Financing R&D, Financial Constraints, and Employment

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Abstract

This study examines the speed of labor adjustment in high-tech and non-high-tech firms and the effect of balance sheet liquidity (cash holdings) on employment changes in response to demand shocks. It offers robust evidence that firms in the high-tech sector, which account for most R&D, adjust employment toward the target employment slowly. The finding supports that adjustment costs for labor in high-tech firms are high. This study also documents that firms with more cash holdings show fewer employment changes in response to consumer demand shocks. These effects are amplified within financially constrained firms. The results suggest that cash holdings may help financially constrained firms to maintain stable employment in response to consumer demand shocks, particularly for high-tech, young, and small firms.

Keywords: Corporate Finance, Firm Employment Decisions, R&D

JEL: G30, M51, O30

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1 Introduction

Firms with high R&D consider human capital as one of their greatest assets because these workers have critical knowledge that embodies firm intellectual property. High R&D firms value the information and skills their workers possess more than firms with low R&D. Hence, it would result in critical damages to high R&D firm values if they cut human capital (Hall, 2002). Firms in the high-tech sector invest the most in R&D across sectors (Brown et al., 2017). Thus, it is critical for high-tech firms to achieve the desired employment levels and maintain stable employment levels for high-tech firms in response to consumer demand shocks. There is a large body of empirical literature on labor adjustment and employment changes in response to exogenous shocks for each firm (Erashin and Irani, 2015; Giroud and Mueller, 2017; Kleiner, 2015). Unlike previous studies that focus on the role of household and financial intermediary balance sheets (Guerrieri and Lorenzoni, 2017; Midrigan and Philippon 2016; Moreira and Savov, 2017), Giroud and Mueller (2017) argue firms' balance sheets, like corporate structures, take a critical role in the transmission of consumer demand shocks. This paper provides a comprehensive study to compare the speed of labor adjustment in high-tech and non-high-tech firms, and also shows how balance sheet liquidity (cash holdings) affects employment changes in response to consumer demand shocks in financially constrained and unconstrained firms. It shows that cash holdings are critical to maintain stable employment for financially constrained firms, particularly for high-tech, young, and small firms. This contributes to the literature by showing that the financial side of a firm matters to labor.

The dynamics of labor adjustment have been extensively studied (Caballero and Engel, 1993; Caballero, Engel, and Haltiwanger 1997). Caballero, Engel, and Haltiwanger (1997) find that the gap between the actual and desired (target) employment levels influences employment changes. Caballero and Engel (1993), on the other hand, use a structural model to find the dynamics of labor adjustment. In this paper, the model developed by Caballero, Engel, and Haltiwanger (1997) is estimated by using a system Generalized Method of Moments (GMM) estimator. This estimator can settle potentially endogenous regressors and firm fixed effects (Arellano and Bover, 1995; Blundell and Bond, 1998). Using both the dynamic panel and cross-section analyses, this paper finds that firms with more R&D as a percentage of total assets show a low speed of labor adjustment. In other words, high R&D firms adjust employment toward their target employment levels more slowly because the speed of labor adjustment is inversely related to adjustment costs. The adjustment costs for labor are high for the high-tech firms, so the results are consistent with previous studies.

To compare the speed of labor adjustment between high R&D firms and low R&D firms, the causal link between R&D and employment needs further examination. This link is not clearly established due to the possibility of confounding factors that are not included in the analysis or due to the likely endogeneity of R&D. As examples, young firms are more likely to invest in R&D, and young firms have faster growth rates. Therefore, the link may be due to the age of the firm. A second possibility is that firms with growing sales volumes may expand their investments in employment and R&D, and so the missing causal factor is the growth in firm demand. Or, it may be that expansion in R&D comes at the expense of other inputs including employment. These are just three of many possible reasons that the correlation between R&D and employment may not be causal. Thus, this paper uses an alternative approach suggested by the literature to divide the sample into a high-tech sector and a non-high-tech sector, and identifies the impact of R&D on firms' labor demand.

The speed of adjustment has been studied widely in a financial context. Faulkender et al. (2012) find that cash flow realization can reduce leverage adjustment costs. Eventually, firms with high cash flows have a faster speed of adjustment towards leverage targets. Similar properties are observable in firms with more dividend smoothing. In particular, cash cows and firms with lower volatility in earnings and returns exhibit more dividend smoothing (Leary and Michaely, 2011). In empirical specifications, this paper follows Faulkender et al.'s (2002) approach to measure the speed of labor adjustment using the system GMM approach.

Several recent papers have investigated the effect of firms' balance sheets on employment. Muller and Giroud (2015) find firms' balance sheets play critical roles in employment changes during crises. The firms with high leverage show a substantial decline in employment when they face consumer demand shocks. (Giroud and Mueller, 2017). Ersahin and Irani (2015) note that shocks to real estate, which lead to change in collateral values, influence employment. Kleiner (2015) explains the decline of employment in the Great Recession by the decrease in housing values.

Other studies relate the financial side of a firm to employment. In a discussion of finance, Berger (2015) finds that access to finance matters in employment. She offers evidence that an increase in local finance leads to employment growth. In general, channels for external financing tighten when there are supply shocks. Then, cash reserves play a critical role during financial crises (Duchin et al., 2010). Duchin et al. (2010) also find firms with low cash reserves reduce investments more than the others.

This study documents how liquidity management (holding more cash) can buffer employment changes in response to consumer demand shocks. Using Hall's identification strategy (2002), which explains that the financial side of a firm matters for R&D expense, this paper argues that the financial side of a firm influences the firm-level employment since salaries of employees account for most R&D expense. The paper shows that cash holdings play a critical role in maintaining stable employment levels in response to demand shocks. These effects are amplified within financially constrained firms like high-tech, young, and small firms.

2 Background and Empirical Predictions

2.1 Financing R&D: Cash, Leverage, External Equity

According to the Modigliani-Miller theorem (1958), the capital structure of a firm cannot influence investment decisions since it assumes perfect capital markets with no financial frictions. This assumption leads to the same cost of funds between internal financing and external financing. However, in real-world situations, financial frictions such as information and transaction costs lead to different costs of funds across sources of financing. Hall (2002) illustrates the identification of investments by showing how different costs of funds can change investments in Figure 1. The cost of funds will increase after internal funds are exhausted as shown in points A and B in Figure 1.

The downward-sloping curve in Figure 1 represents the demand for R&D investment funds; the upward-sloping curves represent the supply of R&D investment funds. If a firm has enough internal funds to finance investments, the firm is financially unconstrained as shown in point C. However, if firms need to use external funds, investments decrease from point C to point D. A positive shock in internal funds, such as an increase in cash holdings, can shift investments from point D to point C.

On the other hand, the cost of funds varies between investments in fixed (tangible) assets and R&D (intangible) assets. The costs for financing R&D investments are likely to be more expensive, mainly due to high information costs (Brown et al., 2009; Brown et al., 2012; Hall, 2002). The pecking order theory (Myers and Majluf, 1984) argues that internal financing costs the least among sources of funds. Then, external financing with debt is the next least costly source because banks prefer to finance for physical assets. External financing with issuing equity is the most costly because of high transaction and information costs caused by information asymmetries. R&D investments are seldom financed by debt (Brown et al., 2009; Brown et al., 2012). For instance, some firms may not be able to borrow money from banks at the same cost of funds due to credit rationing (Stiglitz, 1988). This limitation in sources of funds makes firms with high R&D more financially constrained (Brown et al., 2009; Brown et al., 2012).

2.2 Labor Adjustment and Employment Changes

R&D is mainly composed of salaries for high-skilled workers. These workers produce intangible assets such as patents and business methodologies. In other words, R&D could be embodied in workers, and the firm risks losing intellectual property or development potential if it loses its researchers. Hiring and training costs are higher for these workers; therefore, the firms with high R&D consider workers as one of their greatest assets. It would be more of a loss if workers left a high R&D firm compared to a firm with low R&D. Thus, firms with high R&D have high adjustment costs for labor, and this leads to:

Prediction 1: It is anticipated that high-tech firms adjust employment toward their target employment levels more slowly due to high adjustment costs for labor.

This paper applies a framework developed by Caballero, Engel, and Haltiwanger (1997). They argue that employment changes depend on the difference between the desired and actual employment as shown in Equation (1). $Employee_{i,t}$ represents the level of employment at time *t* for firm i.

$$Ln(Employee)_{i,t} - Ln(Employee)_{i,t-1} = \gamma(Employee\ deviation)_{i,t} \quad (1)$$

$$Employee\ deviation_{i,t} \equiv Ln(Employee)^*_{i,t} - Ln(Employee)_{i,t-1} \qquad (2)$$

$Employee^*_{i,t}$ is the desired level of employment. Then, $Employee_{i,t-1}$ is the level of employment before the adjustment at time *t*. The speed of labor adjustment toward the target levels is not extensively studied across sectors. Using an approach developed by Caballero, Engel, and Haltiwanger (1997), the speed of labor adjustment in the high-tech sector is estimated in this study.

Giroud and Mueller (2017) argue firms' balance sheets are critical in employment changes during crises. In particular, high leverage leads to more reduction in employment in response to demand shocks (Giroud and Mueller, 2017). Likewise, the depreciation in housing values, which decreases collateral values, affects change in the employment levels of firms. However, the effect of cash holdings on employment levels is not well documented.

Brown and Petersen (2011) show that cash holdings are critical in smoothing R&D investments. Since the biggest share of R&D is salaries of workers, employment levels should be affected by cash holdings. This discussion leads to:

Prediction 2: It is anticipated that more cash holdings should help buffer employment levels in response to demand shocks. This prediction should be amplified within the high-tech sector as well as other financially constrained firms since cash holdings are more critical.

3 Data and Sample Characteristics

3.1 Sample Construction

The data to construct the sample used in this study is from Compustat and Zillow. Compustat database provides detailed financial information of publicly traded firms in the United States. The firm-level data from 1997 to 2014, which will be used to create the main variables, are collected excluding the following firms: finance (SIC 60-69), public utilities (SIC 49), and public administration (SIC 90-99). Then, firms with negative assets, negative sales, and less than four employees are dropped from the data used to construct the sample. Also, the sample excludes firms that do not report at least one string of five consecutive employee observations. Housing price is measured by median home values per square foot available at the zip code level from Zillow. This data is merged in the sample using the location of company headquarters and year. For instance, the headquarters of AAR corporation was located at 60191 in 1997, and the median home value per square foot at this zip code was $142 in 2017 according to Zillow. This results in the acquisition of an unbalanced panel data with 38,811 observations. All variables are winsorized at 1% level to account for outliers. Table 1 shows descriptions of the main variables.

3.2 Industries and Descriptive Statistics

The following industries are in the high-tech sector (Brown et al., 2009; Brown et al., 2017): drugs (SIC 283), computer and office equipment (SIC 357), communications equipment (SIC 366), electronic components and accessories (SIC 367), laboratory instruments (SIC 382), medical instruments (SIC 384), and computer related services (SIC 737). As shown in Figure 2, these seven industries take account of 72% of the total R&D in the U.S. during the sample period. The rest of the industries are considered as the non-high-tech sector for the following analysis. In the sample, the high-tech sector comprises 12,659 observations and the non-high-tech sector consists of 26,152 observations.

Table 2 shows the mean and median for main variables across sectors. As noted above, the mean of R&D is significantly greater in the high-tech sector (Hall 2002; Brown et al., 2009; Brown et al., 2012). Also, both the mean and median of cash holdings are greater for firms in the high-tech sector. It shows that firms with high R&D keep cash holdings. Last, this table shows that leverage is low in the high-tech sector. It can be explained by the limitation of financing through debt. High-tech firms, on average, have a higher Tobin's Q, which can imply a high growth potential. On the other hand, non-high-tech firms show large absolute values for firm size, age, Size-Age index, and Whited-Wu index. These all imply that high-tech firms are more financially constrained.

4 Empirical Specification and Results

4.1 Speed of Labor Adjustment

A firm's speed of labor adjustment toward targets is estimated using the gap approach developed by Caballero, Engel, and Haltiwanger (1997). This study argues that a firm's speed of labor adjustment varies by spending on R&D. However, there is an issue of the endogeneity of R&D so this study uses the Standard Industrial Classification in Compustat to construct high-tech sector and non-high-tech sector instruments. $Employee_{i,t}$ is the number of employees of the firm i at time t. In Equation (1), γ represents the speed of labor adjustment toward the target employment level. In other words, the firm fills γ percent of the difference between the target employment and the lagged employment every discrete time period.

In Equation (2), the desired (target) employment level, $Employment_{i,t}^{*}$, is a theoretical construct (Caballero, Engel, and Haltiwanger, 1997). This study uses a model of labor demand developed by Berman, Bound, and Griliches (1993) to model the target employment level. Berman, Bound and Griliches (1993) assume that the variable cost function is in a transcendental logarithmic form:

$$\ln(CV) = \alpha_0 + \alpha_Y \ln(Y) + \sum_i \alpha_i \ln(W_i) + \beta \ln(K) + 0.5\gamma_{YY} \ln(Y)^2$$
$$+ 0.5 \sum_i \sum_j \gamma_{ij} \ln(W_i) \ln(W_j) + 0.5\delta \ln(K)^2 + \sum_i \rho_{Y_i} \ln(Y) \ln(W_i)$$
$$+ \sum_i \rho_i \ln(W_i) \ln(K) + \pi \ln(Y) \ln(K) + \phi_t t + 0.5\phi_{tt} t^2 + \phi_{tY} t ln(Y)$$
$$+ \sum_i \phi_{tw_i} t \ln(W_i) + \phi_{tK} t \ln(W_i K)$$

where Y indicates value added; K indicates capital; W_i and W_j indicate wages for *i* and *j* types of workers, respectively; t indicates a technological change; and CV indicates variable costs. Labor inputs (x_i) are variable. Their necessary assumptions (Berman, Bound, and Briliches, 1993) also include that there are constant returns to scale, and firms choose inputs to minimize costs. Using the envelope theorem, we know that $\frac{\partial CV^*}{\partial W_i} = x_i^*$, where x_i^* is the labor input of the *i* type of workers. We have $\frac{\partial \ln(CV^*)}{\partial \ln(W_i)} = \frac{\partial CV^*}{\partial W_i}\frac{W_i}{CV} = x_i^* \frac{W_i}{CV} = S_i^*$, where S_i^* is the share of wages for *i* type of workers in total wages. Then, we obtain $S_i^* = \alpha_i + \rho_{Y_i} \ln(Y) + \sum_j \gamma_{ij} \ln(W_j) + \rho_i \ln(K) + \phi_{tw_i} t$. This solution yields that labor inputs are influenced by capital. Inspired by Berman, Bound and Griliches (1993), the target employment level comes from firms constrained in choosing capital levels.

In Equation (3), $X_{i,t-1}$ is a vector that includes firm characteristics for modeling the target employment level such as capital levels, Tobin's Q ratio, and financial variables. A higher Tobin's Q ratio is a signal of future growth of the company, which can lead to an increase in employment levels. This measure can be viewed as exogenous in the short run. Lagged *X* is used because firms do not respond immediately to decide target employment levels.

$$Employee_{i,t}^* = \beta X_{i,t-1} \qquad (3)$$

$$Ln(Employee)_{i,t} = \gamma\beta Ln(X)_{i,t-1} + (1-\gamma)Ln(Employee)_{i,t-1} + \epsilon_{i,t} \qquad (4)$$

As mentioned above in Section 2.1, the financial variables in $X_{i,t-1}$ include cash flows, stock issues, and debt issues. In Equation (4), the speed of labor adjustment (γ) is estimated using the system Generalized Method of Moments (GMM) estimator, which is introduced by Arellano and Bover (1995) and Blundell and Bond (1998). Both Tobin's Q ratio and financial variables are potentially endogenous, so the system GMM approach uses lagged levels and lagged differences as instruments for regressions in differences and levels, respectively. This method solves problems of endogenous regressors and firm fixed effects. Because lagged levels of t-3 to t-4 are not appropriate in this case (see below), this study employs lagged levels of t-5 to t-6 as instruments for regressions in differences, and lagged differences of t-4 as instruments for regressions in levels.

To verify instruments and specifications, the following tests are reported: a Hansen J-test, a difference-in-Hansen test, and an m2 test. The Hansen J-test addresses the validity of the over-identifying restrictions and a difference-in-Hansen test addresses the validity of the additional instruments in the levels equation. The m2 test addresses second-order autocorrelation for the first differenced residuals. These tests can show whether instruments and specifications have any problems. Using lagged levels of t-3 to t-4 as instruments for regressions in differences does not pass these tests.

Table 3 shows that the estimate of the speed of labor adjustment using the System GMM lies near the range between the other two estimates obtained from OLS and fixed effect models. The System GMM estimator is superior among the other estimators because it takes account of dynamic panel bias and fixed effects (Roodman, 2006). Using the System GMM as a base model, Table 3 shows that the speed of labor adjustment for high-tech firms and non-high-tech firms are 0.3% and 0.6%, respectively. The firms in the high-tech sector adjust employment level toward the target employment level slower than the non-high-tech sector. Although the difference in the speed of adjustment is modest, this is consistent with high adjustment costs for labor in the high-tech sector.

4.2 Change in Employment and Demand Shocks

This study uses a fixed effect model to find the effect of cash holdings on the change in employment levels in response to demand shocks. Equation (5) shows empirical specifications:

$$\Delta Ln(Employee)_{i,t} = \beta_1 Cash_{i,t-1} + \beta_2 \Delta Ln(Sale)_{i,t-1} * Cash_{i,t-1} + \beta_3 Leverage_{i,t-1} + \beta_4 \Delta Ln(Sale)_{i,t-1} * Leverage_{i,t-1} + \beta_5 \Delta Ln(Sale)_{i,t-1} + \beta_6 Tobin's\ Q_{i,t-1} + \delta_i + \theta_t + \epsilon_{i,t} \qquad (5)$$

Table 4-1 shows that cash holdings help to increase employment levels (in logs) since β_1 is positive. On top of that, β_2 is a negative value which supports that cash holdings decrease the sensitivity of the change in employment levels in response to demand shocks. For instance, Table 4-1 shows that if firms decrease sales by 10%, one unit of cash holdings can buffer a decrease in labor by 0.5%. Table 4-2 and Table 4-3 show that the absolute magnitude of the coefficient on $\Delta Ln(Sale)_{i,t-1} * Cash_{i,t-1}$ is greater for the high-tech sector than the non-high-tech sector. However, the coefficient on $Leverage_{i,t-1}$ is not statistically significant. Decomposing leverage to short-term and long-term leverages also yields the same results. This shows that cash holdings are critical in maintaining stable employment levels in response to demand shocks, especially in the high-tech sector.

This paper also uses a modification of empirical specifications developed by Giroud and Mueller (2017) to find how cash holdings influence the change in employment levels in response to demand shocks as shown in Equation (6). For this analysis, percentage changes on firm-level sales between 2006 and 2009 are used as demand shocks. However, due to the issue of endogeneity, percentage changes on house price at the zip code level between 2006 and 2009 are employed as instrumental variables for the sale percentage changes. Table 5 shows the result of the IV regression analysis.

$$\Delta Ln(Employee)_{i,2007-2009} = \beta_1 Cash_{i,2006} + \beta_2 \Delta Ln(Sale)_{i,2006-2009} * Cash_{i,2006} + \Delta Ln(Sale)_{i,2006-2009} + \epsilon_{i,t} \quad (6)$$

The coefficients for the interaction term between $Cash_{i,2006}$ and $\Delta Ln(Sale)_{i,2006\text{-}2009}$ are negative. In other words, it is evident that cash holdings can help buffer labor declines, especially in response to large negative shocks where housing prices decrease by more than 10% on average. When there is a large negative shock, one unit of cash holdings can buffer labor declines by 1% in the event of a l% decrease in sales. It is evident that cash holdings are critical for firms to buffer labor declines in response to demand shocks.

5 Financially Constrained and Unconstrained Firms

5.1 Cross-sectional Analysis: The Speed of Labor Adjustment

A cross-sectional analysis is used here to find the characteristics of firms that adjust employment levels quickly. This approach can help show what other firm characteristics aside from R&D influence the speed of labor adjustment. Inspired by Leary and Michaely (2011), the median employment level during the sample period is used for the target employment level, $Employee_{i,target}$, for each firm i.

$$\Delta Ln(Employee)_{i,t} = \gamma(Employee\ deviation_{i,t}) + \epsilon_{i,t} \quad (7)$$

$$Employee\ deviation_{i,t} = \frac{Ln(Employee)_{i,target}}{Ln(Sale)_{i,target}} * Ln(Sale)_{i,t} - Ln(Employee)_{i,t-1} \quad (8)$$

Then, γ is estimated using Equation (7). Firms in the highest quartile adjust employment levels most quickly. Table 6 suggests that other proxies for financial constraints including size, age, Size-Age index and Whiter-Wu index do not relate to the speed of adjustment. In fact, Table 6 shows no significant patterns in firms' characteristics of the speed of adjustment, except R&D. Firms with more R&D adjust slowly toward the target employment level. These results closely follow the results in Section 4.1.

5.2 Financial Constraints and Changes in Employment

This study also uses two approaches to divide the sample into financially constrained firms and unconstrained firms: firm age and size. Firms are defined as young (or old) if the firm's age is below (or above) the median age of the sample. Firms are defined as small (or large) if the asset size of the firm is below (or above) the median asset size of the sample. By splitting samples, Equation (5) is estimated in Table 7 using the fixed effect model. Since β_2 is a negative value, cash holdings decrease the sensitivity of change in employment in response to housing price shocks for both young firms and small firms. These firms are identified as financially constrained firms by the literature. However, cash holdings do not seem to take part in buffering labor for financially unconstrained firms. The results are similar to those in Section 4.2. The high absolute magnitude of β_2 indicates that cash holdings play a more critical role in financially constrained firms like high-tech, young, and small firms.

6 Summary and Implications

Firms in the high-tech sector make up the most R&D spending in the U.S. Thus, they are more financially constrained due to the higher cost of funds mainly caused by information asymmetries. Internal financing and external equity are the main sources of funds for R&D.

Since R&D is comprised mainly of the salaries of workers, employment levels are anticipated to be influenced by internal financing and external equity.

The empirical results in this study support these empirical predictions. Cash holdings of high-tech firms and other financially constrained firms help the firms to buffer employment levels in response to demand shocks such as sales shocks and housing price shocks. Additionally, the adjustment cost for labor in the high-tech sector is high. Confirming this prediction, the empirical results show that firms in the high-tech sector tend to adjust employment levels toward employment targets more slowly.

This study also shows cash holdings are necessary to maintain stable employment levels in response to demand shocks. These effects are amplified even further in the high-tech sector and financially constrained firms. Firms, particularly high-tech firms and financially constrained firms, should therefore possess adequate cash holdings in order to maintain stable employment levels in response to demand shocks.

To summarize, firms in the high-tech sector adjust employment levels toward employment targets more slowly, and financially constrained firms with more cash holdings are more likely to maintain stable employment levels in response to consumer demand shocks.

Giroud and Mueller (2017) argue that employment policies should directly target firms unlike previous studies that focus on indebted households (Guerrieri and Lorenzoni, 2017; Midrigan and Philippon 2016). They provide evidence that significant job losses in the Great Recession were mainly due to weak firm balance sheets in response to consumer demand shocks. Firms with high leverage experience more employment losses than firms with low leverage (Giroud and Mueller, 2017).

This paper strengthens their arguments for the importance of firm balance sheets by providing empirical evidence about the effect of cash holdings in different types of firms in response to consumer demand shocks. In Germany, short-time work programs encourage firms to reduce hours of employees instead of laying them off in response to consumer demand shocks. These programs reimburse firms to provide additional income to employees with reduced hours. Firms in Germany are subsidized to a great degree and these programs are successful in maintaining stable employment levels (Krugman, 2009).

Employment policies on targeting firms are critical, but the policies should vary across sectors. As shown in short-time work programs in Germany, it would be useful to provide subsidies to firms directly. This paper suggests that a subsidy in the form of cash holdings may even be better, which especially helps financially constrained firms to maintain stable employment levels in response to consumer demand shocks.

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Table 1 Description of the Variables Used in This Study

Variable	Source	Description
Age_t	Compustat	Natural log of the difference between the fiscal year (FYEAR) and the first year that the company appeared in Compustat
$Size_t$	Compustat	Natural log of the book value of total assets (AT) in period t using the year 2012 dollar values
$Cash_t$	Compustat	Cash and short-term investments (CHE) in period t, scaled by the book value of total assets (AT) in period t
$Capital_t$	Compustat	Gross book value of property, plant, and equipment (PPEGT) in period t, scaled by the book value of total assets (AT) in period t
$CashFlow_t$	Compustat	Gross cash flow in period t, scaled by the book value of total assets (AT) in period t, where gross cash flow is the sum of Income before extraordinary items (IB) and research and development expense (XRD) and depreciation and amortization (DP)
$StockIssues_t$	Compustat	Net cash inflow from stock issues in period t, scaled by the book value of total assets (AT) in period t, where cash inflow from stock issues is the sale of common and preferred stock (SSTK) plus the purchase of common and preferred stock (PRSTKC)
$DebtIssues_t$	Compustat	Net cash inflow from debt issues in period t, scaled by the book value of total assets (AT) in period t, where net cash inflow from debt issues is long-term debt issued (DLTIS) minus long-term debt reduction (DLTR)
$Leverage_t$	Compustat	Total debt in period t, scaled by the book value of total assets (AT) in period t, where total debt is equal to total long-term debt (DLTT) plus total debt in current liabilities (DLC)
Short-term $leverage_t$	Compustat	Total debt in current liabilities (DLC) in period t, scaled by the book value of total assets (AT) in period t
Long-term $leverage_t$	Compustat	Total long-term debt (DLTT) in period t, scaled by the book value of total assets (AT) in period t
Tobin's Q_t	Compustat	Market value of total assets scaled by the book value of total assets (AT) in period t, where market value of total assets is the book value of total assets (AT) minus the book value of equity (CEQ) plus the product of closing price (PRCC_F) and common shares outstanding (CSHO)
$R\&D_t$	Compustat	Research and development expense (XRD) in period t, scaled by the book value of total assets (AT) in period t
HP_t	Zillow	Median home value for square feet at the zip code level in period t using the year 2012 dollar values

Notes. Table 1 reports the variables used in this study. All data come from Compustat and Zillow, and data codes for Compustat are in parentheses.

Table 2 Descriptive Statistics

Variable	Total		High-tech sector		Non-high-tech sector	
	Mean	Median	Mean	Median	Mean	Median
Ln(Employee)	6.768	6.800	5.771	5.509	7.251	7.444
Ln(Sale)	19.12	19.29	17.94	17.89	19.70	19.92
R&D	0.0614	0	0.153	0.0944	0.0171	0
Cash	0.187	0.0978	0.330	0.282	0.118	0.0583
Leverage	0.252	0.190	0.179	0.056	0.287	0.245
Tobin's Q	2.716	1.519	3.921	2.030	2.127	1.375
Size	5.499	5.499	4.590	4.410	5.939	6.075
Age	2.629	2.708	2.418	2.485	2.732	2.773
Size-Age Index	-4.099	-4.101	-3.439	-3.311	-4.418	-4.519
Whited-Wu Index	-0.263	-0.269	-0.215	-0.217	-0.286	-0.293

Notes. Table 2 shows the mean and median of variables across the total, high-tech sector, and non-high-tech sector samples. Variables are winsorized at 1% level to account for outliers. Ln(Employee) is the natural log of the number of employees. Ln(Sale) is the natural log of the net sales using the year 2012 dollar values. R&D is the research and development expense, scaled by the book value of total assets. Cash is the cash and short-term investments, scaled by the book value of total assets. Leverage is the total debt, scaled by the book value of total assets. Tobin's Q is the market value of total assets, scaled by the book value of total assets. Size is the natural log of the book value of total assets. Age is the natural log of the difference between the fiscal year and the first year that the company appeared in Compustat. Size-Age index and Whited-Wu index are based on Hadlock and Pierce (2010) and Whited and Wu (2006), respectively.

Table 3 Speed of Labor Adjustment

	Full			High-tech	Non-high-tech
	OLS	Fixed Effect	System GMM	System GMM	System GMM
Dependent variable: $Ln(Employee)_{i,t}$					
$Ln(Employee)_{i,t-1}$	0.995***	0.792***	1.008***	0.997***	1.006***
	(0.001)	(0.003)	(0.007)	(0.011)	(0.009)
$Capital_{i,t-1}$	-0.022***	-0.111***	-0.027***	-0.098***	-0.025***
	(0.004)	(0.009)	(0.007)	(0.015)	(0.006)
Tobin's $Q_{i,t-1}$	0.016***	0.021***	0.056***	0.019**	0.021*
	(0.001)	(0.001)	(0.011)	(0.008)	(0.012)
$CashFlow_{i,t-1}$	0.171***	0.135***	0.130**	0.052	0.163**
	(0.007)	(0.008)	(0.060)	(0.053)	(0.083)
$StockIssues_{i,t-1}$	0.118***	0.082***	0.016	-0.176	0.142
	(0.012)	(0.013)	(0.107)	(0.110)	(0.130)
$DebtIssues_{i,t-1}$	0.140***	0.108***	-0.001	0.136	0.082
	(0.017)	(0.018)	(0.186)	(0.199)	(0.183)
Speed of Adjustment	0.005	0.208	0.008	0.003	0.006
M1 (p-value)	N/A	N/A	0	0	0
M2 (p-value)	N/A	N/A	0.842	0.961	0.851
Hansen J-test (p-value)	N/A	N/A	0.183	0.124	0.193
Diff-Hansen(p-value)	N/A	N/A	0.193	0.068	0.296
Observations	32,650	32,650	32,650	10,171	22,479
Year FE	Y	Y	Y	Y	Y
Firm FE	N	Y	Y	Y	Y

Notes. Table 3 shows the OLS model, fixed effect model, and system GMM model estimates of Equation (4) using the full sample. It shows the system GMM model estimates across high-tech sector and non-high-tech sector samples. Variables are winsorized at 1% level to account for outliers. Ln(Employee) is the natural log of the number of employees. Ln(Sale) is the natural log of the net sales using the year 2012 dollar values. Capital is the gross book value of property, plant, and equipment, scaled by the book value of total assets. Tobin's Q is the market value of total assets, scaled by the book value of total assets. CashFlow is the gross cash flow, scaled by the book value of total assets. StockIssues is the net cash inflow from stock issues, scaled by the book value of total assets. DebtIssues is the net cash inflow from debt issues, scaled by the book value of total assets. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4-1 Demand Shocks on Firms

	Full	Full	Full	Full
	FE	FE	FE	FE
Dependent variable: $\Delta Ln(Employee)_{i,t}$				
$Cash_{i,t-1}$	0.237***	0.187***	0.184***	0.184***
	(0.056)	(0.054)	(0.055)	(0.055)
$\Delta Ln(Sale)_{i,t-1}$* $Cash_{i,t-1}$		-0.045***	-0.045***	-0.044***
		(0.011)	(0.011)	(0.012)
$Leverage_{i,t-1}$			-0.020	-0.023
			(0.040)	(0.040)
$\Delta Ln(Sale)_{i,t-1}$* $Leverage_{i,t-1}$				-0.003
				(0.008)
$\Delta Ln(Sale)_{i,t-1}$	0.750***	0.750***	0.750***	0.750***
	(0.005)	(0.005)	(0.005)	(0.005)
Tobin's $Q_{i,t-1}$	-0.000	-0.001	-0.000	-0.000
	(0.004)	(0.004)	(0.004)	(0.004)
Observations	38,625	38,524	38,368	38,368
Firms	3,533	3,532	3,530	3,530
Adjusted R-squared	0.748	0.748	0.748	0.748
Year FE	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y

Notes. Table 4-1 shows a fixed effect model estimates of Equation (5) using the full sample. Variables are winsorized at 1% level to account for outliers. ΔLn(Employee) is the change in the natural log of the number of employees. Cash is the cash and short-term investments, scaled by the book value of total assets. ΔLn(Sale) is the change in the natural log of the net sales using the year 2012 dollar values. Leverage is the total debt, scaled by the book value of total assets. Tobin's Q is the market value of total assets, scaled by the book value of total assets. Robust standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 4-2 Demand Shocks on the High-Tech Sector

	High-tech	High-tech	High-tech	High-tech
	FE	FE	FE	FE
Dependent variable: $\Delta Ln(Employee)_{i,t}$				
$Cash_{i,t-1}$	0.207***	0.147*	0.136*	0.140*
	(0.078)	(0.076)	(0.076)	(0.075)
$\Delta Ln(Sale)_{i,t-1}$* $Cash_{i,t-1}$		-0.045***	-0.044***	-0.041***
		(0.014)	(0.014)	(0.014)
$Leverage_{i,t-1}$			-0.064	-0.083
			(0.067)	(0.066)
$\Delta Ln(Sale)_{i,t-1}$* $Leverage_{i,t-1}$				-0.020
				(0.018)
$\Delta Ln(Sale)_{i,t-1}$	0.694***	0.694***	0.692***	0.692***
	(0.009)	(0.009)	(0.009)	(0.009)
Tobin's $Q_{i,t-1}$	0.001	0.001	0.002	0.002
	(0.005)	(0.005)	(0.006)	(0.006)
Observations	12,601	12,566	12,485	12,485
Firms	1,200	1,200	1,199	1,199
Adjusted R-squared	0.726	0.726	0.725	0.725
Year FE	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y

Notes. Table 4-2 shows a fixed effect model estimates of Equation (5) using the high-tech sector. Variables are winsorized at 1% level to account for outliers. ΔLn(Employee) is the change in the natural log of the number of employees. Cash is the cash and short-term investments, scaled by the book value of total assets. ΔLn(Sale) is the change in the natural log of the net sales using the year 2012 dollar values. Leverage is the total debt, scaled by the book value of total assets. Tobin's Q is the market value of total assets, scaled by the book value of total assets. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4-3 Demand Shocks on the Non-High-Tech Sector

	Non-high-tech	Non-high-tech	Non-high-tech	Non-high-tech
	FE	FE	FE	FE
Dependent variable: $\Delta Ln(Employee)_{i,t}$				
$Cash_{i,t-1}$	0.228***	0.196**	0.200**	0.199**
	(0.077)	(0.076)	(0.078)	(0.078)
$\Delta Ln(Sale)_{i,t-1}$* $Cash_{i,t-1}$		-0.041**	-0.040**	-0.041**
		(0.018)	(0.018)	(0.018)
$Leverage_{i,t-1}$			0.011	0.011
			(0.045)	(0.045)
$\Delta Ln(Sale)_{i,t-1}$* $Leverage_{i,t-1}$				0.001
				(0.009)
$\Delta Ln(Sale)_{i,t-1}$	0.784***	0.784***	0.784***	0.784***
	(0.006)	(0.006)	(0.006)	(0.006)
Tobin's $Q_{i,t-1}$	-0.005	-0.005	-0.005	-0.005
	(0.006)	(0.006)	(0.006)	(0.006)
Observations	26,024	25,958	25,883	25,883
Firms	2,333	2,332	2,331	2,331
Adjusted R-squared	0.763	0.762	0.763	0.763
Year FE	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y

Notes. Table 4-3 shows a fixed effect model estimates of Equation (5) using the non-high-tech sector. Variables are winsorized at 1% level to account for outliers. ΔLn(Employee) is the change in the natural log of the number of employees. Cash is the cash and short-term investments, scaled by the book value of total assets. ΔLn(Sale) is the change in the natural log of the net sales using the year 2012 dollar values. Leverage is the total debt, scaled by the book value of total assets. Tobin's Q is the market value of total assets, scaled by the book value of total assets. Robust standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 5 Demand Shocks on Firms

	Full	Large Positive Shock	Large Negative Shock
	IV	IV	IV
Dependent variable: $\Delta Ln(Employee)_{i,2007\text{-}2009}$			
$\Delta Ln(Sale)_{i,2006\text{-}2009}$	0.475	1.300	0.936**
	(0.602)	(1.318)	(0.388)
$Cash_{i,2006}$	0.688	-0.505	-0.034
	(0.704)	(3.372)	(0.161)
$Cash_{i,2006}$*	-2.374	-1.115	-1.192**
$\Delta Ln(Sale)_{i,2006\text{-}2009}$	(1.655)	(3.126)	(0.563)
Observations	2,119	104	1,399
Adjusted R-squared	-0.948	-0.472	-0.004
Year FE	N	N	N
Firm FE	N	N	N

Notes. Table 5 shows the IV regression estimates of Equation (6) using the full, large positive shock, and large negative shock samples. Variables are winsorized at 1% level to account for outliers. $\Delta Ln(Employee)_{i,2007\text{-}2009}$ is the change in the natural log of the number of employees from 2007 to 2009. $Cash_{i,2006}$ is the cash and short-term investments in 2006, scaled by the book value of total assets in 2006. $\Delta Ln(Sale)_{i,2006\text{-}2009}$ is the change in the natural log of the net sales using the year 2012 dollar values from 2006 to 2009. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6 Firms Characteristics Across the Speed of Adjustment Quartiles

Variable	Speed of Adjustment Quartile			
	1	2	3	4
Ln(Employee)	6.391	6.508	6.452	6.465
Ln(Sale)	18.75	18.81	18.77	18.73
R&D	0.0749	0.0728	0.0672	0.0608
Cash	0.201	0.205	0.192	0.177
Leverage	0.259	0.258	0.262	0.273
Short-term leverage	0.0647	0.0636	0.0696	0.0750
Long-term leverage	0.188	0.186	0.185	0.192
Tobin's Q	2.249	2.445	2.469	2.334
Size	5.192	5.238	5.204	5.050
Age	2.444	2.493	2.501	2.424
Size-Age Index	-3.868	-3.901	-3.877	-3.763
Whited-Wu Index	-0.240	-0.244	-0.243	-0.233

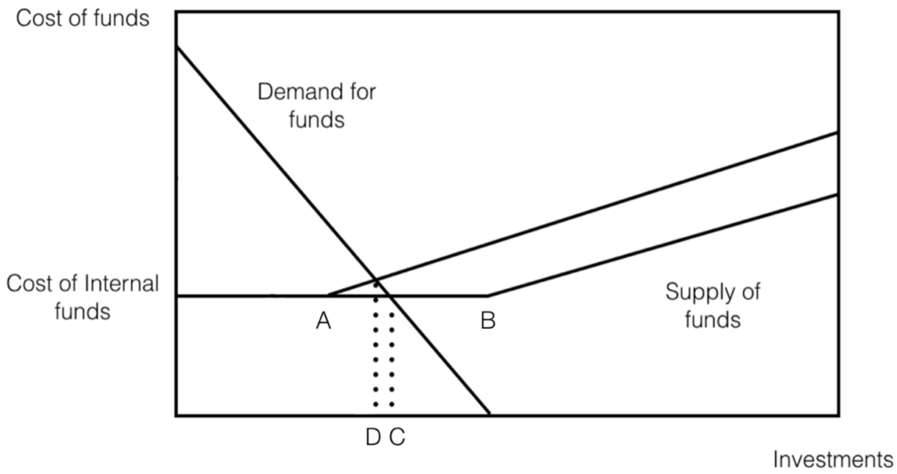
Notes. Table 6 shows the mean of variables across the speed of adjustment quartiles. Firms in the highest quartile adjust employment levels most quickly. Variables are winsorized at 1% level to account for outliers. Ln(Employee) is the natural log of the number of employees. Ln(Sale) is the natural log of the net sales using the year 2012 dollar values. R&D is the research and development expense, scaled by the book value of total assets. Cash is the cash and short-term investments, scaled by the book value of total assets. Leverage is the total debt, scaled by the book value of total assets. Short-term leverage is the total debt in current liabilities, scaled by the book value of total assets. Long-term leverage is the total long-term debt, scaled by the book value of total assets. Tobin's Q is the market value of total assets, scaled by the book value of total assets. Size is the natural log of the book value of total assets. Age is the natural log of the difference between the fiscal year and the first year that the company appeared in Compustat. Size-Age index and Whited-Wu index are based on Hadlock and Pierce (2010) and Whited and Wu (2006), respectively.

Table 7 Demand Shocks on Financially Constrained and Unconstrained Firms

	Firm Size		Firm Age	
	Small	Large	Young	Mature
	FE	FE	FE	FE
Dependent variable: $\Delta Ln(Employee)_{i,t}$				
$Cash_{i,t-1}$	0.171**	0.159	0.212***	0.149
	(0.067)	(0.105)	(0.071)	(0.092)
$\Delta Ln(Sale)_{i,t-1}$* $Cash_{i,t-1}$	-0.046***	-0.023	-0.067***	-0.003
	(0.013)	(0.022)	(0.014)	(0.021)
$Leverage_{i,t-1}$	-0.064	-0.001	-0.074	0.041
	(0.056)	(0.054)	(0.054)	(0.054)
$\Delta Ln(Sale)_{i,t-1}$* $Leverage_{i,t-1}$	-0.005	-0.002	-0.020	0.011
	(0.015)	(0.011)	(0.013)	(0.012)
$\Delta Ln(Sale)_{i,t-1}$	0.700***	0.801***	0.726***	0.775***
	(0.008)	(0.006)	(0.007)	(0.007)
$Q_{i,t-1}$	0.005	-0.021***	0.003	-0.007
	(0.005)	(0.007)	(0.005)	(0.007)
Observations	18,670	19,520	18,344	19,499
Firms	1,985	1,590	2,039	1,488
Adjusted R-squared	0.703	0.793	0.722	0.775
Year FE	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y

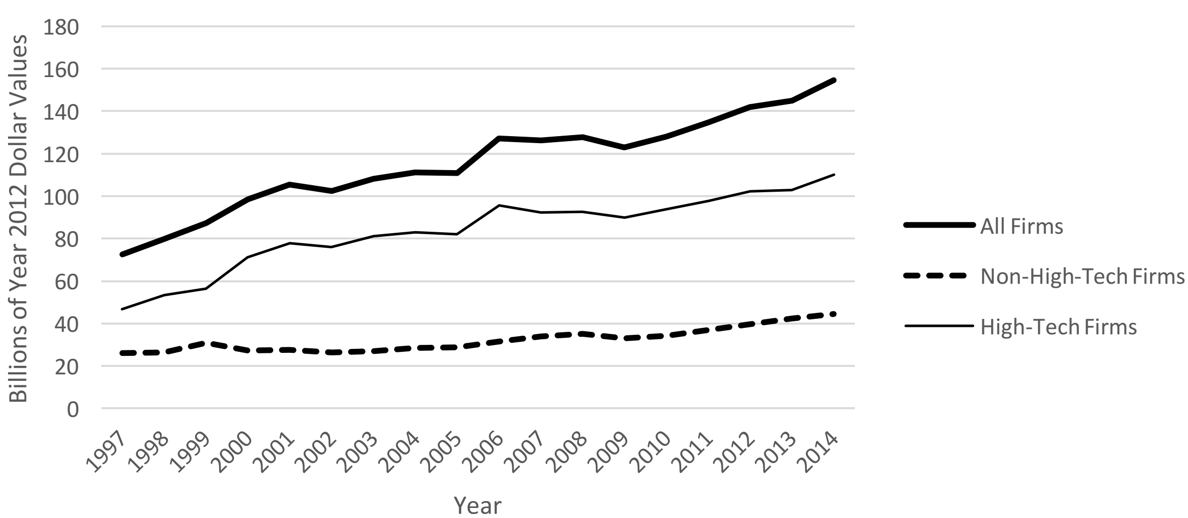
Notes. Table 7 shows the fixed effect model estimates across different firm size and age. Variables are winsorized at 1% level to account for outliers. ΔLn(Employee) is the change in the natural log of the number of employees. Cash is the cash and short-term investments, scaled by the book value of total assets. ΔLn(Sale) is the change in the natural log of the net sales using the year 2012 dollar values. Leverage is the total debt, scaled by the book value of total assets. Tobin's Q is the market value of total assets, scaled by the book value of total assets. Robust standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Figure 1 Constrained and Unconstrained Firms (Hall, 2002)



Notes. The downward-sloping curve in Figure 1 represents the demand for R&D investment funds. The upward-sloping curves represent the supply of R&D investment funds.

Figure 2 R&D Investment



Notes. The thick line plots the sum of R&D investments of all publicly traded firms in the U.S. except the firms in the finance (SIC 60-69), public utilities (SIC 49), and public administration (SIC 90-99) industries. The following seven industries take account of 72% of the total R&D in the U.S. during the sample period: drugs (SIC 283), computer and office equipment (SIC 357), communications equipment (SIC 366), electronic components and accessories (SIC 367), laboratory instruments (SIC 382), medical instruments (SIC 384), and computer related services (SIC 737). This study defines the firms in these seven industries as high-tech firms (Brown et al., 2009; Brown et al., 2017). The thin line plots the sum of R&D investments of high-tech firms. The dashed-line plots the sum of R&D investments of non-high-tech firms, which are the rest of the firms.