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Testing Q theory with financing frictions ☆

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Abstract

We develop a Q theory of investment under financing constraints. The firm invests and saves optimally facing convex costs of external equity, overhang from outstanding debt, and collateral constraints on new borrowing. Overhang and costs of external equity discourage investment. Conversely, firms anticipating collateral constraints experience a side benefit from investing as installed capital relaxes future constraints. Empirical tests support the model. Conditional on average Q, investment is lower for equity issuers and for firms with large debt overhang. The Kaplan and Zingales and the Whited and Wu indices are used as proxies for future collateral constraints. Consistent with the model, both indices enter investment regressions positively.

Introduction

The effect of financing imperfections on investment remains a topic of continued interest.[1] The workhorse structural model in this literature is the Q theory developed by Hayashi (1982), who shows that marginal q is a sufficient statistic for investment when there are convex costs of adjusting the capital stock. Of greater interest to empiricists is Hayashi's proof that average Q, which is observable, is equal to the inherently unobservable marginal q when profits are linear in capital and financing is frictionless. Elegance aside, the utility of Hayashi's model in empirical corporate finance is limited, because it provides no guidance regarding structural tests for financial market imperfections. For example, within the Q theory, what kind of investment behavior distinguishes credit rationing from, say, lemons premia in equity markets?

Few workable alternatives to the Hayashi framework have been offered. The objective of this paper is to formulate and test a Q theory of investment in the presence of financial frictions. The model of Hayashi (1982) is extended to allow for uncertainty, a cash buffer-stock, collateral constraints on intermediated

hang arising from long-term public debt, and convex costs of external equity. Some

recent papers simulate dynamic structural models in which the firm faces a similar set of frictions.[2] The contribution of our model is twofold. First, in contrast to simulation-based studies, we derive an easy-to-estimate optimality condition in which investment is linear in the relevant variables. Second, we derive a relation between marginal and average Q in a setting in which the firm finances optimally in the presence of a rich set of frictions.

An attractive feature of the model is that the empirical investment equation contains terms that can be linked directly to each of the three distortions: convex costs of external equity, collateral constraints, and debt overhang. The empirical section of the paper uses US firm-level data to test three predictions related to the three frictions. The first prediction of the model is that, conditionally, investment is decreasing in an interaction variable: average Q multiplied by capital-normalized equity issuance. This prediction could run counter to casual intuition. After all, firms tend to issue equity to finance large investments. However, average Q already captures shocks to the investment opportunity set. The interaction variable captures the following effect. Suppose firms A and B have the same investment opportunity set, but firm B has no cash on hand and must float equity to fund its investment program. Convex costs of external equity raise the marginal cost of each unit of capital acquired by firm B. Consequently, firm B invests less than A. Consistent with the model, estimated coefficients on this interaction variable are always negative and typically statistically significant. Further, correcting for measurement error in observed Q increases the absolute magnitude of the coefficients three- to fivefold. The measurement-error consistent estimates are also economically significant. For example, according to our estimates, the median equity-issuing firm in our sample would increase investment by approximately 5% if it were able to finance with internal funds.

The second prediction of the model could also run counter to intuition: ceteris paribus, firms anticipating binding collateral constraints on future borrowing invest more today. For example, consider a high Q firm anticipating valuable investment opportunities in the future. If this firm has a high ratio of loans to tangible capital, lenders are reluctant to provide funds for these future investments. For such a firm, installing capital today provides a spillover benefit, because this capital serves as collateral for future loans. This spillover benefit increases investment incentives at the margin.

We use the Kaplan and Zingales (hereafter, KZ, 1997) and Whited and Wu (hereafter, WW, 2006) indices to proxy for firms anticipating binding collateral constraints. The motivation is similar to that provided by Baker, Stein, and Wurgler (2003), who use the KZ index to identify equity dependent firms. First, both indices load in the right way onto firm characteristics suggestive of binding collateral constraints. For example, both indices are increasing in proxies for investment opportunities, increasing in financial leverage, and decreasing in internal funds. Second, both indices have been used in other contexts so concern over data mining should be assuaged. Consistent with the model, coefficients on the KZ and WW indices are always positive and significant. The signs of these coefficients are also robust to correcting for measurement error in observed Q.

The final friction tested is the debt-overhang effect. The overhang correction variable is the same as that derived by Hennessy (2004). The model presented in our paper is more general in that it includes endogenous cash retention, credit rationing, and costs of external equity. The theory predicts that overhang is most pronounced for firms with high leverage, high default probabilities, and high lender recoveries in default. Intuitively, the overhang correction is intended to pick up investment returns accruing to lenders as opposed to shareholders. Consistent with the theory, the overhang correction always enters negatively, is always statistically significant, and is robust to measurement error. Its ...tial. Our measurement-error consistent estimates indicate that the elasticity of

investment with respect to leverage for the median firm is approximately −2. Because our model controls for other frictions that one might expect to be correlated with the overhang correction, these results suggest that the findings in Hennessy (2004) do not stem from omitted variables.

Hayashi (1985) and Chirinko (1987) pursue the same agenda undertaken in this paper, endogenizing finance in Q theoretic models of investment and then relating marginal q to average Q. These two models are more limited than the one here. The Hayashi (1985) model is essentially the trade-off theory, because the only frictions incorporated are taxes and reduced-form bankruptcy costs. The model of Chirinko (1987) does not allow for uncertainty. In addition, Chirinko's model loads financial market imperfections directly into the production function. For example, in his model, debt reduces current period profits. However, we show that agency costs of debt, such as the Myers (1977) overhang effect, are not isomorphic to foregone production today. Instead, debt overhang causes shareholders to ignore future investment returns accruing after default.

The distortions included in the model are motivated by a number of theoretical papers. Convex costs of external equity are intended to capture the effect of informational asymmetries. Myers and Majluf (1984) consider a firm with a single indivisible investment opportunity. They show that asymmetric information can raise the cost of external equity if the firm is pooled with those of lower quality. If the lemons problem is sufficiently severe, good firms find it optimal to pass up positive net present value (NPV) projects. Krasker (1986) presents a generalized model of adverse selection in equity markets. In his model, as in our model, the firm chooses the scale of new investment. Krasker shows that under rational expectations the shadow cost of external equity is convex. The reasoning is as follows. As the firm issues more equity, beliefs about the manager's private information are revised downward, lowering the price paid for both marginal and inframarginal shares.

Myers and Majluf (1984) argue that lemons premia associated with external equity create incentives to use retained earnings and debt as sources of funds. However, the lemons problem also limits the ability of firms to obtain debt financing on fair terms. Jaffee and Russell (1976) and Stiglitz and Weiss (1981) present models of the intermediated loan process, showing that banks could ration credit in response to adverse selection. These models are empirically relevant, because bank debt is the most important source of financing. For example, within a random sample of NYSE and Amex corporations, Houston and James (1996) find that the median percentage of bank debt in total debt is 77%.

Concerns regarding moral hazard on the part of the borrower may also lead to credit rationing. For example, Hart and Moore (1994) consider a setting in which the entrepreneur has the option to repudiate a debt contract. By threatening to withdraw valuable human capital from the project, the entrepreneur can extract debt forgiveness from the lender. Under any renegotiation-proof debt contract, the maximum loan balance at any time is capped at the liquidation value of physical assets. The Hart and Moore model seems to best fit bank debt, given its assumption of frictionless bargaining between the firm and lender.

Almeida and Campello (2004) devise a novel empirical test of theories emphasizing the importance of tangible capital in credit markets, e.g. Hart and Moore (1994), showing that exogenous cash shocks should have a larger effect on capital accumulation when the tangibility of capital is high. This is because a dollar windfall buys a unit of capital, which serves as collateral for another loan. When asset tangibility is high, the chain of collateralized investments ultimately results in a large multiplier effect. Almeida and Campello find that their prediction holds across a broad range of specifications. Our model and the Almeida and Campello model rely upon similar arguments. In both models, the firm and lender

rationally account for the spillover effect provided by capital in terms of loosening the collateral constraint. However, the two papers rely upon different methods for empirical identification.

Myers (1977) shows that preexisting defaultable debt creates an overhang problem, with the problem being most severe for long-lived debt. In particular, an equity-maximizing manager underinvests relative to first-best whenever capital accumulation provides a positive spillover to existing lenders. Lang, Ofek, and Stulz (1996) present empirical evidence supportive of the Myers theory and consistent with our results. When book leverage is included as a regressor, along with average Q, leverage only enters significantly negative for low Q firms. This is precisely the set of firms for which the overhang correction is likely to be large.

Fazzari, Hubbard, and Petersen (1988) try to infer the magnitude of financing frictions based upon the sensitivity of investment to cash flow. Kaplan and Zingales (1997) question the formal justification for this traditional methodology. For example, in simulations of a dynamic model, Gomes (2001) shows that financial frictions are neither necessary nor sufficient for significant cash flow effects. In contrast to the traditional approach, the empirical tests in our paper do not rely upon cash flow coefficients and are derived explicitly from a dynamic structural model.

The Stein (2003) recent survey provides a convenient taxonomy. The model presented in this paper includes the main frictions discussed in his models of costly external finance: convex costs of external equity, credit rationing, and debt overhang. Excluded from our analysis are theories based upon agency conflicts between managers and shareholders. The omission reflects tractability concerns, not perceptions of relative importance.

Section 2 presents the model; Section 3, the data; and Section 4, the empirical estimation. Section 5 concludes. Proofs of all propositions are in Appendix A, a description of the data is in Appendix B, and the derivation of the generalized method of moments (GMM) estimators used in Section 4 in Appendix C.

Section snippets

The model

The manager works in the interest of current shareholders. Investors are risk neutral and discount cash flows at the risk-free rate $r > 0$. The endogenous state variable K denotes the capital stock and I denotes investment. An exogenous state variable ε captures innovations in output prices, variable input costs, and productivity. Operating profits are $F(K, \varepsilon) - G(I, K)$. The function F represents gross profits, excluding costs of installing new machinery or removing old machinery. The function G...

Data and summary statistics

The data come from two sources. The first is the combined annual, research, and full coverage 2005 Standard and Poor's Compustat industrial files. The sample is selected by first deleting any firm-year observations with missing data or for which total assets, the gross capital stock, or sales are either zero or negative. All observations that fail to obey standard accounting identities are deleted. A firm is included it has at least three consecutive years of complete...

Empirical tests

Table 2 presents results from estimating the investment regression in Eq. (29) via ordinary least squares (OLS).[6] As is standard in the literature, the model is estimated using firm and year-specific intercepts. A number of factors can generate fixed effects. For example, in Eq. (29), depreciation rates (δ) differs across firms and over time, affecting the optimal rate of investment....

Conclusion

This paper provides an internally consistent framework for empirically examining the effects of financial frictions on investment. This endeavor is a contribution to a literature that has based most of its tests on embedding predictions from a static investment model into a regression of investment on Q, which is itself based on a dynamic model. For example, the most commonly used test consists of inserting cash flow into such a regression and examining whether a priori constrained firms have...

References (44)

R. Chirinko
Tobin's *q* and financial policy
Journal of Monetary Economics (1987)

R. Cooper *et al.*
Financial frictions and investment: requiem in *q*
Review of Economic Dynamics (2003)

J. Hausman *et al.*
Identification and estimation of polynomial errors-in-variables models
Journal of Econometrics (1991)

F. Hayashi
Corporate finance side of the *q* theory of investment
Journal of Public Economics (1985)

L. Lang *et al.*
Leverage, investment, and firm growth
Journal of Financial Economics (1996)

S. Myers
Determinants of corporate borrowing
Journal of Financial Economics (1977)

T.M. Whited *et al.*
Financial constraints risk
Review of Financial Studies (2006)

T.M. Whited
Is it inefficient investment that causes the diversification discount?
Journal of Finance (2001)

H. White
A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity
Econometrica (1980)

L. Summers
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Brookings Papers on Economic Activity (1981)

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