.70	1.97	3.25	1.32	3.47	2.83	3.48	2.19	4.05	−2.40	4.26	0.07	3.68	2.49	4.01	0.33
[t]	3.39	1.11	2.87	0.49	3.42	1.85	3.17	1.29	3.33	−0.92	3.44	0.04	3.51	1.48	3.42	0.23
b_I		27.99		39.40		7.57		19.24		48.14		30.69		10.94		28.94
[t]		2.51		1.89		0.55		1.89		2.77		3.59		0.88		3.95
MAE	2.16	0.60	2.66	1.21	0.62	0.30	1.76	1.42	5.11	1.50	2.30	1.30	1.01	0.28	3.15	1.72
	2^{nd} stage GMM															
b_M	4.33	2.32	4.59	0.30	3.13	2.37	5.54	3.35	4.58	0.19	3.42	−0.53	3.14	1.65	4.74	0.59
[t]	5.10	1.85	4.15	0.13	3.43	1.74	8.88	5.06	4.66	0.13	3.88	−0.33	3.59	1.12	7.29	0.99
b_I		21.91		41.98		13.10		24.11		37.73		30.37		15.86		27.99
[t]		3.21		2.74		1.27		4.87		4.03		4.60		1.52		6.74
MAE	2.73	0.77	3.05	2.49	1.29	0.51	5.53	3.93	4.86	4.04	3.86	2.32	1.73	1.08	3.47	1.65

Table 3 : Issuance cost shocks and aggregate consumption

This table reports results from the following long-horizon predictability regression:

$$\Delta C_{t+h} = a + b \times \text{ICS}_t + c \times \text{TFPS}_t + e_{it+h}$$

in which $h = 1, .., 5$ is the forecast horizon in years, ΔC_{t+h} is the growth rate of per capita real nondurables consumption from t to t+h, and ICS and TFPS are the h-period lagged values of the issuance cost stock and total factor productivity shock, respectively. For each forecasting horizon, the table reports the corresponding OLS estimate of the slope coefficient, slope, the Newey-West corrected t-statistic, $[t]$, using a Newey-Weste lag equal to one year plus the horizon, and the regression adjusted R^2. The sample is annual data from 1975 to 2012.

		Forecast horizon in years				
Regressor		1	2	3	4	5
ICS	Slope	0.10	0.20	0.33	0.37	0.32
	$[t]$	1.47	1.93	2.94	2.38	1.62
TFPS	Slope	0.34	0.47	0.56	0.68	0.37
	$[t]$	3.05	2.21	2.54	2.18	0.82
	R^2	16.61	14.04	18.63	16.37	2.84

Table 4 : 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
Adjustment cost parameters in capital	c_k^+/c_k^-	0/40
Adjustment cost parameters in debt	c_b	1
Resale value of capital	φ	0.85
Wedge between the borrowing and saving rates	κ	0.005/12
Fixed/linear/convex issuance cost	$\eta_0/\eta_1/\eta_2$	.002/0.1/0.0004
Parameter of time-varying issuance cost	η_3	12
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	$\bar{z}$	-3.7
Persistence coefficient of firm-specific productivity	ρ_z	0.98
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	5
Loading of the SDF on the issuance cost shock	γ_ξ	15

Table 5 : 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 cross-sectional firm-level moments are computed by first computing the cross sectional moments and then taking the average of these moments across years. The real data are from 1975 to 2012. 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.

Panel A: Benchmark moments

Moments	Data	Model
Asset prices		
Aggregate stock market excess return (%)	5.71	5.87
Sharpe ratio of stock market returns	0.35	0.37
Real risk-free rate (%)	1.65	1.65
Real quantities: Aggregate-level		
Standard dev. of profits	0.14	0.15
Standard dev. of net issuance-to-assets ratio	0.04	0.04
Standard dev. of debt growth rate	0.09	0.10
Average frequency of net issuance	0.38	0.31
Marginal issuance cost	$.084 - .12$	0.10
Real quantities: Cross section		
Standard dev. of net issuance/book	0.41	0.46
Standard dev. of investment rate	0.24	0.17
Autocorrelation of investment rate	0.48	0.34
Interquatile range of investment rate	0.23	0.17
Skewness of investment rate	1.62	1.85
Kurtosis of investment rate	6.56	8.42

Panel B: Firm level correlations

Moments	Data	Model
Investment rate, issuance-to-book equity ratio	0.07	0.08
Investment rate, debt growth rate	0.29	0.97
Investment rate, sales growth rate	0.27	0.79
Issuance-to-book equity ratio, debt growth	−0.07	−0.01
Issuance-to-book equity ratio, profits growth rate	0.14	−0.16
Gross issuance, sales growth	0.19	0.19
Debt growth, sales growth	0.23	0.85

Table 6 : Issuance cost shocks and systematic risk in the model

This table replicates the empirical analysis (return characteristics of the portfolios and asset pricing tests) reported in Table 2, using data generated by the simulation of the model. See Table 2 for a description of the variables and tests. 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: Portfolio return characteristics and pricing errors

	5 BM				5 IK				5 SZ			
				Data				Data				Data
	L	H	H-L	H-L	L	H	H-L	H-L	L	H	H-L	H-L
	Portfolio returns and Sharpe ratios											
$E[r^e]$	2.87	9.76	6.89	7.06	9.27	4.10	−5.17	−5.92	9.52	4.23	−5.30	−4.67
$[t]$	3.78	14.32	42.48	2.36	12.19	5.43	−32.05	−2.55	12.75	5.51	−23.92	−1.01
SR	0.15	0.57	1.99	0.42	0.49	0.22	−1.53	−0.38	0.52	0.22	−1.18	−0.21
	Risk factor covariances											
Cov^{MKT}	3.10	3.09	−0.01	−0.56	3.09	3.07	−0.02	0.95	3.02	3.14	0.12	−0.79
$[t]$	15.67	15.63	−0.43	−1.13	15.55	15.64	−0.73	1.61	15.68	15.57	3.39	−1.30
Cov^{ICS}	0.84	1.01	0.17	0.27	0.98	0.84	−0.15	−0.19	1.01	0.83	−0.18	−0.37
$[t]$	8.65	10.21	8.34	3.09	9.94	8.72	−7.16	−1.73	10.53	8.43	−6.74	−4.78
	Pricing errors: CAPM and 2 factor model											
α	−4.19	2.73	6.92	9.08	2.57	−2.56	−5.12	−8.92	2.75	−2.81	−5.56	−1.99
$[t]$	−15.50	14.70	15.28	2.05	14.11	−13.93	−14.40	−2.47	13.16	−13.46	−13.46	−0.41
α^{2F}	−0.83	−0.18	0.65	0.75	0.61	−0.35	−0.96	0.07	−0.42	0.16	0.58	0.25
$[t]$	−3.23	−0.80	2.20	1.21	2.73	−2.41	−3.50	0.46	−3.05	1.33	4.14	0.37

Panel B: Risk factor loadings

									Data	
	5 BM		5 IK		5 SZ		ALL		ALL	
	CAPM	2F	CAPM	2F	CAPM	2F	CAPM	2F	CAPM	2F
	1st stage GMM									
b_M	2.28	−1.20	2.17	−1.50	2.25	−1.42	2.23	−1.59	3.48	2.19
$[t]$	9.65	−3.58	9.19	−3.92	9.50	−4.07	9.45	−3.96	3.17	1.29
b_I		38.04		29.24		28.99		31.03		19.24
$[t]$		4.32		5.27		5.59		5.13		1.89
MAE	2.49	0.46	1.60	0.49	2.07	0.34	2.08	0.57	1.76	1.42
	2nd stage GMM									
b_M	3.05	−1.88	2.86	−1.61	2.87	−1.31	4.54	−0.28	5.54	3.35
$[t]$	12.48	−3.78	11.73	−4.25	11.82	−4.41	8.91	−1.76	8.88	5.06
b_I		29.73		21.35		23.25		15.98		24.11
$[t]$		4.82		5.99		5.96		3.94		4.87
MAE	2.89	0.65	2.29	0.68	2.34	0.86	2.68	3.95	5.53	3.93

Table 7 : Investment, financial flows, and productivity in the data versus model

This table reports the average portfolio characteristics of 5 book-to-market (5 BM), 5 investment rate (5 IK), and 5 size (5 SZ) portfolios in the real data (column "Data"), and in data simulated from the model (columns "Model"). For each portfolio sort we report the characteristics of portfolios 1 (Low, L), and 5 (High, H). H-L stands for the high-minus-low portfolio. IK is investment rate; Gross equity/BE is the gross-equity-issuance-to-book-equity ratio; ΔDebt is the growth rate in total debt; Leverage is the firms' book 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, 2014). The portfolio-level characteristic is the time series average of the median characteristic across the firms in the portfolio in each year. The data is annual from 1975 to 2012. The reported statistics for the model are obtained from 100 samples of simulated data, each with 3,600 firms and 600 monthly observations.

	Data			Model		
Characteristic	L	H	H-L	L	H	H-L
			5 BM			
IK	0.28	0.15	-0.13	0.15	−0.02	−0.17
Gross equity/BE	0.03	0.00	-0.03	0.18	0.12	−0.06
ΔDebt	0.04	-0.01	-0.05	0.03	−0.15	−0.18
Leverage	0.17	0.23	0.06	0.33	0.37	0.04
TFP	0.62	0.46	-0.16	0.02	0.01	−0.01
			5 IK			
IK	0.06	0.45	0.39	0.00	0.19	0.19
Gross equity/BE	0.00	0.01	0.01	0.13	0.24	0.11
ΔDebt	−0.06	0.16	0.22	−0.13	0.08	0.21
Leverage	0.28	0.13	−0.15	0.36	0.30	−0.06
TFP	0.46	0.60	0.14	0.01	0.02	0.01
			5 SZ			
IK	0.20	0.21	0.01	0.10	0.12	0.02
Gross equity/BE	0.00	0.01	0.01	0.19	0.16	−0.03
ΔDebt	0.00	0.04	0.04	−0.03	0.03	0.05
Leverage	0.18	0.22	0.04	0.26	0.34	0.08
TFP	0.48	0.65	0.17	0.00	0.02	0.02

Table 8 : Selected data versus model-implied moments across alternative calibrations

This table presents several comparative statics exercises. The reported statistics for each alternative specification of 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.	S.D.	MKT	BM		IK		Size	
Spec.	(ICS, ξ)	IK	E/BE	r^e	r^e	α	r^e	α	r^e	α
0-Data										
	n.a.	0.17	0.41	5.71	7.06	9.08	−5.92	−8.92	−4.67	−1.99
1-Benchmark										
	0.46	0.20	0.46	5.87	6.89	6.92	−5.17	−5.12	−5.30	−5.56
2-Zero price of risk of ICS shock ($\gamma_\xi = 0$; benchmark $\gamma_\xi = 15$)										
	0.31	0.24	0.38	9.66	0.03	0.69	−1.16	−0.44	−0.46	0.07
3-Small price of risk of TFP shock ($\gamma_x = 1.5$; benchmark $\gamma_x = 5$)										
	0.40	0.16	0.42	3.38	5.40	5.55	−3.53	−3.60	−5.88	−6.03
4-Zero issuance costs ($\eta_0 = \eta_1 = \eta_2 = 0$)										
	−0.01	0.30	0.53	11.15	−0.89	1.47	−2.98	0.76	−1.04	0.99
5-No stochastic issuance costs ($\eta_3 = 0$)										
	0.01	0.23	0.31	12.86	−0.46	0.22	−0.97	0.55	0.10	3.11
6-Tight collateral constraint ($\varphi = 0.05$; benchmark $\varphi = 0.85$)										
	0.13	0.22	0.22	4.38	1.24	2.36	−0.62	−0.28	5.65	6.19
7-High debt adjustment cost ($c_d = 50$; benchmark $c_d = 1$)										
	0.38	0.24	0.21	6.54	−2.24	−0.04	0.89	−0.25	−1.64	−1.15

Table 9 : Financial flows across ICS and TFP states

This table presents the time series average portfolio-level realized (that is, in the year after portfolio formation) gross issuance-to-book equity ratio (Issuance), change in debt (growth rate), and change in cash (growth rate) for the low (L) and high (H) portfolios sorted on book-to-market (BM), investment (IK), or size (SZ). The reported time series averages of the portfolio characteristics are computed separately across different ICS and TFP states, defined as periods characterized by High, Medium, and Low realizations of the ICS and TFP shocks. The High ICS state periods, which correspond to years with unusually low costs of issuing equity (good times), are defined as the years in which the realized ICS is in the top 20th percentile of the ICS distribution. The Low ICS states (years with unusually high cost of issuing equity, hence, bad times) are defined as the years in which the realized ICS is in the bottom 20th percentile of the ICS distribution. The High TFP state periods (good times), are defined as the years in which the realized TFP growth rate is in the top 20th percentile of the TFP growth distribution. The Low TFP states (bad times) are defined as the years in which the realized TFP growth rate is in the bottom 20th percentile of the TFP growth distribution. The intermediate (Mid) states corresponds to the years in which the corresponding variable (ICS or TFP) is between the 20th and 80th percentile of the corresponding distribution. The data is annual from 1975 to 2012.

	Across ICS States						Across TFP States					
	5 BM		5 IK		5 SZ		5 BM		5 IK		5 SZ	
ICS/TFP states	L	H	L	H	L	H	L	H	L	H	L	H
	Equity issuance											
High - good times	4.26	0.07	0.28	1.29	0.34	1.54	3.24	0.06	0.18	0.95	0.29	1.21
Mid	3.16	0.08	0.26	1.10	0.35	1.13	3.36	0.08	0.25	1.14	0.33	1.23
Low - bad times	2.72	0.08	0.17	0.83	0.29	1.23	3.17	0.10	0.29	1.06	0.39	1.28
	Change in debt											
High - good times	−0.45	−5.15	−5.38	2.41	−4.90	0.64	2.44	−3.60	−3.91	8.94	−1.97	7.27
Mid	3.31	−2.33	−3.81	7.87	−1.29	4.00	3.23	−2.19	−3.98	7.61	−1.32	4.23
Low - bad times	3.16	−1.47	−2.90	10.80	−0.13	8.67	0.51	−3.41	−3.92	5.00	−2.97	1.40
	Change in cash											
High - good times	19.26	3.60	7.95	8.40	4.50	17.07	15.46	−1.48	4.48	6.93	−0.12	11.94
Mid	12.59	−0.16	4.62	3.98	1.41	8.24	13.05	−0.22	3.89	4.05	1.20	8.77
Low - bad times	8.95	−5.94	−1.23	1.45	−4.79	5.65	11.46	−0.70	4.23	2.75	0.42	9.33

Figure 1 : Equity issuance, aggregate TFP, and shocks

This figure reports the time series of the fraction of firms issuing equity 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 out-of-sample equity issuance cost shock (ICS) and TFP shock obtained as the residuals from a VAR(1) system (bottom left Panel). Shaded bars are NBER recession years. The data is annual from 1971 to 2012.

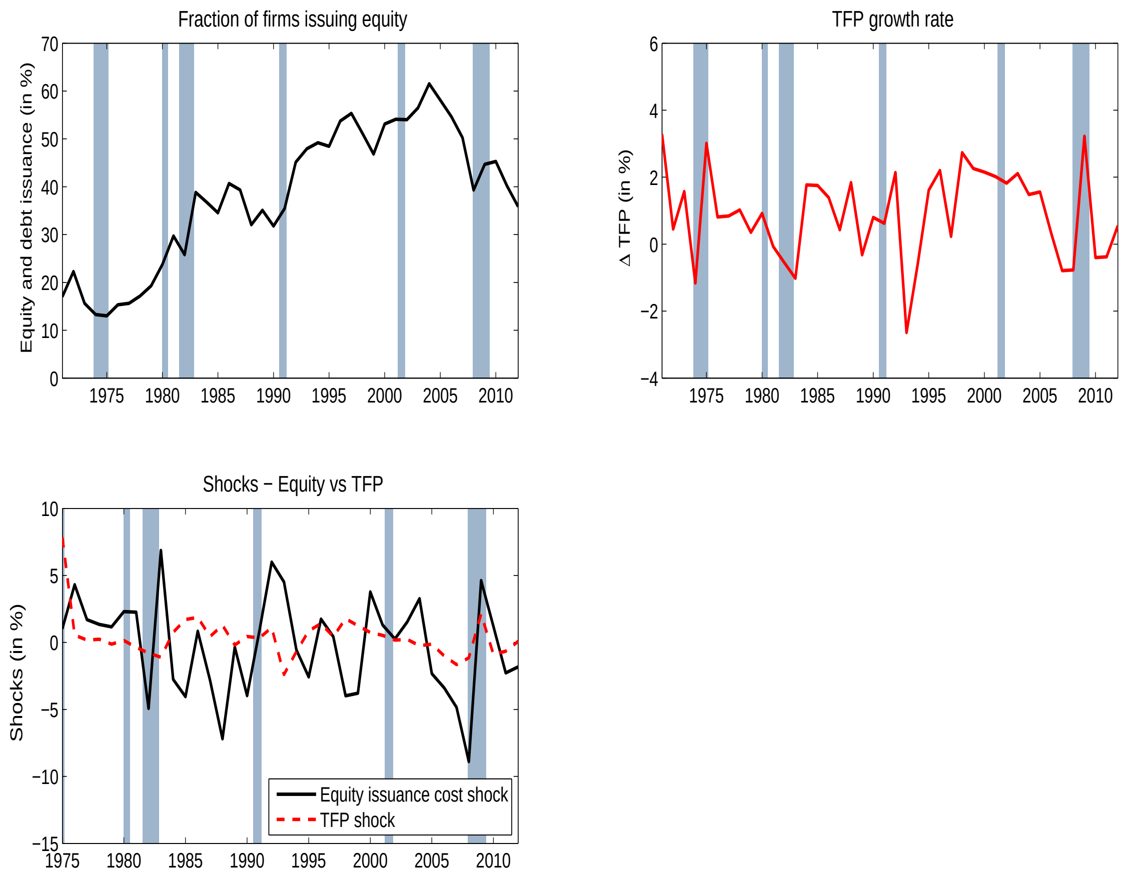

Figure 2 : Market and equity issuance cost shock covariances

This figure reports the risk exposures (covariances) of the excess returns of the five book-to-market portfolios, five investment portfolios, and five size portfolios, with respect to the aggregate market factor, and the aggregate equity issuance cost shock factor, using data simulated from the model. The covariances are expressed relative to the covariance of the first (low) portfolio in each sort to emphasize the cross sectional variation. 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.

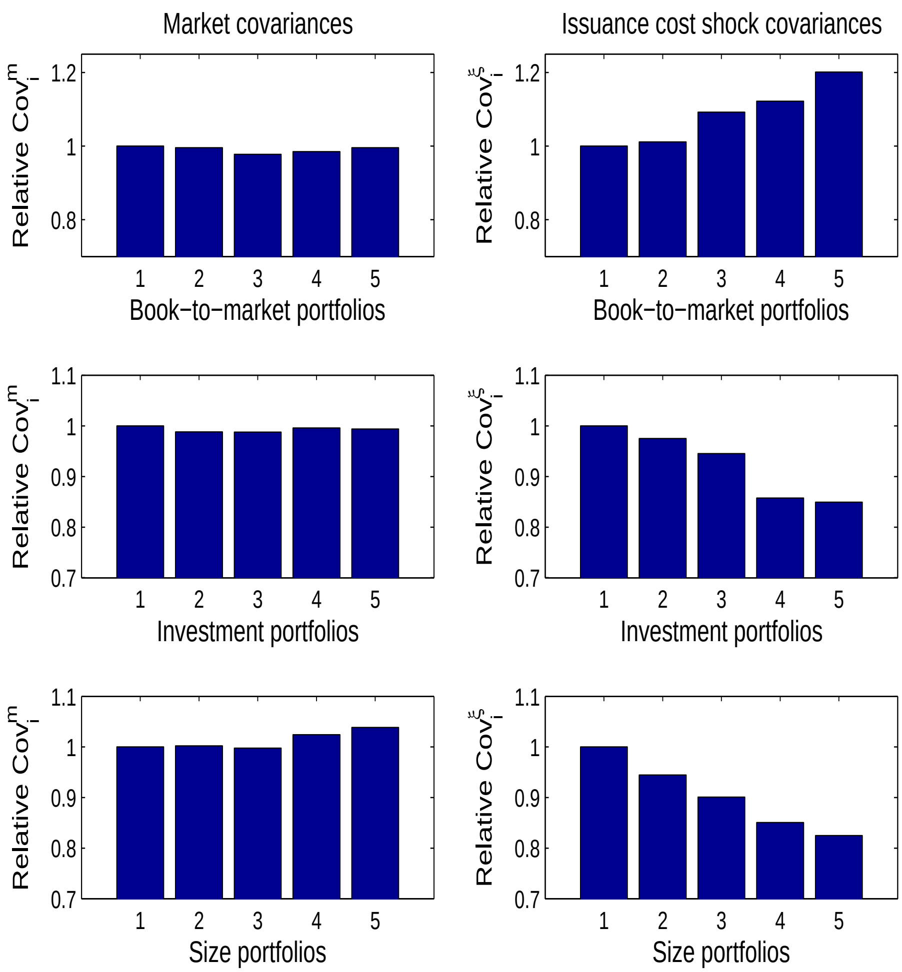

Figure 3 : Impulse responses to an aggregate equity issuance cost shock

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, bad times). 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).