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Information Asymmetry About Investment Risk and Financing Choice

Mufaddal H. Baxamusa
University of St Thomas - Saint Paul, baxa0428@stthomas.edu

Sunil Mohanty
City University of New York, Brooklyn, skmohanty@brooklyn.cuny.edu

Ramesh P. Rao
Oklahoma State University - Main Campus, ramesh.rao@okstate.edu

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Mufaddal Baxamusa
Department of Finance
University of Saint Thomas
Minneapolis, MN
baxa0428@stthomas.edu

Sunil Mohanty
Department of Finance
Brooklyn College
City University of New York
Brooklyn, NY
skmohanty@brooklyn.cuny.edu

AND

Ramesh P. Rao*
Department of Finance
Oklahoma State University
Stillwater, OK
ramesh.rao@okstate.edu

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*Corresponding Author

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Information Asymmetry about Investment Risk and Financing Choice

ABSTRACT

Though it is generally accepted that information asymmetry has an impact on capital structure policy, the nature of the information asymmetry is not well understood. Recent theoretical work and empirical evidence suggests that security choice depends upon the information asymmetry associated with the investment risk of the particular use of proceeds. Consistent with this view, using the sources and uses of funds framework, we find that equity is used to fund projects with greater information asymmetry about their risk such as research and development expenditure, while debt is used to fund investments with lower information asymmetry about their risk such as liquidity enhancement.

JEL Classification: *G310 and G320*

Key Words: *Firm Investment, Capital Structure, Information Asymmetry*

I. Introduction

The role of information asymmetry in corporate financing has become one of the basic tenets of capital structure theory. The most enduring version is the popularly known pecking order (PO) hypothesis posited by Myers and Majluf (1984). The model predicts that information asymmetry between managers and investors leads to adverse selection costs, creating a hierarchy of financing preference based on the information sensitivity of the security. In this scheme, retained earnings are the least information sensitive, followed by debt, and then external equity. Thus, firms are inclined to fund their financing deficit first by retained earnings, then by debt issuance, and only as a last resort by external equity issuance. The intensity of research in this area is only matched by the lack of empirical consensus for the PO theory.[1] For example, the PO theory cannot explain why young, small, and non-dividend paying firms that face large asymmetric information problems, issue equity securities (e.g., Ambarish et al., 1987; Fama and French, 2002; and Wu and Wang 2005). Survey findings of Graham and Harvey (2001) also suggest that small and non-dividend paying firms' financing decisions are not consistent with PO theory.

Though evidence in favor of PO is mixed, Leary and Roberts (2010) suggest that measures of information asymmetry may be systematically related to financing behavior, albeit not necessarily in sync with the predictions of the PO model. Specifically, some of the observed patterns with respect to small firms, age, and asset tangibility suggest that *information asymmetry relating to future investments* may play an important role. Recent theoretical work by Halov and Heider

[1] Shyam-Sunder and Myers (SM) (1999) find some support for the PO theory while Frank and Goyal (2003), Fama and French (2002, 2005),Wu and Wang (2005), and Leary and Roberts (2010) find significant evidence against it.

(2012,), Halov, Heider and John (2011), and Fulghieri and Lukin (2001), and Wu and Wang (2005) provide support for such a view. These models predict a preference for equity over debt when there is greater information asymmetry between the firm and outsiders about future investment risk (i.e., project risk to which the funds are directed). WW also show that announcement returns associated with issuance of equity are more likely to be positive when the asymmetric information about firm value arises mainly from growth (future investment) rather than assets-in-place.

In this paper, we provide empirical evidence to support the notion that the information asymmetry of the underlying project risk (e.g., relative success of a new product such as a new drug or the growth potential from a plant expansion) is what drives financing choice. For testing purposes, we classify investments into a hierarchy based on their underlying risk information asymmetry: liquidity investments (lowest risk), capital expenditures (moderate risk), and R&D investments (highest risk). We argue that liquidity-enhancing investments (e.g., building up cash) are associated with fairly low information asymmetry about their risk while, at the other extreme, investments in R&D are expected to be associated with the greatest information asymmetry about their project risk. On the other hand, as capital expenditures tend to be focused on investments in fixed assets, they are assumed to hold an intermediate position between liquidity-enhancing investments and intangible investments (i.e., R&D expenditures). Thus, we expect debt financing to be associated with subsequent low risk information asymmetry liquidity-enhancing investments while equity financing should be more closely related with high underlying risk information asymmetry investments such as R&D.

For our empirical methodology we employ the sources and uses of funds framework used in several studies (e.g., Chang, Dasgupta, Wong, and Yao, 2014; Gatchev, Pulvino, and Tarhan, 2010) based on the accounting identity that the total funds used by the firm should equal internal cash flows in addition to debt and equity raised by the firm. The primary uses of funds we consider are research and development expenditure (R&D), capital expenditure, working capital changes, changes in cash holdings and cash dividends.[2] We find that per dollar of equity issued 22 cents is used for R&D, while only 1 cent per dollar of debt goes toward R&D financing. With respect to capital expenditures, 11 cents of every dollar of debt financing is devoted to this expenditure in contrast to only 5 cents in the case of equity financing. A similar pattern is evident for working capital expenditures where 9 cents of every dollar of debt financing ends up but only 3 cents in the case of equity. In the case of cash, we find that 77 cents of every dollar of debt goes towards building up cash while the equivalent for equity is 68 cents. Thus, we can conclude that investments with high information asymmetry about their risk (e.g., R&D) are funded primarily by equity and not debt, while investments with low information asymmetry about their risk exhibit an affinity for debt financing.

Our investigation builds on the prior works of Kim and Weisbach (2008), DeAngelo, DeAngelo, and Stulz (2010), Halov and Heider (2012), and Gatchev, Spindt, and Tarhan (2009). Kim and Weisbach (2008) and DeAngelo et al. (2010) link equity issuance proceeds to how they are subsequently utilized. However, their choice of methodology and the focus on equity issuances

[2] Though our focus is on investment related uses of funds, we include dividends to meet the cash flow identity requirement.

exclusively makes it difficult to draw any causal inferences between sources of financing and the particular use of funds. Specifically, it is difficult to infer that an equity issuance in the current period is used for a particular investment in the following period, if other sources of financing are not controlled for in the current and subsequent period. That is, it is possible that next period's capital expenditure may be more closely associated with next period's debt financing and not necessarily with this period's equity issuance. Additionally, these studies are not focused specifically on linking sources of financing to investments differentiated on the basis of their risk information asymmetry. Rather, the studies are more broadly focused on how equity issuances are deployed. Further, in the case of DeAngelo et al. (2010) they don't consider R&D as a possible use of funds.

Similar to our study, Gatchev et al. (2009) use the accounting identity framework to relate financing decisions to changes in investments. Among other things, they find R&D and advertising expenses (classified together) and net working capital investments are primarily financed by equity while fixed asset investments, e.g., capital expenditures, are largely financed by debt. Gatchev et al. (2009) do not separate R&D from advertising expenses arguing that as both are intangible in nature their information asymmetry will be high. Though intangible in nature, our view is that advertising expenses are primarily about promoting current products and services and protecting current market share (e.g., Coke), as such they should be closely associated with the firm's current and past investment in tangible assets. Consequently, the information asymmetry surrounding advertising expenditures should be much less than that associated with

R&D. By combining both expenditures together, we are unable to determine to what extent Gatchev et al.'s (2009) findings are driven by R&D and by advertising expenses.

Additionally, in our study we conduct robustness tests to ensure that the R&D results are due to information asymmetry about investment risk rather than to the inherently greater risk associated with R&D investments. Our study also adds to the evidence in Halov and Heider (2012) for their theoretical model that information asymmetry about project risk drives security preference. They use recent firm asset volatility as a proxy for project risk asymmetry and find that greater asset volatility is associated with preference for equity issuance. By linking the capital raised to where it is deployed, we are able to provide additional evidence in support of Halov and Heider's (2012) theoretical argument and empirical evidence.

Overall, our contributions may be summarized as follows: (1) We provide empirical support for recent theoretical work that links financing choice to information asymmetry about the risk of future investments. Consistent with Halov and Heider (2012), Gatchev et al. (2009), and Wu and Wang (2005) we provide evidence that equity is predominantly used to finance R&D projects where information asymmetry about investment risk and debt contracting costs (agency cost of debt) are likely to be high. In contrast, debt is predominantly used to finance capital expenditures and liquidity needs where risk information asymmetry and debt contracting costs (agency cost of debt) are likely to be low. (2) We provide this empirical support in a comprehensive framework that considers *both* debt and equity financing and on the investment side *differentiates* investments by their underlying degree of risk information asymmetry. Previous studies either ignored one of the sources of financing or did not delineate investments by their risk information asymmetry. (3)

Our methodology is based on a framework of joint determination of sources and uses of funds, allowing us to better establish causality between financing choice and how those funds are deployed, and mitigate the problem of omitted variables.

The rest of the paper is organized as follows. The next section develops the hypotheses. In Section III, we discuss our empirical design and sample. Section IV presents the results, and Section V concludes.

II. Hypotheses Development

Recent work by Halov and Heider (2012) and Fulghieri and Lukin (2001) suggests that the nature of the investment may dictate financing preference. Halov and Heider (2012) argue that the traditional PO model ignores investment risk. Specifically, the traditional Myers and Majluf (1984) PO model assumes that the adverse selection costs vary across securities but that investment risk is constant. Halov and Heider (2012, p. 2) argue that "debt dominates equity financing only if there is *no* asymmetric information about the risk of firm's future investments." More importantly, they demonstrate that at the other extreme equity dominates debt financing when "there is *only* asymmetric information about the risk of the firms' future investments." (Halov and Heider, 2012, p. 2). Their model shows that firms prefer equity over debt when there is greater information asymmetry between the firm and outsiders about future investment risk, i.e., adverse selection cost of debt increases with information asymmetry about investment risk. They note that their theory is consistent with observed patterns that the debt-financing deficit relationship is weakest for small and young firms (e.g., Fama and French (2002), Frank and Goyal (2003), Lemmon and Zender

(2010)), precisely the firms that are deemed to be most affected by adverse selection costs in the traditional PO model. HH note that small and young firms are the ones most likely to be associated with greater information asymmetry about the risk of their future investments. Similarly, Fulghieri and Lukin, (2001, p. 5) find that "the likelihood that a firm will issue equity increases with the value of the project relative to the amount of external funds raised and with the extent of the informational asymmetry between insiders and outsiders." Cooney and Kalay (1993) refine Myers and Majluf's (1984) model and show that if the market anticipates a valuable project for the firm and the uncertainty surrounding the NPV of the new project is sufficiently large relative to assets-in-place, then stock price reaction would be positive in response to an equity issue announcement. This in turn implies a preference for equity financing. Cooney and Kalay (1993) suggest that high market-to-book value firms are likely to have greater uncertainty about the value of their investment opportunities than about the value of their assets-in-place, and hence are more likely to experience positive announcement effects. Wu and Wang (2005) show that taking into account the private benefits of control may yield predictions that diverge from the original Myers-Majluf. Their model shows that when the asymmetric information comes from growth rather than assets-in-place it is possible that the adverse selection cost of equity is actually reversed.

We test the proposition that debt (equity) will be associated with investments characterized by lower (greater) information asymmetry regarding their risk. To test this hypothesis, we consider three major financing needs by investment type: R&D, capital expenditures, and liquidity. We focus on these needs because they are the most frequently stated reasons for issuing debt and equity. These discrete investment types are assumed to have varying information asymmetries with

regard to their risk, ranging from low to high in the following order: liquidity, capital expenditures, R&D. In the next few paragraphs, we discuss each of these investment types and their relevance to financing choice.

A. R&D

All corporate investments are presumed to be associated with information asymmetries because managers are better informed, whereas outside investors observe only aggregated and perhaps cryptic information about the potential of the firm's investments. However, we argue that different classes of investments are associated with varying levels of information asymmetry about their risk. For example, relative to R&D investments, capital expenditures tend to be more tangible (fixed assets) and capitalized on the firm's balance sheet. R&D expenditures on the other hand are generally viewed as intangible investments that are associated with the creation of growth options. Investments in R&D are expensed with little disclosure about the potential future cash flow benefits (Aboody and Lev, 2000). Additionally, R&D projects are inherently uncertain. For example, Kothari, Laguerre, and Leone (2002) and Coles, Daniel, and Naveen (2006) document that R&D expenditures, in contrast to capital expenditures, are associated with greater future earnings volatility and stock return volatility. Eberhart, Maxwell, and Siddique (2004) suggest that while increases in firms' R&D expenditures are beneficial investments, the market is slow to recognize the future potential benefit associated with investments in R&D. To the extent that R&D expenditure is unique and is strategic in nature, insiders have a better read on R&D project risk than outside investors. In such a setting, an asymmetric problem exists with regard to the project

risk associated with R&D investments. Overall, R&D expenditures represent investments that are informationally less transparent relative to capital expenditures.

The above arguments imply that firms may prefer to issue equity to finance R&D investments where informational asymmetries about investment risk and the debt issuance cost (agency cost of debt) are likely to be high. This leads to our first testable hypothesis:

H_1: *R&D investments are more closely associated with equity than debt financing.*

B. Capital Expenditures

While both R&D and capital expenditures are considered long-term investments that are needed for the growth of the firm, capital expenditures differ from investment in R&D in several ways (e.g., Aboody and Lev (2000)). First, while R&D is associated with the creation of growth options, capital expenditure is associated with the exercise of growth options. Second, as noted above, R&D is an investment in intangible asset, while capital expenditure is an investment in tangible (fixed) asset such as property, plant, and equipment. Third, most capital expenditure investments share common characteristics across firms and within the industry, while R&D projects in general are unique to the developing firm. Fourth, there exists a secondary market for tangible assets which can provide information about their asset value. In contrast, R&D has no organized markets and hence there is less reliable information available about its value. Fifth, accounting measurement and reporting rules treat tangible assets differently from R&D, which is immediately expensed. For example, quarterly or annual financial statements report periodic recognition of value of impairment of tangible assets, providing investors with updated information about changes in asset values. Thus, the extent of information asymmetry associated

with investment in capital expenditures is significantly less than that associated with investments in R&D. In such cases, firms prefer to issue less information-sensitive securities such as debt to finance capital expenditures. Thus, we hypothesize that, all else being equal, firms should prefer debt to finance capital expenditures:

H_2: *Capital expenditure investments are more closely associated with debt than equity financing.*

C. Liquidity

We define liquidity investment as a need for cash and working capital by a firm that is otherwise fundamentally sound (Neamtiu et al. 2014). From the investors' point of view, supplying capital to fulfill liquidity needs is associated with less information asymmetry about the risk of the investment. Investors can make reasonable judgments by looking at the firm's financial statements and public disclosures. In this situation, debt financing would be the cheaper alternative as there is very little information asymmetry surrounding the nature of the investment. On the other hand, from the point of view of potential outside equity investors, an increase in the firm's cash holdings may not add enough value considering relatively high information production costs and may thus be less attractive to outside equity holders to justify their risk of owning a part of the firm. Once again, consistent with Halov and Heider (2012) and Halov et al. (2011) models, we argue that firms tend to issue debt to fund liquidity needs:

H_3: *Liquidity enhancing investments are more closely associated with debt than equity financing.*

III. Empirical Strategy and Sample

The above hypotheses are evaluated using the sources and uses of funds framework commonly adopted in tests of the pecking order and, more broadly, in research that links investments to financing (e.g., Chang et al., 2014; and Gatchev, Pulvino, and Tarhan, 2010). Chang et al. (2014) and Gatchev et al. (2010) adopt the view that investment and financing decisions are made jointly subject to the constraint that sources of cash must equal uses of cash. We focus on four primary uses of funds— R&D expenditure (R&D), capital expenditure (CAPEX), change in working capital (WORKCAP), and change in cash (ΔCASH). An additional use of funds is the cash dividends (DIV) paid out by firms, which is not a focus of this study but included to meet the cash flow identity requirement. Specifically, following Chang et al. (2014) and Gatchev et al. (2010) our empirical strategy exploits the following cash flow identity:

$$R\&D + CAPEX + WORKCAP + \Delta CASH + DIV = Cashflow + Debt + Equity \quad (1)$$

The left hand side of the above equation identifies the various uses of funds. These include R&D expenditure (R&D), capital expenditure (CAPEX), change in working capital (WORKCAP), change in cash holdings (ΔCASH), and cash dividends (DIV).[3] The right hand side shows the sources of funds, which includes internally generated cash flows (Cashflow), net equity issuance (Equity), and net debt issuance (Debt). The basic idea in equation (1) is that the uses of funds

[3] Our definition of CAPEX includes acquisitions paid with cash and other investments. This definition is identical to the variable INVESTMENTS used in Chang et al. (2014). We note that acquisitions and other investments account for a very small percentage of the variable (about 10 %). We use this definition to preserve comparability with Chang et al. (2014) on which our methodology closely follows. However, equation (1) differs from Chang et al. (2014) in that we consider R&D and working capital as uses of capital whereas in Chang et al. (2014) both of these sources are netted out in the Cashflow variable on the right hand side. Accordingly, we adjust our calculation of the Cashflow variable to preserve the identity between the left and right hand sides of equation (1).

equal the sources of funds. Recall that our objective is to see how uses of funds vary with the particular choice of external financing: debt and equity. Following GPT, we estimate various uses of funds in a given period as follows:

$$Y_{i,t} = \alpha + \beta_1 \text{Debt}_{i,t} + \beta_2 \text{Equity}_{i,t} + \beta_3 \text{Cashflow}_{i,t} + \beta_4 X_{i,t-1} + \varepsilon_{i,t} \ . \quad (2)$$

In the above equation, Debt, Equity and Cashflow are the sources of funds. Y represents the particular use of funds (e.g., R&D, CAPEX, WORKCAP, ΔCASH, and DIV). X represents control variables primarily taken from Frank and Goyal (2009) and Rajan and Zingales (1995) and include growth opportunities (value to book (VB))[4], sales growth, leverage, tangibility and size. All variables are indexed on *i* and *t*, which represent the firm and time (year), respectively. A detailed description and construction of all variables used in the study is provided in the Appendix. The contemporaneous relationship between the uses of funds (dependent variable) and the sources of funds (independent variables) is consistent with the sources and uses of funds constraint that every firm must meet in any given period, but also reflects the firm's decision to raise funds and use the funds raised in the same year. This latter point could pose a problem in the context of our investigation since it is conceivable that funds raised in a given period are not deployed to their

[4] Most studies use market to book (MB) as a proxy for growth opportunities. While MB appears to be a reasonable proxy to capture future growth investments, the measure has been criticized because it is also used as a proxy for misvaluation. Thus the MB ratio may be confounded by both effects. Rhodes-Kropf, Robinson, and Vishwanathan (2005) disentangle the MB ratio into its components, enabling us to isolate the growth opportunities element of the ratio. We follow Rhodes-Kropf et al. (2005) and model the log stock market capitalization of the firm to depend on the firm's log total assets, log leverage, log net income, and net income dummy if income is negative. The fitted variable is then divided by total assets to obtain the value-to-book (VB) measure. According to Rhodes-Kropf et al. (2005), this measure is a better representation of the firm's growth opportunities and is not influenced by potential firm misvaluation.

final use until a subsequent period (e.g., following year), but are parked in a cash account temporarily. Thus, the contemporaneous framework of equation (2) may lead to the incorrect inference that a financing source is used to build up liquidity when in fact it is used for an alternate purpose such as capital expenditure (e.g., CAPEX), which occurs in a following period. However, this is easily remedied by including lagged values of financing in estimating equation (2). Gatchev et al. (2010) recommend estimating equation (2) simultaneously, across the various uses of funds, using seemingly unrelated regression estimation procedure with the constraint that the coefficients across each use of funds equation for any given source of funds (i.e., debt, equity, cashflow) should sum to one. Chang et al. (2014) show that so long as the variables are defined consistently there is no need to impose the constraint that the coefficients sum to one and that OLS estimation, in contrast to more sophisticated methodologies like seemingly unrelated regressions, produces the most reliable estimates so long as we define the variables consistently. Consequently, we adopt OLS in estimating equation (2).[5]

The sample consists of U.S. firms in the annual CRSP/Compustat merged dataset and spans fiscal years 1971 through 2008. In order to ensure comparability of data over time, all dollar denominated variables are converted to 1983 dollars by using the Consumer Price Index (CPI) from the Bureau of Labor Statistics (BLS). Firm-years are excluded if they have missing data for book assets or are financial companies. Missing values for R&D are replaced with zero.[6] We

[5] We thank an anonymous reviewer for suggesting the use of the sources and uses of funds framework and, in particular, reference to the work by Chang et al. (2014).

[6] In unreported results, regressions using only non-missing values of R&D were also estimated. The results are similar to those reported here. This is not surprising as the literature (see Himmelberg, Hubbard and Palia, 1999) has already established that missing values of R&D generally represents zero R&D expenditures.

mitigate the effects of misreported data and extreme outliers in the case of all numeric variables by winsorizing either tail at the 0.5% level.

Table I presents the summary statistics of the variables used in equation (2). Table II presents correlation coefficients between the various uses of funds and the sources of funds . As a percentage of assets, capital expenditure accounts for the most significant use of funds at 9.53 percent followed by R&D at 3.7 percent. The mean change in working capital expenditure is negative 4.5 percent while the mean change in cash is a negative 0.1 percent, both scaled by assets. On average, debt financing in any given year amounts to 4.65 percent of assets, while external equity financing is equal to 3.3 percent of assets. Consistent with Chang et al.'s (2014) observation, the sum of the means of R&D, CAPEX, ΔWORKCAP, Δ Cash, and DIV less the means for Debt, Equity and Cashflow equal to zero. Thus, the accounting identity can be observed in the data.

The pair-wise correlations in Table II reveal that equity (debt) financing is significantly positively (negatively) correlated with R&D. On the other hand, increases in cash are significantly positively (negatively) correlated with debt (equity) financing. Both debt and equity financing are positively correlated with increases in working capital investments, while both appear to be uncorrelated with capital expenditures. Overall, the results provide preliminary support for the investment risk information asymmetry argument, especially when contrasting the correlations between external financing source and their use for R&D and cash buildup.

(Insert Table I here.)

IV. Results

Columns 1 through 5 in Tables III and IV provide estimates of equation (2) for each of the uses of funds. Table III presents results using ordinary least squares regressions. In Table IV the independent variables are augmented with lagged values for debt and equity financing to account for the effects of past financing on current uses of funds. This could be critical since results may be confounded by a pure mechanical effect arising from a short-term increase in cash holdings whenever capital is issued. Cash holdings one year after issuance are less likely to be subject to such an effect. For instance, a firm that issues capital for non-liquidity purposes (e.g., capital expenditures) will register an immediate increase in its cash balance, but this balance may not be drawn down until later when project development is in full swing. Examining only the contemporaneous effect could lead to the incorrect inference that capital was raised for liquidity enhancement when in fact it was used to fund capital expenditure.

A. Debt Usage.

Table III shows that coefficients for the debt financing (Debt) variable in columns (2), (3), and (4) are positive and statistically significant at the 1% level. These results indicate a positive sensitivity of capital expenditures, working capital, and cash, to debt financing. Specifically, the results show that a one dollar increase in debt increases capital expenditure by 9.5 cents, working capital by 8.8 cents and cash holdings by 76.8 cents. In the case of R&D (column (1)), the magnitude is very small. R&D accounts for only one cent of every dollar of debt financing. It is interesting to note that the coefficients for debt financing when added across the five use of funds equations adds up to one. We observe this for the equity financing variable as well. This is

consistent with Chang et al.'s (2014) observation that so long as the variables are consistently defined there is no need to impose the constraint that coefficients across the various uses should sum to one for any given source of financing. The large increase in cash holdings suggests that the firm maybe issuing debt in a particular year and then using the funds in subsequent years. This is evident from Table IV which shows that the increases in working capital and capital expenditure are positively related to lagged debt financing. For example, Table IV shows that contemporaneous debt financing accounts for 11 cents of capital expenditure while 4 cents comes from lagged debt financing. This coupled with the much smaller coefficient for lagged debt financing in the cash equation (compared to the coefficient for contemporaneous debt) indicates that there may be a lag between financing and where it is eventually used. Considering both Tables III and IV we find that debt financing is associated with a build-up in cash, working capital, and investment in capital expenditures. The insignificant coefficient for debt financing in the R&D equation (Tables III and IV) indicates that this source of financing is less likely to be used to finance R&D expenditures. The combined evidence from Table III and Table IV supports the view that debt financing is used to fund investments with low information asymmetry about their risk such as liquidity enhancement and capital expenditures but not R&D investments, which are at the opposite end of the spectrum.

(Insert Tables III and IV here.)

B. Equity Usage.

Table III shows the contemporaneous relationship between equity financing and various uses of funds. The regression estimates reveal positive statistically significant coefficients for the equity

issuance variable across the various uses of funds. In terms of economic significance, a one-dollar increase in equity financing increases investment in R&D by 21 cents, capital expenditures by 5 cents, working capital by 3 cents, and cash holdings by 69 cents. When compared to the coefficient for debt financing, there is clear preference by firms to use equity to finance R&D projects. The preference for equity financing in funding R&D investments is also evident when lagged values of the financing variable are included (Table IV). Though equity financing is positively associated with contemporaneous increases in capital expenditures, working capital and cash, the coefficients are smaller than those evidenced for debt financing. The bottom row of Tables III and IV presents the difference in the debt and equity financing sensitivity with respect to each of the uses of funds and their significance levels. All of the differences are statistically significant. Additionally, from Table IV we observe that lagged equity financing is not related to current capital expenditure and is significantly negatively related to increases in working capital and cash.

Overall, the results from Tables III and IV suggest that firms are most likely to use debt financing to fund capital expenditures and current liquidity needs. On the other hand, firms are likely to use equity over debt to finance R&D projects. Our results suggest that investments with the highest risk information asymmetry, i.e., R&D, are financed through equity while investments with relatively low information asymmetry about their risk, i.e., capital expenditures and liquidity, are financed primarily through debt financing. Thus investments with high (low) information asymmetry about risk such as R&D (liquidity and capital expenditures) are financed by more (less) information sensitive equity (debt) securities.

C. Robustness Tests for R&D

In this section we address the issue of whether our results for R&D are due to lack of collateral associated with these projects and therefore are financed by equity regardless of the information asymmetry of risk. R&D projects are often characterized by a lack of hard assets (i.e., they are intangible assets) to serve as collateral. Hence, it may appear that irrespective of underlying project risk information asymmetry the natural choice is to fund R&D through equity financing. Our finding that equity (but not debt) financing is associated with R&D investment may reflect the lack of collateral rather than any presumed information asymmetry about investment risk inherent in R&D projects. To test whether our results reflect information asymmetry or collateral effects, we conduct two robustness tests. The first test involves splitting the sample into two halves based on the median value of tangible assets (as a proportion of total assets). Our assumption is that R&D projects for firms that are less (more) tangible asset intensive have lower (higher) collateral value associated with them. Consequently, if we find that debt issuance is not significant in either group, then it can be presumed that our full sample results for R&D are due to an information asymmetry about the investment risk rather than to the lack of collateral. Our second robustness test involves subsample analysis by age of the firm. As firms become older, investors have a larger information set about the firm and the nature of its projects. Therefore, in relation to younger firms, older firms should have less information asymmetry about the risk of their R&D projects. Consequently, we expect equity financing to be more closely associated with R&D expenditures for younger firms compared to older firms.

The robustness results using the two tangible asset subgroups are presented in Table V. We regress R&D on current period debt and equity financing, cashflow, and other control variables (columns (1) and (2)).We also include lagged values of debt and equity sources of funds in the regression model to account for the effects of past financing on current use of funds in R&D investments (columns (3) and (4)).

Results reported in Table V show that the R&D investment-debt financing relationship is significantly negative for firms with low tangible assets while it is insignificant for firms with high tangible assets. On the other hand, the R&D investment-equity financing sensitivities reported in columns (1) through (4) are positive and significant indicating that firms, irrespective of tangible assets, fund R&D through equity. These results suggest that firms with R&D investments inherently face greater risk information asymmetries and higher debt contracting costs, therefore, firms are more likely to issue equity to finance their R&D expenditures.

(Insert Table V here)

Table VI presents alternative robustness results for R&D by examining subsamples classified by firm age. We present estimates for young firms defined as those with five or fewer years of post-IPO existence and older firms defined as those with more than 10 post-IPO years of existence. We observe from columns (1) and (2) that the estimated coefficient of R&D for the contemporaneous equity financing variable is positive and significant for young and older firms alike, but the coefficient for older firms at 0.10 is much smaller than the 0.36 for young firms. The results are qualitatively similar when lagged values for financing are included (columns (3) and (4)). This is consistent with our prediction that the greater information asymmetry associated with

younger firms will yield a stronger sensitivity between equity issuance and the use of funds for R&D purposes. In contrast, the R&D-debt financing sensitivities across the four regression models are negative and significant, irrespective of the age of firms. These results indicate that both young and older firms are less likely to issue debt to finance R&D projects which are associated with higher risk of information asymmetries and greater debt contracting costs.

(Insert Table VI here.)

V. Conclusions

We investigate the role of investment-specific information asymmetry in capital structure decisions. Recent theoretical work indicates that for projects with less information asymmetry about their risk, e.g., increasing liquidity, the preferred choice is to issue debt as it has low contracting costs under these conditions. On the other hand, for projects with greater information asymmetry about their risk, e.g., R&D, the optimal choice is to issue equity as the returns from the project's risk accrue to the stockholders and contracting costs of debt are very high.

Our empirical methodology utilizes the sources and uses of funds framework based on the well-established accounting identity that the total funds used by the firm should equal internal cash flows in addition to debt and equity raised by the firm. Our primary test methodology involves regressing various uses of funds on the sources of funds and other control variables, following Chang et al. (2014). The primary uses of funds we consider are research and development (R&D), capital expenditure, working capital changes, changes in cash holdings and cash dividends. The sources of funds include debt and equity financing and internal cash flow, though our focus is on the former (external capital sources). If investment risk information asymmetry is a major driver

of financing choice, we should find debt financing to be closely associated with low risk information asymmetry uses (e.g., liquidity enhancement investments) while equity financing should be more closely related with projects characterized by high information asymmetry about their risk investments such as R&D. Consistent with our hypothesis, we find that equity, but not debt, financing is closely associated with R&D investments which have high information asymmetry about their risk. On the other hand, debt financing is favored in the case of liquidity enhancement investments, which have low information asymmetry about their risk and low agency costs of debt. These findings are consistent with recent theoretical and empirical findings by Wang and Wu (2005), Halov and Heider (2012), Fulghieri and Lukin (2001).

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Table I
Descriptive Statistics of Variables Used in the Study

The sample consists of 64,64l firm-year observations from the CRSP/Compustat merged dataset with fiscal years between 1971-2008. The variables include (1) uses of funds: R&D expenditure (R&D), capital expenditures (CAPEX), change in working capital (ΔWORKCAP) change in cash holdings (ΔCASH), cash dividends (DIV), (2) sources of funds: cash flow (Cashflow), net debt issued (Debt), and net equity issued (Equity), and (3) control variables: value to book ratio (VB), a proxy for investment opportunities; Sales Growth is the change in net sales scaled by lagged net sales; Leverage (Lev) is defined as total debt (the sum of short-term and long-term debt) divided by total assets; Tangibility is the net property, plant and equipment over total assets; and Size is the natural log of sales (SALE). All variables are winsorized at the top and bottom 0.5% of their distributions.

	Mean	Median	Standard Deviation
R&D	0 .0366	0.0000	0.3354
CAPEX	0.0953	0.0104	0.242
ΔWORKCAP	-0.0447	0.4139	0.4228
ΔCASH	-0.0073	0.0030	0.4823
DIV	0.0010	0 .0067	0.0277
Debt	0.0465	0.0000	0.1104
Equity	0.0335	0.0000	0.3679
Cashflow	0.0083	0.0808	0.181
VB	0 .7414	0 .7397	0 .4134
Sales Growth	0.1929	0.0912	0 .5591
Leverage (Lev)	0 .1723	0 .0699	0 .2420
Tangibility (Tang)	0 .2425	0 .1566	0.2373
Size	3.7281	3.8305	2.4210

Table II
Pair-wise Correlations between Sources and Uses of Funds Variables

This table presents pair-wise correlations between the uses of funds (columns) and the sources of funds (rows). The sample consists of 64,64l firm-year observations from the CRSP/Compustat merged dataset with fiscal years between 1971-2008. The uses of funds include R&D expenditure (R&D), capital expenditure (CAPEX), change in working capital (ΔWORKCAP), change in cash holdings (ΔCash), and cash dividends (DIV). The sources of funds include internal cash flow (Cashflow), net debt issued (Debt), and net equity issued (Equity). The Bonferroni adjusted significance levels are indicated. Coefficients significant at the 5%, and 1% levels are indicated by *, **, respectively.

	R&D	CAPEX	ΔWORKCAP	ΔCASH	DIV
	(1)	(2)	(3)	(4)	(5)
Debt	-0.03**	0.00	0.04**	0.11**	0.02*
Equity	0.11**	0.02	0.03*	-0.07**	0.04**
Cashflow	-0.23**	0.13**	0.49**	0.29**	0.01

Table III
Use of Funds and Debt and Equity Financing

This table presents ordinary least squares regression estimates of equation (2) based on the methodology of Chang et al. (2014). The sample consists of 64,64l firm-year observations from the CRSP/Compustat merged dataset with fiscal years between 1971-2008. The dependent variable is the use of funds and the independent variables consist of sources of financing and other control variables. We consider 5 uses of funds (columns 1-5): R&D expenditure (R&D), capital expenditure (CAPEX), change in working capital (WORKCAP), change in cash holdings (ΔCASH), and cash dividends (DIV). The sources of funds include net debt issued (Debt), net equity issued (Equity) and cash flow (Cashflow). The control variables include $VB_{t-1,}$ Sales Growth $_{t-1}$, Leverage $_{t-1}$, Tang $_{t-1}$, and Size $_{t-1}$. VB_{t-1} is a proxy for investment opportunities (as estimated in Rhodes-Kropf et al. (2005)) and is defined as the lagged value of the firm divided by lagged book value of assets. Sales Growth $_{t-1}$ is the lagged change in net sales scaled by net sales in the beginning of the year, Leverage $_{t-1}$ is defined as the lagged value of total debt (the sum of short-term and long-term debt) divided by total assets. Tangibility (Tang $_{t-1}$) is the lagged value of net property, plant, and equipment over total assets. Size $_{t-1}$ is the lagged value of natural log of sales (SALE). Firm-level fixed effects are generated by demeaning the data for each firm for both the dependent and independent variables. Constant terms, and Year dummies are not reported. The last row shows the difference in the coefficient for Debt and Equity financing variables and the associated significance level. Standard errors of estimates for the coefficients are presented in parentheses. Coefficients significant at the 5%, and 1% levels are indicated by *, **, respectively.

	R&D	CAPEX	ΔWORKCAP	ΔCASH	DIV
	(1)	(2)	(3)	(4)	(5)
$Debt_t$	0.0086	0.0947	0.0881	0.7678	0.0408
	(0.0141)	(0.0029)**	(0.0057)**	(0.0066)**	(0.0310)
$Equity_t$	0.2115	0.0478	0.0340	0.6870	0.0196
	(0.0461)**	(0.0026)**	(0.0035)**	(0.0042)**	(0.0006)**
$Cashflow_t$	-0.0430	0.1142	0.6992	0.2279	0.0017
	(0.0007)**	(0.0004)**	(0.0004)**	(0.0007)**	(0.0001)**
VB_{t-1}	0.0081	0.0042	0.0061	-0.0113	-0.0071
	(0.0048)	(0.0036)	(0.0023)	(0.0046)*	(0.0008)**
Sales Growth $_{t-1}$	-0.0030	-0.0230	0.0229	0.0003	0.0027
	(0.0004)**	(0.0005)**	(0.0004)**	(0.0007)	(0.0001)**
Leverage $_{t-1}$	-0.0658	0.0038	0.0283	0.0369	-0.0032
	(0.0019)**	(0.0020)	(0.0022)**	(0.0027)**	(0.0005)**
$Tang_{t-1}$	0.0928	-0.1192	-0.0625	0.0564	0.0322
	(0.0079)**	(0.0081)**	(0.0062)**	(0.0073)**	(0.0013)**
Size $_{t-1}$	-0.0240	-0.0247	0.0066	0.0061	0.0355
	(0.0009)**	(0.0007)**	(0.0008)**	(0.0010)**	(0.0002)**
R-square	0.18	0.12	0.34	0.28	0.08
Coefficients of $Debt_t$ - $Equity_t$	-0.2029**	0.0469**	0.0541**	0.0808**	0.0212**

Table IV
Use of Funds from Lagged Debt and Lagged Equity Financing

This table presents ordinary least squares regression estimates of equation (2) based on the methodology of Chang et al. (2014). The sample consists of 64,64l firm-year observations from the CRSP/Compustat merged dataset with fiscal years between 1971-2008. The dependent variable is the use of funds and the independent variables consist of sources of financing and other control variables. We consider 5 uses of funds (columns 1-5): R&D expenditure (R&D), capital expenditure (CAPEX), change in working capital (WORKCAP), change in cash holdings (ΔCASH), and cash dividends (DIV). The sources of funds include net debt issued (Debt), net equity issued (Equity), lagged net debt issued ($Debt_{t-1}$), lagged net equity issued ($Equity_{t-1}$), and cash flow (Cashflow). The control variables include VB_{t-1}, $Sales\ Growth_{t-1}$, $Leverage_{t-1}$, $Tang_{t-1}$, and $Size_{t-1}$. VB_{t-1} is a proxy for investment opportunities (as estimated in Rhodes-Kropf et al. (2005)) and is defined as the lagged value of the firm divided by lagged book value of assets. $Sales\ Growth_{t-1}$ is the lagged change in net sales scaled by net sales in the beginning of the year, $Leverage_{t-1}$ is defined as the lagged value of total debt (the sum of short-term and long-term debt) divided by total assets. Tangibility ($Tang_{t-1}$) is the lagged value of net property, plant, and equipment over total assets. $Size_{t-1}$ is the lagged value of natural log of sales (SALE). Firm-level fixed effects are generated by demeaning the data for each firm for both the dependent and independent variables. Constant terms and Year dummies are not reported. The last row shows the difference in the coefficient for Debt and Equity financing variables and the associated significance level. Standard errors of estimates for the coefficients are presented in parentheses. Coefficients significant at the 5%, and 1% levels are indicated by *, **, respectively.

	R&D	CAPEX	ΔWORKCAP	ΔCASH	DIV
	(1)	(2)	(3)	(4)	(5)
$Debt_{t-1}$	-0.0077	0.0437	0.0251	0.0101	-0.0013
	(0.0040)	(0.0043)**	(0.0056)**	(0.0103)	(0.0011)
$Equity_{t-1}$	0.0194	0.0011	-0.0128	-0.0345	-0.0023
	(0.0033)**	(0.0028)	(0.0029)**	(0.0060)**	(0.0018)
$Debt_t$	0.0078	0.1067	0.0904	0.7923	0.0030
	(0.0049)	(0.0249)**	(0.0135)**	(0.1070)**	(0.0020)
$Equity_t$	0.2189	0.0467	0.0247	0.6984	0.0114
	(0.0562)**	(0.0140)**	(0.0039)**	(0.2046)**	(0.0026)**
Cashflow	-0.0393	0.0214	0.7878	0.2231	0.0071
	(0.0107)**	(0.0055)**	(0.1204)**	(0.0529)**	(0.0021)**
VB_{t-1}	0.0119	0.0003	0.0017	-0.0089	-0.0050
	(0.0032)**	(0.0029)	(0.0031)	(0.0051)	(0.0009)**
$Sales\ Growth_{t-1}$	-0.0034	-0.0005	0.0035	0.0001	0.0003
	(0.0011)**	(0.0003)	(0.0006)**	(0.0006)	(0.0001)**
$Leverage_{t-1}$	-0.0574	0.0069	0.0245	0.0332	-0.0072
	(0.0128)**	(0.0014)**	(0.0068)**	(0.0087)**	(0.0027)**
$Tang_{t-1}$	0.0875	-0.1058	-0.0400	0.0568	0.0015
	(0.0158)**	(0.0265)**	(0.0070)**	(0.0189)**	(0.0019)
$Size_{t-1}$	-0.0183	-0.0110	0.0104	0.0079	0.0110
	(0.0029)**	(0.0018)**	(0.0019)**	(0.0018)**	(0.0023)**
R-square	0.19	0.14	0.36	0.27	0.10
Coefficients of					
$Debt_{t-1}$ –$Equity_{t-1}$	-0.027**	0.0426**	0.0379**	0.0446**	0.0010
$Debt_t$ - $Equity_t$	-0.2111**	0.0600**	0.0658**	0.0939**	-0.0084**

Table V
Robustness Test for R&D Using Asset Tangibility

This table presents regression estimates of equation (2) for R&D expenditures classified by proportion of tangible assets to total assets. The test involves splitting the sample into two halves (low tangible assets and high tangible assets based on the median value of tangible assets (as a proportion of total assets). Number of observations is 32,320 (32,321) for the low (high) tangible subset. The dependent variable is R&D expenditure. The independent variables consist of sources of funds variables and other control variables. The sources of funds include net debt issued (Debt), net equity issued (Equity), lagged net debt issued ($Debt_{t-1}$), lagged net equity issued ($Equity_{t-1}$), and cash flow (Cashflow). The control variables include VB_{t-1}, Sales $Growth_{t-1}$, $Leverage_{t-1}$, $Tang_{t-1}$, and $Size_{t-1}$. VB_{t-1} is a proxy for investment opportunities (as estimated in Rhodes-Kropf et al. (2005)) and is defined as the lagged value of the firm divided by lagged book value of assets. Sales $Growth_{t-1}$ is the lagged change in net sales scaled by net sales in the beginning of the year, $Leverage_{t-1}$ is defined as the lagged value of total debt (the sum of short-term and long-term debt) divided by total assets. Tangibility ($Tang_{t-1}$) is the lagged value of net property, plant, and equipment over total assets. $Size_{t-1}$ is the lagged value of natural log of sales (SALE). Firm-level fixed effects are generated by demeaning the data for each firm for both the dependent and independent variables. Constant terms and Year, dummies are not reported. Standard errors of estimates for the coefficients are presented in parentheses. Coefficients significant at the 5%, and 1% levels are indicated by *, **, respectively.

R&D	Low Tangible Assets	High Tangible Assets	Low Tangible Assets	High Tangible Assets
	(1)	(2)	(3)	(4)
$Debt_{t-1}$			-0.0052	-0.0050
			(0.0067)	(0.0235)
$Equity_{t-1}$			0.0404	0.0202
			(0.0070)**	(0.0052)**
$Debt_t$	-0.0784	0.0522	-0.0667	0.0757
	(0.0084)**	(0.0389)	(0.0099)**	(0.0642)
$Equity_t$	0.2806	0.1924	0.2968	0.1853
	(0.0960)**	(0.0789)*	(0.1060)**	(0.0694)**
Cashflow	-0.0497	-0.0703	-0.0493	-0.0560
	(0.0057)**	(0.0054)**	(0.0068)**	(0.0053)**
VB_{t-1}	0.0338	0.0109	0.0256	0.0353
	(0.0061)**	(0.0068)	(0.0057)**	(0.0063)**
Sales $Growth_{t-1}$	-0.0003	-0.0003	-0.0007	-0.0005
	(0.0012)	(0.0020)	(0.0010)	(0.0012)
$Leverage_{t-1}$	-0.0018	-0.0008	-0.0033	-0.0023
	(0.0003)**	(0.0003)**	(0.0001)**	(0.0003)**
$Tang_{t-1}$	0.0373	0.0450	0.0445	0.0626
	(0.0134)**	(0.0200)*	(0.0208)*	(0.0131)**
$Size_{t-1}$	-0.0161	-0.0210	-0.0150	-0.0085
	(0.0031)**	(0.0034)**	(0.0030)**	(0.0022)**
R-square	0.19	0.18	0.19	0.18

Table VI
Robustness Test Using Firm Age Subsamples

This table presents regression estimates of equation (2) for R&D expenditures classified by firm age: Young firms (=< 5 years post IPO) and Older firms (> 10 years post IPO). Number of observations is 34,519 (9,558) for young (older) firms. The independent variables consist of sources of funds variables and other control variables. The sources of funds include net debt issued (Debt), net equity issued (Equity), lagged net debt issued ($Debt_{t-1}$), lagged net equity issued ($Equity_{t-1}$), and cash flow (Cashflow). The control variables include VB_{t-1}, Sales Growth $_{t-1}$, Leverage $_{t-1}$, Tang $_{t-1}$, and Size $_{t-1}$. VB_{t-1} is a proxy for investment opportunities (as estimated in Rhodes-Kropf et al. (2005)) and is defined as the lagged value of the firm divided by lagged book value of assets. Sales Growth $_{t-1}$ is the lagged change in net sales scaled by net sales in the beginning of the year, Leverage $_{t-1}$ is defined as the lagged value of total debt (the sum of short-term and long-term debt) divided by total assets. Tangibility (Tang $_{t-1}$) is the lagged value of net property, plant, and equipment over total assets. Size $_{t-1}$ is the lagged value of natural log of sales (SALE). Firm-level fixed effects are generated by demeaning the data for each firm for both the dependent and independent variables. Constant terms, and Year dummies are not reported. Standard errors of estimates for the coefficients are presented in parentheses. Coefficients significant at the 5%, and 1% levels are indicated by *, **, respectively.

R&D	Young	Older	Young	Older
	(1)	(2)	(3)	(4)
$Debt_{t-1}$			-0.0053	-0.0186
			(0.0074)	(0.0149)
$Equity_{t-1}$			0.0274	0.0134
			(0.0065)**	(0.0060)*
$Debt_t$	-0.0715	-0.0447	-0.0594	-0.0484
	(0.0055)**	(0.0186)*	(0.0067)**	(0.0239)*
$Equity_t$	0.3584	0.0995	0.3622	0.1108
	(0.0975)**	(0.0179)**	(0.0965)**	(0.0181)**
Cashflow	-0.0500	-0.0860	-0.0566	-0.0821
	(0.0009)**	(0.0021)**	(0.0003)**	(0.0026)**
VB_{t-1}	-0.0005	0.0076	0.0001	0.0065
	(0.0049)	(0.0078)	(0.0047)	(0.0080)
Sales $Growth_{t-1}$	-0.0009	-0.0022	-0.0005	-0.0004
	(0.0005)	(0.0027)	(0.0005)	(0.0014)
$Leverage_{t-1}$	0.0030	-0.0025	0.0005	-0.0073
	(0.0046)	(0.0087)	(0.0016)	(0.0098)
$Tang_{t-1}$	0.0524	0.0075	0.0394	0.0094
	(0.0062)**	(0.0061)	(0.0132)**	(0.0249)
$Size_{t-1}$	-0.0109	-0.0142	-0.0261	-0.0331
	(0.0019)**	(0.0042)**	(0.0030)**	(0.0032)**
R-squared	0.23	0.24	0.23	0.24

Appendix. Variable Construction

Variable Name	**Description and Source** (Note: Compustat variable names in parentheses)
Panel A: Use of Funds Variables	
ΔCASH	Change in Cash between post-issuance year and pre-issuance year. Cash is defined as cash and short-term investments (CHE) divided by AT. Source: Compustat
CAPEX	This variable is defined and estimated the same way as Investments in Chang et al. (2104): (Before 1988): Capital expenditure (CAPX) plus increase in investment (IVCH) plus acquisitions (AQC) less sale of property plant and equipment (SPPE) less sale of investment (SIV) plus other use of funds (FUSEO). Source: Compustat (After 1988): Capital expenditure (CAPX) plus increase in investment (IVCH) plus acquisitions (AQC) less sale of property plant and equipment (SPPE) less sale of investment (SIV) less change in short term investment (IVSTCH) less other investing activities (IVACO) . Source: Compustat
DIV	Cash dividends (dv) divided AT. Source: Compustat
R&D	R&D expenditures (XRD) divided by AT. As is customary (Himmelberg, Hubbard, and Palia (1999)), missing R&D is set equal to zero. Source: Compustat
ΔWORKCAP	(Before 1988): Change in working capital (WCAPC) divided AT. Source: Compustat (After 1988): Is the negative of the sum of the following items. Change in accounts recievable (RECCH) , change in inventory (INVCH), change in accounts payable (APALCH), accrued income taxes (TXACH), changes in assets and liabilities (AOLOCH), other financing activities (FIAO). Source: Compustat
Panel B: Sources of Funds Variables	
Cashflow	Is the sum of income before extra items (IBC) + extra items and discontinued operations (XIDOC) + depreciation and amortization (DPC) + deferred taxes (TXDC) + equity in net loss (ESUBC) + gains in sale of PPE & investment (SPPIV) + other funds from operation (FOPO) + other sources of funds (FRSCO) + R&D expenditure (XRD) divided by AT. Source: Compustat
Debt	Is long-term debt issuance (DLTIS) less long-term debt reduction (DLTR) less changes in current debt (DLCCH) divided by the beginning of the year book assets (AT). Source: Compustat
Equity	Sale of stock less purchase of stock (SSTK – PRSTKC) divided by the beginning of the year AT. Source: Compustat
Panel C: Other Control Variables	
Leverage	Total long-term debt (DLTT) and short-term debt (DLC) divided by AT. Source: Compustat
Sales Growth	Year over year percentage change in sales. Source: Compustat
Size	Log of sales (SALE). Source: Compustat
Tang (Tangibility)	Net property, plant, and equipment (PPENT) divided by AT. Source: Compustat
VB (Value to Book)	Value of the firm is estimated as in Rhodes-Kropf et al. (2005). Market value is a function of AT, net income (NI), and leverage. The fitted market value is then divided by AT to generate the VB ratio. Source: Compustat