Investment, Alternative Measures of Fundamentals, and Revenue Indicators

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Abstract: The paper investigates the empirical significance of revenue management in determining firm-level fixed capital investment when investment opportunities are controlled for by two of the recently-introduced empirical fundamentals: profitability shocks and the gap measure between the desired and actual capital stocks (mandated investment rate). Tobin’s q is also included in the analyses for the purpose of comparison. The data set, which is constructed from the COMPUSTAT database, includes U.S. based manufacturing firms. The results show that financial variables are important determinants of investment but they are not as significant as claimed by some empirical studies focusing on capital market imperfections. The explanatory power of financial variables in the investment process declines with increasing significance of fundamentals. Another interesting result is that the level of investment by expected-to-be financially constrained firms, identified by commonly used a priori measures of financial constraints, tends to be relatively less sensitive to changes in financial variables compared to changes in fundamentals even though the opposite is predicted in the literature. This result questions whether investment-cash flow sensitivity can be a good measure of financial constraints, as well as whether some of the firm characteristics used in identifying financially constrained firms in the literature are sufficient.

Keywords: revenue management, investment, fundamentals, financial variables, financing constraints.

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1. Introduction

Empirical fundamentals, such as average Tobin's $q$, have produced disappointing empirical results in explaining the investment process of firms in the neoclassical investment literature. Even though the $Q$ theory shows that a firm's marginal $q$ should be the only determinant of investment, a well-developed empirical literature shows that investment is sensitive to a firm's internal fund management after controlling for Tobin's $q$, i.e. the ratio of asset market value to replacement cost of capital. Possible explanations for this high investment-internal fund sensitivity are investigated in two groups: the presence of financial market imperfections, or the existence of measurement problems related to Tobin's $q$, which prevent it from fully capturing investment opportunities.

In the first group, the financial market imperfections literature assumes that firms' net worth determines their financial position. When a firm's net worth is low, this firm can be considered financially constrained. The reason is that it is likely to face an asymmetric information problem in financial markets, which makes it difficult for them to find enough external funds to finance their investment projects. Even if they could find external funds, they would be too expensive compared to the opportunity cost of internal funds. Financial constraints lead firms’ investment decisions to be highly correlated with their internal funds. In the literature, it has been shown that the premium on external finance varies inversely with the firm's net worth such that a fall in net worth causes the premium on external finance to increase, which may lead to a reduction in investment. Some examples of these studies are: Bernanke and Gertler (1990), Bernanke, Campbell and Whited (1990), Whited (1992), Hu and Schiantarelli (1998), Gilchrist and Himmelberg (1998), Jaramillo, Schiantarelli, and Weiss (1996), Eisfeldt and Rampini (2007), Caggese (2007a), Bohacek (2007), Lorenzoni and Walentin (2007), and Hennessy, Levy, and Whited (2007).

Firms with high net worth, on the other hand, are expected to have a smaller asymmetric information problem. Thus, they can find enough external funds to finance their capital adjustment, and follow the investment process suggested by changes in fundamentals. This implies that the investment decision of firms with high net worth would be independent of the availability of their internal funds. Indeed, the empirical literature investigating financial market imperfections shows that firms that are classified as financially constrained present a larger sensitivity of investment to internal funds even after investment opportunities are controlled for by fundamentals such as Tobin's $q$. Kashyap, Lamont and Stein (1994), Carpenter, Fazzari and Petersen (1998), Hoshi, Kashyap, and Scharfstein (1991), Schiantarelli (1996), and Hubbard (1998) among others studies these issues.

In the second group of studies, the presence of measurement error problems of fundamentals is given as an alternative explanation to high sensitivity of investment to financial variables. The lack of importance of fundamentals in determining investment can be reasoned by their low quality of capturing firms' investment opportunities. Different authors argue that when measurement errors are controlled for, fundamentals become significant determinants of investment. Thus, as long as proper measures of
investment opportunities are introduced, cash flow or other financial variables are not expected to add any new information in investment regressions. Kaplan and Zingales (1995 and 1997), Gomes (2001), Erickson and Whited (2000), Cooper and Ejarque (2003), Abel and Eberly (2003), Caggese (2007b), and Grenadier and Wang (2007) study this issue. In order to overcome measurement error problems, new measures of fundamentals are introduced in the literature. For example, Gilchrist and Himmelberg (1995 and 1998) introduce a "Fundamental $Q$" measure, which is the present discounted value of future profit rates. They show that investment is more sensitive to this fundamental compared to Tobin's $q$, but financial variables are still significant determinants of investment.

Recent papers based on investment models with non-convex adjustment costs have also introduced alternative empirical measures of fundamentals. Two of them are profitability shocks and the gap measure between the desired and actual capital stocks (mandated investment rate). Caballero, Engel and Haltiwanger (1995), Cooper and Haltiwanger (2005), and Cooper and Ejarque (2003) are the papers studying these new measures of fundamentals. These fundamentals are compared with "Fundamental $Q$" and Tobin's $q$ in Bayraktar (2002). They are found to be more significant in explaining investment compared to Tobin's $q$ and "Fundamental $Q$." Bayraktar, Sakellaris, and Vermeulen (2005) show that financial variables are also important in determining investment in addition to fundamental determinants, using a structural investment model based on both convex and non-convex adjustment costs, where fundamentals are measured by profitability shocks.

Since the recently-introduced alternative fundamentals present a forward-looking behavior of firms, they are expected to better capture investment opportunities compared to Tobin's $q$. To test this hypothesis, in this paper, we investigate whether the relative significance of firms' financial position in the investment process may change when investment opportunities are controlled for by these new fundamentals. The answer to this question helps us better understand the relationship among fundamentals, investment, and financial variables. The aim is to shed light on the extent to which the investment-financial variable sensitivity can be linked to capital market imperfections versus mismeasured fundamentals.

The analyses in this paper are based on a reduced form investment equation, in which both fundamental determinants of investment and revenue indicators are taken as explanatory variables. A panel data set at the firm level is constructed from the COMPUSTAT database. The data set includes U.S. manufacturing firms for the period of 1983-1996. The fundamental determinants of investment are represented by profitability shocks and the gap measure. It should be noted that a "Fundamental $Q$" measure calculated by Gilchrist and Himmelberg (1995, 1998) is not included in the paper since they have already reported that the significance of financial variables drops when investment opportunities are captured by "Fundamental $Q$." Tobin's $q$ is also included for the purpose of comparison. Financial variables are represented by the ratio of cash flow to capital, sales to capital, and working capital to capital.
The empirical results show that revenue management and financial variables indicators are still important determinants of investment, but they are not as significant as claimed by studies focusing on capital market imperfections. The findings indicate that the explanatory power of financial variables in the investment process declines with increasing significance of fundamentals. On the one hand, the explanatory power of financial variables in a reduced form investment equation is the lowest when investment opportunities are measured by the gap between the desired and actual capital stocks. As investigated in Bayraktar (2002), this fundamental measure is the most significant empirical determinant of investment when compared with other fundamentals. Tobin's $q$, on the other hand, is the weakest determinant of investment, and financial variables have the highest explanatory power for investment when Tobin's $q$ is the proxy for investment opportunities. Thus, this result implies that the previous empirical failure of fundamentals against financial variables might be caused by measurement errors in fundamentals. When investment opportunities are captured better, the statistical and economic significance of financial variables drops.

Similar analyses are repeated after firms are classified into different groups using two alternative, commonly used a priori criteria used to identify financially constrained firms. The firm characteristics are the level of capital stock and the number of employees. The empirical results based on these sub-samples report how the response of investment to fundamentals, and to revenue indicators changes, depending on whether firms belong to a financially constrained or relaxed group. It is expected that firms with financial constraints exhibit significant investment-cash flow sensitivity compared to firms that appear less financially constrained. An interesting result is that when profitability shocks and the mandated investment rates are the fundamentals, the sensitivity of investment to financial variables tends to be lower for financially constrained firms even though the opposite is expected in the literature. However, when Tobin's $q$ is the fundamental measure, the results are as expected in the literature, such that financial variables are more important in determining investment for firms taking place in a financially constrained group. One implication of this result is that high investment-cash flow sensitivity may not be seen as evidence of financial constraints. This high sensitivity for financially constrained firms might be caused by the fact that investment opportunities are captured by insufficient measures of fundamental such as Tobin's $q$. This has been also shown by Kaplan and Zingales (1995 and 1997). They indicate that firms classified as less financially constrained exhibit significantly greater investment-cash flow sensitivity than firms classified as more financially constrained. The results in our paper also imply that a priori criteria used in classifying firms may not be that successful in identifying financially constrained ones.

The rest of the paper is organized as follows. Section 2 gives information about the relationship between investment, fundamentals, and financial variables. In Section 3, details on the data set and variables are given. In Section 4, the empirical results are presented. Section 5 concludes.
2. Investment, Fundamentals, and Revenue Indicators

The $Q$ theory of investment presents a formal link between a firm's investment and marginal $q$, and shows that marginal $q$ should be the sole determinant of investment. This result can be illustrated using the following neoclassical model with convex capital adjustment costs (See Bayraktar (2002) for more details). The purpose of the competitive firm's manager is to maximize the present discounted value of the firm:

$$V(A_{it}, K_{it}) = \max_{I_{it}} \Pi(A_{it}, K_{it}) - C(K_{it}, I_{it}) + \beta E_{A_{it+1}|A_{it}} V(A_{it+1}, K_{it+1}),$$  \hspace{1cm} (1)

subject to the following constraint:

$$I_{it} = K_{it+1} - (1 - \delta)K_{it},$$

where the subscripts $i$ and $t$ denote the firm level variables and time period, respectively. $V(\cdot)$ is the value function, $A_{it}$ is the profitability shock in period $t$ and $K_{it}$ is the current capital stock. $\Pi(\cdot)$ is the profit function. $C(\cdot)$ is the investment cost function and $I_{it}$ stands for investment. $\beta E_{A_{it+1}|A_{it}} V(\cdot)$ is the present discounted future value of the firm where $\beta$ is the fixed discount factor. In the investment equation, $\delta$ is the depreciation rate.

It is assumed that both $C(\cdot)$ and $\Pi(\cdot)$ are homogenous of degree one in investment and capital (homogeneity assumptions). $C(\cdot)$ is assumed to be a convex function such that:

$$C(K_{it}, I_{it}) = pI_{it} + \frac{\gamma}{2} \left[ \frac{I_{it}}{K_{it}} \right]^2 K_{it}.$$ \hspace{1cm} (2)

Given these assumptions, we can scale equation (1) by $K_{it}$:

$$v(A_{it}) = \max_{i_{it}} \pi(A_{it}) - c(i_{it}) + \beta(1 - \delta - i_{it})E_{A_{it+1}|A_{it}} v(A_{it+1}),$$ \hspace{1cm} (3)

where $\pi(A_{it}) = V(A_{it}, K_{it})/K_{it}$, $\pi(A_{it}) = \Pi(A_{it}, K_{it})/K_{it}$, $c(i_{it}) = C(K_{it}, I_{it})/K_{it}$, $i_{it} = I_{it}/K_{it}$, and $\beta(1 - \delta - i_{it})E_{A_{it+1}|A_{it}} v(A_{it+1}) = \beta E_{A_{it+1}|A_{it}} V(A_{it+1}, K_{it+1})/K_{it}$.

Maximizing equation (3) gives the following first order condition:

$$\frac{\partial c(\cdot)}{\partial i_{it}} = \beta E_{A_{it+1}|A_{it}} v(A_{it+1}).$$ \hspace{1cm} (4)

From equation (2),
\[
\frac{\partial c(.)}{\partial t_i} = p + \mathcal{N}_i. 
\]

If we combine equations (4) and (5), the investment rate is going to be a function of marginal \( q \)

\[
i_t = \frac{1}{\gamma} (\beta E_{A_{t+1}} v(A_{t+1}) - p),
\]

where \( \beta E_{A_{t+1}} v(A_{t+1}) \) is marginal \( q \). Given homogeneity assumptions listed above, it can be shown that marginal \( q \) is equal to average \( q \).

\[
\beta E_{A_{t+1}} v(A_{t+1}) = \beta E_{A_{t+1}} V(A_{t+1}, K_{t+1})/K_{t+1},
\]

where average \( q \) is \( V(A_{t+1}, K_{t+1})/K_{t+1} \). Since marginal \( q \) is not empirically observable, it is replaced by average \( q \) (Tobin's \( q \)) in empirical studies. The explanatory power of Tobin's \( q \) for investment has not only been found to be negligible, but they have also produced extremely high parameter estimates for capital adjustment cost functions, which is \( \gamma \) in the model presented above.

The empirical failure of neoclassical investment models has led to a search for alternative determinants of investment in the literature. One of the most prominent groups of studies focuses on the importance of the financial position of firms in explaining their investment behavior. It is theoretically assumed that firms' net worth determines their financial position, which, in turn, determines their investment behavior. Firms with low net worth are considered financially constrained since they are likely to face an asymmetric information problem in financial markets, which prevents those finding cheap external funds to finance their investment projects. In this case, investment is expected to be highly correlated with internal funds. Firms with high net worth, on the other hand, are expected to have a smaller asymmetric information problem; thus, they can borrow external funds, and follow the investment process suggested by fundamentals, independent of the availability of their internal funds.

It has been empirically shown that investment is sensitive to internal funds after controlling for \( q \), using a reduced form investment equation, which can be written, in general terms, as follows:

\[
i_{it} = bx_{it} + cFV_{it} + T\alpha + F\phi + u_{it},
\]

where \( i \) represents firms and \( t \) represents years. \( i_{it} \) is the investment rate at firm \( i \) in period \( t \). While \( x \) is a fundamental measure used in capturing investment opportunities, \( FV \) captures financial variables and revenue indicators such as net worth or internal funds. \( T \) represents a set of time dummies, and \( F \) represents a set of firm dummies used in
removing fixed effects. \( u \) is the error term. This regression equation estimates the sensitivity of investment to changes in internal funds, \( FV \), controlling for investment opportunities, \( x \). If fundamentals are the sole determinants of investment, as specified by the \( Q \) theory, the coefficient of \( FV \) should be statistically insignificant, given that fundamentals are not mismeasured. In the literature, the equation is estimated separately for financially constrained and unconstrained firms, which are identified by a priori proxies. The purpose is to distinguish between possibly mismeasured fundamentals and capital market imperfections. Fazzari, Hubbard, and Petersen (1988) is the first paper following this methodology. It has been shown that the sensitivity of investment to financial variables is higher for financially constrained firms, which has been taken as evidence in favor of capital market imperfections.

There are three basic issues in the financial market imperfections literature: determining good proxies for internal funds, identifying financially constrained firms, and capturing investment opportunities by variables expected to be free of mismeasurement problems. The cash-flow-to-capital ratio is the most commonly used financial variable to capture changes in internal funds in the investment equation. For example, Fu, Cheng, Chang, and Lai (2007) studies the link between investment on innovation projects and revenue management in American and Taiwanese firms. One would expect that financial constraints should make investment more responsive to this ratio. Even though it is used extensively in the existing literature, its ability to capture the financial position of firms is questionable. The basic problem is that cash flow may contain information on future profits as well as on firms’ financial position. In addition, cash flow may not be a good measure of changes in firms’ net worth. Because of this, alternative financial variables, which are hopefully less correlated with investment opportunities, have been introduced. One alternative is stock measures of internal funds since they are less directly linked to investment opportunities. A commonly used candidate is the cash-and-equivalents-to-capital ratio, which captures the short-term liquid asset position of firms. Another stock measure is the ratio of working capital (current assets minus current liabilities plus inventories) to capital, which captures the leverage position of firms net of current liquid assets (Gilchrist and Himmelberg, 1998). Tax payments can also be an instrumental variable for cash flow (Hubbard, Kashyap, and Whited, 1995). The sales accelerator investment demand literature claims that the availability of internal funds depends on sales; investment therefore should be responsive to fluctuations in the sales ratio. Thus, the sales-to-capital ratio is another variable used by the existing literature.

With regard to identifying financially constrained firms, the level of dividend to income ratio is a commonly used indicator. Fazzari, Hubbard, and Petersen (1988) group firms according to this a priori measure of financial constraints, and compare the investment-internal funds sensitivity of different groups. More specifically, they indicate that if information problems in capital markets cause financing constraints on investment, this should be most clearly seen for firms that retain most of their income. Thus, one would expect that the lower the dividend payout ratio is, the more financially constrained firms are. The reason for this expectation is that if firms pay a high dividend relative to their income, they reveal that the opportunity cost of their internal funds is low, so they
are financially unconstrained. The size of firms in terms of their capital stock, total assets, or the number of employees is also used in selecting financially constrained firms, where smaller firms are expected to be more financially constrained. One explanation is that external funds have a significant fixed cost component creating increasing returns, thus, smaller firms have to pay higher costs to obtain external funds. Another restriction on the availability of external funds for smaller firms is that public information about their investment projects is generally more limited.

Another set of variables used in identifying financially constrained firms is their debt structure. Whited (1992) and Calomiris, Himmelberg, and Wachtel (1994) group firms depending on whether they have bond ratings or not. They argue that public debt issuance is a good indicator of firms' financial position since it provides a low-cost access to capital markets. Firms' stock or flow debt burden might be another indicator of financial problems, where debt stock is defined as the market value of debt over the total market value of firms, and debt flow is defined as interest expense over current asset (Bernanke, Campbell, and Whited, 1990). Other possible measures of debt burden are interest coverage, which is interest expenditure over interest expenditure plus cash flow (Whited, 1992), and the ratio of liquid assets to capital (Hu and Schiantarelli, 1998). One would expect that the larger the debt burden is, the more financially constrained firms are since they are expected to pay higher premiums to obtain external funds. Not only are many different indicators used in identifying firms with financial problems, but their cut off values also differ across studies, which use the same indicator to determine financially constrained firms. For example both Fazzari, Hubbard, and Petersen (1988) and Gilchrist and Himmelberg (1998) use the dividend payout ratio in splitting their samples. The first study, on the one hand, splits the sample of firms into three different groups, depending on whether the ratio is less than 0.1, between 0.1 and 0.2, or larger than 0.2. The second study, on the other hand, splits the sample in two, and defines the group of financially unconstrained firms as those in the top one third of the dividend payout ratio.

In addition to firm size and debt burden of firms as mentioned above, Baker, Stein, and Wurgler (2003) introduces an index of equity dependence, which measures financial constraints. This measure is based on the work of Kaplan and Zingales (1997) and Lamont, Polk, and Saa-Requejo (2001).

Despite the presence of a large range of financial variables used in determining firms' financial position, most empirical studies use only average Tobin’s $q$ as a proxy for investment opportunities.\(^1\) Theoretically, the correct measure of capturing investment opportunities is marginal $q$, which is defined as the present discounted value of future profits generated by an additional unit of capital. Since marginal $q$ is not empirically observable, different substitutes are introduced in empirical studies such as Tobin's $q$, defined as the ratio of firm's average value to its capital stock. Empirical results show that

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\(^1\) One of the exceptions is Gilchrist and Himmelberg (1995 and 1998). They introduce "Fundamental $Q$" as a new fundamental, and investigate the effectiveness of this new fundamental measure in explaining investment, and the role of financial variables in this process. They show that even though financial variables are still statistically significant determinants of investment, the new fundamental measure is more successful in explaining investment than Tobin's $q$. 

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the explanatory power of Tobin's $q$ in investment equations is much weaker compared to financial variables, where a possible reason for this failure would be inadequacy of average Tobin's $q$ in capturing investment opportunities due to measurement errors. Erickson and Whited (2000), using measurement error-consistent generalized method of moments estimators, also find that investment-cash flow sensitivity might be reasoned by measurement error. Also see Kaplan and Zingales (1995 and 1997), Cooper and Ejarque (2003), and Abel and Eberly (2003).

Gomes (2001) argues that if fundamentals are measured accurately, there is no reason for financial variables to be significant determinants of investment even if financial constraints are present, since information on the financial position of firms is expected to be already included in fundamentals. A recent investment literature based on non-convex capital adjustment cost models introduces new measures of fundamentals, two of which are profitability shocks and the gap measure between the desired and actual capital stock. Caballero, Engel, and Haltiwanger (1995) and Cooper and Haltiwanger (2005) are the first papers studying these new measures of fundamentals. As investigated in Bayraktar (2002), these measures are more successful in explaining investment than Tobin's $q$. In this paper, these two fundamentals are taken as proxies for investment opportunities to better understand whether sensitivity of investment to financial variables can be explained by measurement errors in fundamentals. One advantage of these fundamentals is that, even though they are constructed using current variables, they present a forward-looking behavior. Since profitability shocks are serially correlated, the current value of shocks gives information about future profitability. The gap measure between the desired and actual capital stocks is also informative about future investment behavior since the magnitude of the gap determines whether a firm invests in the current period or in the future. An additional reason for using these two measures is that they have not been tested together with financial and revenue indicators before.

### 3. Data and Variables

The main data source is the COMPUSTAT firm-level database. The data set, covering the period from 1983 to 1996, includes U.S. manufacturing firms with a SIC code between 2000-3999. It should be noted that since the retirement data, used in constructing investment series, were not collected since 1996, the following years are not included in this study. The total number of firms is 463 and the total number of panel observations is 6450. The balanced data set would have had 6482 observations. Detailed information on the data set and variables is given in Bayraktar (2002). The following subsections introduce main variables used in the study.

#### 3.1 Investment

The definition of capital includes plant, property, and equipment, and investment is defined as capital expenditure net of capital sales, including capital retirements. As defined in the COMPUSTAT User Guide, the data series for sale of capital and
retirements are combined for some firms, but they are separate series for others. In order to obtain a uniform series, the retirements data and sale of capital data are added up whenever the sale of capital data have a lower value than the retirements data, indicating that retirements are not included in the sale of capital data. The replacement value of capital is calculated using a perpetual inventory method as follows:

\[ K_t = (1 - \delta)K_{t-1} + I_t, \]  

where \( K_t \) is the real capital stock, \( I_t \) is real investment, which is calculated by deflating the nominal value by the 4-digit investment price index. \( \delta \) is the 2-digit depreciation rate from the Bureau of Labor Statistics (BLS) database. It is equal to the average value of the depreciation rates for the period of 1981-1996. The investment rate is defined as the ratio of real investment to the replacement value of capital. The distribution function of the investment rate is presented in Figure 1. Since investment is net of sale of capital, there are negative investment rates available, corresponding to nearly 10 percent of the total observations. Descriptive statistics are given in Table 1.

### 3.2 Revenue Indicators and Financial Variables

The following financial variables are used in capturing the effects of internal funds on investment:

- **Cash flow to capital ratio**: The ratio of the book value of cash flow to the beginning of period book value of gross total plant, property, and equipment (PPE).
- **Sales to capital ratio**: The ratio of the book value of net sales revenue to the beginning of period book value of PPE.
- **Working capital to capital ratio**: The ratio of the book value of working capital (the difference between current assets and liabilities) to the beginning of period book value of PPE.

The following a priori proxies are used in identifying financially constrained firms:

- **Book value of PPE stock**: Small firms are expected to be financially constrained.
- **Number of employees**: Firms with a less number of employees are expected to be financially constrained.

### 3.3 Fundamentals

The purpose of this study is to assess the explanatory power of internal funds when firms' investment opportunities are proxied by the mandated investment rate and the profitability shocks, where the last one is calculated following two different ways. Besides these fundamentals, Tobin's \( q \) is also included for the purpose of comparison.

#### 3.3.1 The Mandated Investment Rate
Caballero and Engel (1994) try to explain the lumpy nature of investment using a model based on the standard \((S,s)\) literature. They measure imbalances in capital as the gap between the desired and actual capital stocks (the mandated investment rate). In their model, the investment rule is that once the measure of imbalance reaches a threshold value, the capital adjustment occurs at once. The reason for firms to wait until they reach the trigger point is explained by the presence of non-convex adjustment costs, describing an increasing returns on capital adjustment technology. This model is empirically studied by Caballero, Engel, and Haltiwanger (1995). It should be noted that the mandated investment rate is also used in explaining the fixed capital investment process by Goolsbee and Gross (1997). Caballero, Engel, and Haltiwanger (1995) show that the response of investment to the gap is nonlinear, supporting the availability of non-convex capital adjustment costs.

As shown by Caballero, Engel, and Haltiwanger (1995), the mandated investment rate, \(x_{it}\), is defined as the deviation of the desired capital stock from the actual one such that

\[
x_{it} = \tilde{k}_{it} - k_{it-1},
\]

where \(\tilde{k}_{it}\) and \(k_{it-1}\) represent the natural log of desired and actual capital stocks in firm \(i\) at time \(t\). While positive values of \(x_{it}\) indicate capital shortages, negative ones indicate excess capital. Desired capital refers to the stock of capital that a firm would hold if adjustment costs were momentarily removed. It is constructed under the following assumptions. First, it is assumed that desired capital is proportional to the log of frictionless capital stock, \(k_{it}^*\), such that

\[
\tilde{k}_{it} = k_{it}^* + d_t,
\]

where \(d_t\) is a firm-specific constant. Frictionless capital is the stock of capital that a firm would hold if it never faced adjustment costs.

The second assumption is that frictionless stock of capital, \(k_{it}^*\), is determined by a neoclassical model. This model produces the following empirical equation for the gap measure:\(^2\)

\[
\tilde{k}_{it} - k_{it-1} = \eta_t \{(y_{it} - k_{it-1}) - \psi_t c_{it}\},
\]

where \(y_{it}\) and \(c_{it}\) represent the natural log of the value of output and cost of capital in firm \(i\) at time \(t\), respectively. \(\eta_t\) is assumed to be equal to \((1/(1-\alpha))\) where \(\alpha\) is the cost share of capital. \(\psi_t\) is the long-run elasticity of capital with respect to its cost.

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\(^2\) Details are given in Appendix A2.
The third assumption is the estimation of $\psi_i$ from a cointegrating regression of the natural log of the capital-to-output ratio on the cost of capital at the 2-digit industry level using firm-level panel data. This coefficient can be interpreted as the long-run elasticity of capital with respect to its cost. Bayraktar (2002) calculates the average value of this measure as -0.68. This value is close to -1, which is the long-run elasticity in neoclassical models. After calculating frictionless capital, the firm-specific constant, $d_i$, is estimated by taking the average gap between $k_{i,t-1}$ and $k_{i,t}^*$ for the five points with investment closest to median investment, which can be thought as maintenance investment.

3.3.2 Profitability Shocks

The second variable capturing investment opportunities in this paper is the idiosyncratic profitability shock. Cooper and Haltiwanger (2005) display that the empirical relationship between the investment rate and profitability shocks is nonlinear and asymmetric. The response of investment to positive shocks is much stronger than its response to negative shocks. They show that this behavior of investment is better explained when both convex and nonconvex adjustment costs are taken into account together in a model. As presented in Cooper and Haltiwanger (2005), the profitability shocks can be presented in the following firm-level profit function:

$$\Pi(A_{it}, K_{it}) = A_{it} K_{it}^\theta,$$

where $A_{it}$ is the profitability shock, which consists of both aggregate and idiosyncratic components, $\theta$ is the curvature of the profit function, and $K_{it}$ is the firm level capital stock. $\theta$ is estimated by regressing the natural log of net profit (net of cost of production) on the log of the replacement value of capital stock using firm-level panel data. $\theta$ is assumed to be the same for each firm in each period. However, if there are structural differences across firms, they need to be removed from affecting the analysis. Consequently, we remove fixed effects to solve a possible structural heterogeneity problem.

There are two alternative ways of calculating $A_{it}$. The first way calculates $A_{it}$ by regressing the log of profits on the log of real capital. Time dummies are included to remove the effects of aggregate profitability shocks.

$$\ln \Pi(.) = \theta \ln K_{it} + F\alpha + T\phi + ra_{it},$$

where $ra_{it}$ is the error term taken as idiosyncratic profitability shocks, named as residual profitability shocks from now on.

The second way calculates $A_{it}$ indirectly through the first order condition for profit maximization with respect to employment. Since the employment series are more reliable, the second way allows us to avoid possible measurement errors in profit data. In
this case, \( A_{it} \) is going to be a function of the shocks to revenue, \( \hat{A}_n \), and other parameters such that:\(^3\)

\[
A_{it} = f(\hat{A}_n, \xi, \alpha_K, \alpha_L, w),
\]

where \( \xi \) the price elasticity of demand, \( \alpha_K \) and \( \alpha_L \) are the shares of capital and labor costs, respectively, and \( w \) is the wage level. The aggregate shocks are calculated as the annual mean of \( A_{it} \), and the idiosyncratic component of \( A_{it} \), presented by \( a_{it} \), is taken as the deviation from this mean. \( a_{it} \) is named, from now on, as profitability shocks from the first order condition.

### 3.3.3 Tobin's \( q \)

Tobin's \( q \) (average \( q \)), the ratio of the market value of firms to the replacement value of capital, is the most commonly used fundamental determinant of investment in the literature. Hayashi (1982) and Abel (1979) report that the neoclassical model with convex adjustment costs yields a \( q \) value, which is known as marginal \( q \). Since it is not empirically feasible to calculate this marginal value, the average value of \( q \) can be used as a proxy for the marginal value under some strict assumptions, as shown in Section 2. The assumptions are that firms have a linear homogeneous net revenue function, and operate in perfectly competitive markets.

There are many different ways available to measure the market value of firms and the replacement value of their capital stocks. In this study, the definition of Tobin's \( q \) is the one used by Barnett and Sakellaris (1998).\(^4\) The numerator is the sum of the market value of common stock, the liquidating value of preferred stock, the market value of long-term debt and the book value of short-term debt. The denominator, on the other hand, is the sum of the replacement value of fixed capital and inventories.

### 4. Empirical Results

In this section, the following reduced form investment equation is estimated using a least squares regression technique for panel data:

\[
i_{it} = b_1 x_{it} + b_2 x_{it}^2 + c FV_{it} + T \alpha + F \phi + u_{it},
\]

where \( i \) represents firms and \( t \) represents years. \( i_{it} \) is the investment rate at firm \( i \) in period \( t \). While \( x_{it} \) is a fundamental measure capturing investment opportunities, \( FV \) captures financial variables and revenue indicators such as net worth or internal funds. \( T \) represents a set of time dummies, and \( F \) a set of firm dummies to remove fixed effects. \( u \) is the error term. In this equation, four different fundamentals are included: two types of

---

\(^3\) Details on calculation of these shocks are given in Appendix A.3.

\(^4\) Details on the calculation of these variables are given in Appendix A.1.
profitability shocks, the gap between the desired and actual capital stock (mandated investment rate), and Tobin's \( q \). Since Bayraktar (2002) shows that the relationship between the investment rate and these fundamentals is nonlinear, the squared term of fundamentals is also included. Barnett and Sakellaris (1998), Barnett and Sakellaris (1999), and Abel and Eberly (2002) also investigate the nonlinear relationship between fundamentals and investment. In this study, the cash flow to capital ratio, the ratio of sales to capital, and working capital to capital are included as financial variables.\(^5\) All these ratios are calculated using the book values. The results do not change when the real values are used instead. In addition to the financial variables mentioned above, the ratio of cash and equivalence to capital and the ratio of tax payments to income are also included. But the results are not reported because the ones with the cash and equivalence to capital ratio were similar to the results with the ratio of cash flow to capital, and the statistical significance of tax payments was negligible.

In addition to full sample analyses, the sample is split into subgroups using six alternative a priori criteria to identify financially constrained firms. The criteria introduced in this study are the size of capital stock, number of employees, dividend to capital ratio, dividend payout ratio, debt to capital ratio, and firms' bond rating. The definitions of these variables are given in Section 3.2. Besides them, other criteria such as total assets, real capital stock, flow and stock of debt burdens, and interest coverage ratio are also introduced. But, the results are not reported in the paper since they produce similar results.

In the following sections, the full sample results are reported first, then the subsample results are presented according to the size of capital stock and the number of employees.

4.1 Full sample results

The estimated coefficients are reported in Table 2. Four sets of results, corresponding to each fundamental determinant of investment, are presented in the table. In the first column, financial variables are excluded from the explanatory variable set. In the following columns, different financial variables are introduced. By comparing the results in the first column and in the following columns, the marginal explanatory power of financial variables can be understood.

The estimated coefficients of both the linear and squared terms of the fundamentals, including Tobin's \( q \), are statistically significant at 1 percent. When we check the results without financial variables, the highest adjusted \( R^2 \), on the one hand, belongs to the regression result with the mandated investment rate. The regression result with Tobin's \( q \), on the other hand, produces the lowest adjusted \( R^2 \). Some of these results are comparable to the ones reported in previous studies. For example, Barnett and Sakellaris (1998) present regression results for Tobin's \( q \) and its squared term. Even though their data set is also constructed from the COMPUSTAT database, their sample

\(^5\) As pointed out by one of the referees, the change-in-cash-flow to capital ratio can be an alternative measure which can be a topic of a future study.
period and the definition of investment is different. These differences in the data sets are reflected in results. The results with the profitability shocks obtained from the first order condition \((ait)\) can be compared to the results presented in Cooper and Haltiwanger (2002). Even though they use plant-level data in their analysis, the values of the estimated coefficients are close to each other.

The results with the cash flow ratio \((CF_K)\) are reported in the second column of the table. This variable is statistically significant in each regression except when the mandated investment rate \((kit)\) is the fundamental measure. This means that the sensitivity of investment to \(CF_K\) is negligible when investment opportunities are controlled for by the mandated investment rate. The other interesting result is that while the inclusion of \(CF_K\) does not much change the value of the adjusted \(R^2\) in the first three sets, it jumps from 0.056 to 0.134 when Tobin's \(q\) is the fundamental measure. The sensitivity of investment to \(CF_K\) is also considerably higher in the last case. Since the cash flow-to-capital ratio is one of the most commonly used financial variables in investment regressions, there are several comparable studies in the literature. For example, similar to our results given in Table 2, Fazzari, Hubbard, and Petersen (1988) find that the estimated coefficient of the cash flow ratio is approximately around 0.52, where they include only the level of Tobin's \(q\) to capture investment opportunities.

When the effect of financial variables is captured by the ratio of sales to capital \((Sales_K)\), we obtain similar results, as reported in column 3. The basic difference is that the estimated coefficient of \(Sales_K\) is also statistically significant when the mandated investment rate is the fundamental variable. Again the sensitivity of investment to this financial variable gets the highest value when Tobin's \(q\) is the fundamental measure. The ratio of working capital to capital \((WorkingK_K)\) contributes to the explanation of investment in a statistically significant way in each equation. As is the case in other results, the sensitivity of investment to \(WorkingK_K\) is the highest with Tobin's \(q\) and the lowest with the mandated investment rate.

Overall, even though revenue indicators and financial variables are still significant determinants of investment, the results show that the explanatory power of financial variables drops when investment opportunities are controlled for by the new fundamentals. As discussed in Section 2, the results support the idea that the significance of financial variables in determining investment may be reasoned by mismeasured fundamentals, which prevent them capturing investment opportunities successfully. For example, using measurement error-consistent generalized method of moments estimators, Erikson and Whited (2000) show that most of the stylized facts produced by investment, \(q\), and cash flow regressions are reasoned by measurement error. Cash flow also does not matter after controlling for measurement errors.

4.2 Results Based on Sub-samples

In the following sub-sections, the question of how the relationship between investment, fundamentals, and revenue indicators changes when firms are grouped into
sub-samples, using a priori criteria extensively observed in the literature. The criteria used correspond to alternative definitions of financially constrained status.

4.2.1 Size of Capital Stock

The first criteria are the size of firms in terms of their capital stocks. Small firms are defined as the ones with the average capital stock in the lower half of the empirical distribution. While Class 1 stands for the group of small firms, Class 2 is the group of large firms. One would expect smaller firms to be financially constrained, since costs of getting external funds are presumably higher for them, and public information about their investment projects is generally more limited. These facts restrict their ability to find external funds. Since small firms are expected to be financially constrained, their investment should respond less to changes in fundamentals, but more to internal funds.

The average values of variables for these two groups of firms are reported in the first two columns of Table 3. The average investment rate in both groups is similar. The growth rate of sales for small firms is 21 percent versus only 7 percent for large firms. This means that small firms grow much faster. The earnings retention rate is higher for small firms, while the dividend payout ratio is lower. While the average value of Tobin's \( q \) is much higher for small firms, indicating that these firms are supposed to invest more, the working capital ratio of small firms is also higher. When the average values of fundamentals are compared in two groups, they are closer for the profitability shocks and the mandated investment rate.

The estimation results for firms with small versus large capital stocks are presented in Table 4. In almost each case, while the coefficient of the linear term of the fundamentals is larger for small firms, the coefficient of the squared term is lower.\(^6\) One possible reason for this result might be lower non-convex capital adjustment costs, such as fixed costs, for smaller firms. As a result, these firms can linearly follow investment opportunities. In each set, the adjusted \( R^2 \) is lower for small firms, indicating that the explanatory power of the fundamentals and financial variables for investment is lower. For this group, this gap is relatively larger in the results with Tobin's \( q \), where the adjusted \( R^2 \) is 0.047 for small firms, and 0.263 for large firms, given that financial variables are excluded.

Another interesting observation is that when we compare the relative magnitudes of the estimated coefficients, large firms' investment is more sensitive to changes in

\(^6\) As specified by one of the referees, if one interprets (i) profitability shocks as temporary phenomena (since it may include demand shocks as well, depending on how it is calculated); and (ii) the mandated investment as a gap between the firm's long-term goal and the current status, some interesting discussion could arise from the current findings. For example, if we take a possible temporary shock as the fundamental, firms' investment decision may be more sensitive to financial variables since shock effect could exist only for a limited period of time, thereby increasing the significance of current period's financial variables. On the contrary, if we consider the gap between the long-term capital goal and current level as the fundamental, probably present value of expected all future net worth would matter more for the investment decision, rather than the current period's financial variable.
financial variables and revenue indicators even though these variables are expected to be more important for smaller firms in the literature. The high sensitivity of investment to the cash flow ratio for financially unconstrained firms is also observed in the study by Kaplan and Zingales (1997). The least constrained and the most financially successful firms in their sample seem to depend primarily on their cash flow to finance their investment despite the availability of additional low cost funds. In their study, they use Tobin's q to control investment opportunities, and classify firms as financially constrained by undertaking an in-depth analysis of firms. Erikson and Whited (2000) also show that cash flow does not matter, even for financially constrained firms once measurement errors are corrected.

The exception for the result given in the first sentence of the paragraph is Tobin's q, for which the coefficients of financial variables are higher for smaller firms as presented in many empirical studies. In the capital market imperfections literature, smaller firms are identified as relatively more financially constrained since their investment is more sensitive to changes in internal funds. But this result is not observed when investment opportunities are controlled for by new fundamentals. In fact, the coefficient on $CF_K$ is negative but statistically insignificant for smaller firms when the mandated investment rate is the fundamental measure. There might be different reasons for why less financially constrained firms exhibit higher investment-internal funds sensitivity. As specified by Kaplan and Zingales (1997 and 2000), one possible reason could be excessive conservatism by managers, which may be caused by the way firms are organized or non-optimizing behavior of managers.

### 4.2.2 Number of Employees

The second criteria are the size of firms in terms of the number of employees. Small firms are defined as the ones with the average number of employees in the bottom half of the empirical distribution. As was the case in the first set of results, while Class 1 stands for the group of small firms, Class 2 is the group of large firms. Since firms with a low capital stock typically have few employees, the results obtained using this new criteria are similar to the first set of results. The average values of the variables, when firms are grouped according to the number of employees are reported in the third and fourth columns of Table 3. Again smaller firms grow faster, retain a higher fraction of their income, and pay fewer dividends as a proportion of their income. The average investment rate is a bit higher for small firms, where it is 14 percent for smaller firms on average, and 12 percent for large firms.

The estimation results for these two classes are presented in Table 5. As was the case in Table 4, the sensitivity of investment to the linear term of the fundamentals is higher for smaller firms; but the sensitivity of investment to the squared term is higher for larger firms. The adjusted $R^2$ value is higher for larger firms in each case. The magnitude of the estimated coefficients on financial variables is higher for larger firms except when

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As pointed out by one of the referees, the lower responsiveness of investment in smaller firms can be explained by the existence of high fixed costs of investment.
the fundamental measure is Tobin's $q$. This indicates that results are robust whether the sample is split by the size of capital stock or by the number of employees.

5. Conclusion

The question investigated in this paper is whether the empirical significance of revenue management in determining firm-level investment would be explained by measurement errors in fundamentals, especially in Tobin's $q$. In order to answer this question, it is investigated how the empirical relationship between the investment rate, revenue indicators, and financial variables change when investment opportunities are proxied by profitability shocks and the mandated investment rate, both of which would be good alternatives to Tobin's $q$. The methodology is the estimation of a reduced form investment equation in which different types of fundamentals and financial variables are included as explanatory variables.

The results show that revenue indicators and financial variables are still statistically significant determinants of firm-level investment even when investment opportunities are proxied by the profitability shocks and the mandated investment rate. But the interesting outcome is that the explanatory power of financial variables for investment drops significantly when the profitability shocks and the mandated investment rate are the fundamental variables. For the purpose of comparison, the same analyses are repeated using Tobin's $q$ instead of the recently-introduced fundamentals. The empirical results produced by Tobin's $q$ are different from the ones mentioned above, but exactly as expected in the financial market imperfections literature: financial variables are relatively more significant in explaining investment compared to fundamentals. These results point out that the statistical and economic significance of financial variables indeed would be caused by inadequacy of Tobin's $q$, or any other fundamental, in capturing investment opportunities.

The other interesting result for revenue management is that the link between investment, revenue indicators, financial variables, and fundamentals change when firms are categorized according to different a priori criteria available in the financial market imperfections literature, used in identifying financially constrained versus unconstrained firms. The sub-sample analyses show that when Tobin's $q$ is the fundamental variable, the response of investment to changes in financial variables is relatively higher for financially constrained firms as expected in the literature. On the other hand, the sensitivity of investment to revenue indicators and financial variables, such as the cash flow to capital ratio, is lower for expected-to-be financially constrained firms when the profitability shocks and the mandated investment rate are taken as fundamental determinants of investment. This result is in conflict with the predictions of the finance constraint literature. There might be two alternative implications of it. On the one hand, assuming that a priori criteria, such as the level of dividend payout, are sufficient to identify financially constrained firms, we may conclude that a higher cash flow-investment sensitivity cannot be a good indicator of financial problems since our results indicate that the sensitivity of investment to internal funds is lower for firms taking place in financially constrained groups. This is the issue argued by Kaplan and Zingales (1997)
such that the least constrained and the most financially successful firms in their sample seem to depend primarily on their cash flow to finance their investment despite the availability of additional low cost funds. On the other hand, assuming that a high investment-cash flow sensitivity is a sufficient indicator of financial problems, our results, in this case, imply that a priori criteria used in selecting firms with possible financial problems are not successful in identifying them since investment by firms expected to be financially constrained is relatively less sensitive to internal funds.

In terms of future studies related to this topic, the robustness of the results across different industries can be investigated. One possibility is that the analyses in this study may focus only on durable-goods industries, which are more homogenous compared to nondurables industries. Asymmetric responses of firms’ investment to positive versus negative financial shocks can be another interesting topic to investigate in future studies.
Appendix - Details on the Calculation of Fundamentals

A.1 Tobin's $q$

The numerator of average Tobin's $q$ is the sum of the market value of common stock, the liquidating value of preferred stock, the market value of long-term debt, and the book value of short-term debt. The denominator is the sum of replacement value of fixed capital and inventories. These variables are calculated as follows:

**Replacement value of inventories:** For firms using the first-in-first-out (FIFO) method, inventories are valued at current cost, thus the book value equals the replacement value for them. For firms using the last-in-first-out (LIFO) or any other method, inventories are valued at historic cost. While converting the book value to the replacement value, for the first year, the book value is taken equal to the replacement value. Following Salinger and Summers (1983) and Whited (1992), the following formulas are used for the following years:

$$
INV_t = INV_{t-1} \left( \frac{PPI_t}{PPI_{t-1}} \right) + INV_t^* - INV_{t-1}^* \quad \text{if} \quad INV_t^* \geq INV_{t-1}^*
$$

$$
INV_t = (INV_{t-1} + INV_t^* - INV_{t-1}^*) \left( \frac{PPI_t}{PPI_{t-1}} \right) \quad \text{if} \quad INV_t^* < INV_{t-1}^*
$$

where $INV_t$ is the replacement value of LIFO inventories at time $t$ and $INV_t^*$ is their reported book value.

**Market Value of Long-Term Debt:** The method suggested by Bernanke and Campbell (1988) and Whited (1992) is used on converting the book value of long-term debt to the replacement value. Since the COMPUSTAT database provides only limited information on maturities of debt, it is necessary to construct the maturity distribution of long-term debt from historical information on debt issues. Firstly, following Brainard, Shoven and Weiss (1980), it is assumed that all long-term debts mature in twenty years. For the first year, each individual firm’s maturity distribution is set equal to the aggregate taken from Historical Statistics of the United States, series X 499-509, p. 1005 for the years 1961-1970. I give equal weight to the maturity distribution for years 1971-80. Then, if $D_{jt}$ is debt due in $j$ years at time $t$, $LTD_t$ is the reported value of long-term debt at time $t$, and $DI_t$ is the amount of debt issued at time $t$, the maturity distribution is updated as follows:

$$
D_{20t} = DI_t = LTD_t - (LTD_{t-1} - D_{1,t-1}) \quad \text{if} \quad LTD_t - (LTD_{t-1} - D_{1,t-1}) \geq 0
$$

$$
D_{20t} = DI_t = 0 \quad \text{if} \quad LTD_t - (LTD_{t-1} - D_{1,t-1}) < 0
$$

and

$$
D_{jt} = D_{j+1,t-1}, \quad j = 1, \ldots, 19.
$$
If \( LT_{D_i} - (LT_{D_{r-1}} - D_{1,r-1}) < 0 \), debt due in one to nineteen years is scaled down by the factor:

\[
\frac{LT_{D_i}}{LT_{D_{r-1}} - D_{1,r-1}}.
\]

The actual values of debt due in one to five years are available in COMPUSTAT. These values are replaced by the calculated values and the rest of the maturity distribution is rescaled in order to be consistent with total amount of long-term debt:

\[
D^*_j = D^*_j, \quad j = 1, \ldots, 5;
\]

\[
D^a_j = D^*_j \left( 1 + \frac{\sum_{i=1}^{5} (D^*_j - D^*_j)}{\sum_{j=6}^{20} D^*_j} \right), \quad j = 6, \ldots, 20;
\]

where \( D^a_j \) is the adjusted value of debt due in \( j \) years and \( D^*_j \) is the reported value of debt due in \( j \) years for \( j \) equal to one to five.

The final modification adjusts the book value of total book value of debt to the reported interest expense consistent with that implied by assuming that the firm’s interest expense at time \( t \) is the Baa rate at time \( t \). The new value of total book value is scaled as follows:

\[
NLTD_i = LT_i \times \frac{IEX_t}{\sum_{j=1}^{20} Baa_t + j - 20 D^a_j},
\]

where \( NLTD_i \) is the scaled value of long-term debt at time \( t \), \( Baa_t \) is the interest rate on grade Baa bonds at time \( t \) and \( IEX_t \) is the book value of interest expense at time \( t \). Then the new maturity distribution is set proportional to the old distribution.

Market value of Equity: The value of common stock at the beginning of each year is estimated, following Salinger and Summers (1983), as the closing price of a share of stock for each company in year \( t-1 \) times the number of outstanding shares at \( t-1 \). The value of preferred stock is estimated by dividing preferred cash dividends by the Standard and Poor’s preferred stock yield (taken from CITIBAS database).

A.2 Frictionless Capital

The method to obtain the frictionless capital stock is taken from Caballero, Engel, and Haltiwanger (1995), and applied to the firm-level data. See Bayraktar (2002) for details. All frictions are assumed to be absent, including time-to-build assumption, and any adjustment costs. \( Y \) represents the value of output of an individual firm, where
imperfect competition is assumed, and fixed factors other than capital produce a
decreasing returns:

\[ Y = AK^{\alpha_k} L^{\alpha_L}, \quad \alpha_k + \alpha_L < 1, \]

where \( A, K, \) and \( L \) are profitability shocks, capital stock, and flexible factors, respectively. \( \alpha_k \) is the capital share of production and \( \alpha_L \) is the one for the flexible factor.

Optimizing over flexible factors yields a profit function:

\[ \Pi(A, K) \equiv \max_L Y - w_L L, \]

where \( w_L \) is the price of flexible factors. Given this equation, frictionless capital is defined as

\[ K^* = \arg \max_k \Pi(A, K) - cK, \]

where \( c \) is the cost of capital.

After some manipulations and taking the logarithm of the above expression, the frictionless capital level is expressed as

\[ k^* - k = \eta[y - k - c], \]

where \( \eta = (1 - \alpha_L)/(1 - \alpha_k - \alpha_L) \), and \( y \) is equal to the log of real output, which is defined as the sum of the real sale value of goods plus changes in the real value of finished goods inventories, and \( k \) is equal to the log of real capital. \( \eta \) is a decreasing function of the curvature of the profit function with respect to capital, which is approximately equal to:

\[ \eta \approx \frac{1}{1 - \alpha}, \]

where \( \alpha \) is the cost share of capital, which is estimated at the 4-digit industry level. Details on the calibration of parameters are given in Table A1. The cost of capital, \( c \), is defined as

\[ (r_t + \delta_t) \frac{p_i}{p_t} \rho_t, \]

where \( r_t \) is the real interest rate, which is equal to the average nominal Baa corporate bond rate minus the measure of expected inflation from the Livingston Survey of twelve-month inflation expectations. \( \delta_t \) is the depreciation rate taken from the 2-digit unofficial BLS data set. In this set, depreciation rates are given for three asset groups for each 2-digit industry. I used the wealth share of assets as a weight to calculate the average
depreciation rate in each 2-digit industry group. \( p_{it} \) is the new capital expenditures deflator and \( p_i \) is shipments price deflator taken from Gray and Bartelsman data set (at the 4-digit industry level). The tax parameter, \( \rho_t \), is taken from the BLS database such that:

\[
\rho_t = \frac{(1 - \tau_t, z_t - \kappa_t)}{1 - \tau_t},
\]

where \( \tau_t \) is the corporate income tax, \( z_t \) is the present value of $1 of tax depreciation allowances, and \( \kappa_t \) is the effective rate of investment tax credit. This equation is given for 93 assets for each two-digit industry level. In order to find the two-digit weighted average values, the wealth share of assets in each industry is used.

### A.3 Calculation of profitability shocks

This section explains the second way of calculating profitability shocks through the first order condition of maximizing a profit function with respect to labor. It is assumed that a firm maximizes the following profit function with respect to labor:

\[
\Pi(A, K) = \max_L R(\hat{A}, K, L) - Lw,
\]

where \( A \) is the profitability shock that contains both aggregate and idiosyncratic shocks, \( A \) is the shock to the revenue function, \( K \) is the capital stock, \( L \) is labor, and \( w \) represents the wage of labor. Assuming that the product market is imperfectly competitive, the revenue function is defined as

\[
R(\hat{A}, K, L) = \hat{A}py = \hat{A}y^\xi y = \hat{A}y^{1+\xi},
\]

where the constant returns to scale Cobb-Douglas production function is assumed:

\[
y = AK^{\alpha_L} L^{\alpha_K},
\]

where \( \alpha_L \) and \( \alpha_K \) are the production function coefficients on labor and capital. The demand curve is given as

\[
p = y^\xi,
\]

where \( \xi \) is the elasticity of the demand curve.

From the first order condition with respect to \( L \), the optimum value of \( L \) is:

\[
L^* = \left[ \frac{\hat{A}(1+\xi)\alpha_L}{W} \right]^{-\frac{1}{\alpha_L(1+\xi)}} K^{\frac{\alpha_K(1+\xi)}{1-\alpha_L(1+\xi)}}.
\]
After plugging this optimum labor back into the profit equation, it becomes:

$$\Pi(A, K) = (A_1 - A_2)K^\theta,$$

where \( \theta = \frac{(1 - \alpha_L)(1 + \xi)}{1 - \alpha_L(1 + \xi)} \), \( A_1 = \hat{A}\left[\frac{\hat{A}(1 + \xi)\alpha_L}{w}\right]^{\frac{\alpha_L(1 + \xi)}{1 - \alpha_L(1 + \xi)}}, \) \( A_2 = w\left[\frac{\hat{A}(1 + \xi)\alpha_L}{w}\right]^{\frac{1}{1 - \alpha_L(1 + \xi)}}, \) and

from \( L^* \) equation \( \hat{A} \) is defined as

$$\hat{A} = \frac{w}{(1 + \xi)\alpha_L}\left[\frac{L}{K^\theta}\right]^{1 - \alpha_L(1 + \xi)}.$$

Note that \((A_1 - A_2)\) is the profitability shock, \(A\), which is equal to

$$A = \hat{A}\left[\frac{1}{1 - \alpha_L(1 + \xi)}\right] w^{\frac{-\alpha_L(1 + \xi)}{1 - \alpha_L(1 + \xi)}} \left\{ \left[(1 + \xi)\alpha_L\right]^{\frac{\alpha_L(1 + \xi)}{1 - \alpha_L(1 + \xi)}} - \left[(1 + \xi)\alpha_L\right]^{\frac{1}{1 - \alpha_L(1 + \xi)}} \right\}.$$

In terms of calibration, \( \theta \) is estimated by regressing the log of real profit data on the log of real capital using firm-level panel data. Its value is estimated at 0.61. \( \alpha_L \) is estimated as 0.73 again using firm-level data. \( \alpha_L \) is estimated using cost shares. The cost share of labor is calculated as the ratio of wages times employment level to the sum of the rental price of capital times capital level and wages times employment level. The employment and capital data are from COMPUESTAT database. While the rental price of capital series is obtained from BLS database, the wage data is from Gray and Bartelsman’s 4-digit dataset. \( \xi \) is obtained from \( \theta = \frac{(1 - \alpha_L)(1 + \xi)}{1 - \alpha_L(1 + \xi)} \) equation. These coefficients imply a demand elasticity of -0.15 and a markup of about 18 percent. Details on the calibrated parameters are given in Table A2.
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Figure 1
Investment Rate Distribution, 1983-1996

Note: The data source is the COMPUSTAT firm-level database and author’s calculations. The data set, covering the period from 1983 to 1996, includes U.S. manufacturing firms with a SIC code between 2000-3999. The total number of firms is 463 and the total number of panel observations is 6450.
## Table 1

### Summary Statistics, 1983-1996

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<th>Mean</th>
<th>Standard deviation</th>
<th>Min</th>
<th>25th percentile</th>
<th>50th percentile</th>
<th>75th percentile</th>
<th>Max</th>
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<td>18.71</td>
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<td>48.95</td>
<td>0.00</td>
<td>0.49</td>
<td>1.93</td>
<td>7.70</td>
<td>876.80</td>
</tr>
<tr>
<td>Debt burden (flow)</td>
<td>0.04</td>
<td>0.08</td>
<td>0.00</td>
<td>0.01</td>
<td>0.03</td>
<td>0.06</td>
<td>4.50</td>
</tr>
<tr>
<td>Debt burden (stock)</td>
<td>197.21</td>
<td>6528.13</td>
<td>0.00</td>
<td>0.04</td>
<td>0.16</td>
<td>0.50</td>
<td>375146.26</td>
</tr>
<tr>
<td>Total Debt over PPE</td>
<td>0.39</td>
<td>0.65</td>
<td>0.00</td>
<td>0.12</td>
<td>0.28</td>
<td>0.49</td>
<td>27.20</td>
</tr>
<tr>
<td>Interest expenditure coverage rate</td>
<td>-0.03</td>
<td>12.98</td>
<td>-916.00</td>
<td>0.04</td>
<td>0.12</td>
<td>0.22</td>
<td>244.00</td>
</tr>
<tr>
<td>Dividends over PPE</td>
<td>0.04</td>
<td>0.18</td>
<td>0.00</td>
<td>0.00</td>
<td>0.02</td>
<td>0.05</td>
<td>4.71</td>
</tr>
<tr>
<td>Dividends payout ratio</td>
<td>0.30</td>
<td>4.11</td>
<td>-213.93</td>
<td>0.00</td>
<td>0.19</td>
<td>0.41</td>
<td>152.56</td>
</tr>
<tr>
<td>Growth rate of real (net) sales</td>
<td>0.15</td>
<td>4.24</td>
<td>-0.99</td>
<td>-0.02</td>
<td>0.05</td>
<td>0.15</td>
<td>338.00</td>
</tr>
<tr>
<td>Earnings retention rate</td>
<td>0.68</td>
<td>3.86</td>
<td>-151.56</td>
<td>0.59</td>
<td>0.80</td>
<td>1.00</td>
<td>214.93</td>
</tr>
<tr>
<td>Cash flow to PPE ratio</td>
<td>0.21</td>
<td>0.49</td>
<td>-21.10</td>
<td>0.10</td>
<td>0.18</td>
<td>0.28</td>
<td>8.48</td>
</tr>
<tr>
<td>Sales (net) to PPE ratio</td>
<td>2.86</td>
<td>2.80</td>
<td>0.00</td>
<td>1.54</td>
<td>2.24</td>
<td>3.33</td>
<td>59.70</td>
</tr>
<tr>
<td>Working capital to PPE ratio</td>
<td>0.86</td>
<td>1.89</td>
<td>-2.77</td>
<td>0.26</td>
<td>0.53</td>
<td>0.98</td>
<td>76.70</td>
</tr>
<tr>
<td>Cash and equivalence to PPE ratio</td>
<td>0.35</td>
<td>1.36</td>
<td>0.00</td>
<td>0.03</td>
<td>0.10</td>
<td>0.30</td>
<td>64.00</td>
</tr>
<tr>
<td>Tax rate</td>
<td>31.92</td>
<td>203.75</td>
<td>-7840.00</td>
<td>29.60</td>
<td>36.90</td>
<td>41.40</td>
<td>7340.00</td>
</tr>
<tr>
<td><strong>Fundamentals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profitability shocks</td>
<td>0.00</td>
<td>0.20</td>
<td>-0.69</td>
<td>-0.12</td>
<td>0.00</td>
<td>0.11</td>
<td>0.70</td>
</tr>
<tr>
<td>Profitability shocks (residuals)</td>
<td>0.01</td>
<td>0.28</td>
<td>-1.13</td>
<td>-0.13</td>
<td>0.01</td>
<td>0.15</td>
<td>0.94</td>
</tr>
<tr>
<td>Mandated inv. rate</td>
<td>0.02</td>
<td>0.29</td>
<td>-1.13</td>
<td>-0.14</td>
<td>0.02</td>
<td>0.16</td>
<td>1.14</td>
</tr>
<tr>
<td>Log of Tobin's q</td>
<td>0.25</td>
<td>0.50</td>
<td>-0.94</td>
<td>-0.06</td>
<td>0.19</td>
<td>0.50</td>
<td>2.48</td>
</tr>
</tbody>
</table>

Note: The data source is the COMPUSTAT firm-level database. The data set, covering the period from 1983 to 1996, includes U.S. manufacturing firms with a SIC code between 2000-3999. The total number of firms is 463 and the total number of panel observations is 6450.
Table 2
Full Sample: Investment, Fundamentals, Revenue Indicators, and Financial Variables

<table>
<thead>
<tr>
<th>Financial Variables</th>
<th>None (1)</th>
<th>CF_K (2)</th>
<th>Sales_K (3)</th>
<th>WorkingK_K (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profitability shocks (first-order)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ait</td>
<td>0.229</td>
<td>0.22</td>
<td>0.179</td>
<td>0.202</td>
</tr>
<tr>
<td></td>
<td>(22.380)</td>
<td>(21.745)</td>
<td>(16.880)</td>
<td>19.759</td>
</tr>
<tr>
<td>ait²</td>
<td>0.244</td>
<td>0.225</td>
<td>0.224</td>
<td>0.232</td>
</tr>
<tr>
<td></td>
<td>(6.626)</td>
<td>(6.211)</td>
<td>(6.202)</td>
<td>6.398</td>
</tr>
<tr>
<td>Financial variable</td>
<td>0.035</td>
<td>0.033</td>
<td>0.055</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.247)</td>
<td>(14.525)</td>
<td>(15.422)</td>
<td></td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.227</td>
<td>0.233</td>
<td>0.257</td>
<td>0.261</td>
</tr>
<tr>
<td>Profitability shocks (residuals)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rait</td>
<td>0.125</td>
<td>0.118</td>
<td>0.066</td>
<td>0.099</td>
</tr>
<tr>
<td></td>
<td>(16.103)</td>
<td>(14.325)</td>
<td>(7.855)</td>
<td>(12.567)</td>
</tr>
<tr>
<td>rait²</td>
<td>0.108</td>
<td>0.092</td>
<td>0.072</td>
<td>0.082</td>
</tr>
<tr>
<td></td>
<td>(6.168)</td>
<td>(5.357)</td>
<td>(4.214)</td>
<td>(4.728)</td>
</tr>
<tr>
<td>Financial variable</td>
<td>0.042</td>
<td>0.040</td>
<td>0.054</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.793)</td>
<td>(16.551)</td>
<td>(14.322)</td>
<td></td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.199</td>
<td>0.208</td>
<td>0.239</td>
<td>0.229</td>
</tr>
<tr>
<td>Mandated inv. rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kit</td>
<td>0.196</td>
<td>0.193</td>
<td>0.180</td>
<td>0.173</td>
</tr>
<tr>
<td></td>
<td>(26.963)</td>
<td>(25.456)</td>
<td>(19.529)</td>
<td>(22.204)</td>
</tr>
<tr>
<td>kit²</td>
<td>0.071</td>
<td>0.071</td>
<td>0.069</td>
<td>0.066</td>
</tr>
<tr>
<td></td>
<td>(4.954)</td>
<td>(4.987)</td>
<td>(4.752)</td>
<td>(4.562)</td>
</tr>
<tr>
<td>Financial variable</td>
<td>0.002</td>
<td>0.008</td>
<td>0.033</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.209)</td>
<td>(2.802)</td>
<td>(8.093)</td>
<td></td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.252</td>
<td>0.257</td>
<td>0.253</td>
<td>0.261</td>
</tr>
<tr>
<td>Tobin’s q</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>qit</td>
<td>0.197</td>
<td>0.162</td>
<td>0.100</td>
<td>0.131</td>
</tr>
<tr>
<td></td>
<td>(7.379)</td>
<td>(6.369)</td>
<td>(4.422)</td>
<td>(5.126)</td>
</tr>
<tr>
<td>qit²</td>
<td>0.043</td>
<td>0.031</td>
<td>0.031</td>
<td>0.033</td>
</tr>
<tr>
<td></td>
<td>(2.234)</td>
<td>(1.702)</td>
<td>(1.936)</td>
<td>(1.801)</td>
</tr>
<tr>
<td>Financial variable</td>
<td>0.478</td>
<td>0.166</td>
<td>0.208</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(20.837)</td>
<td>(44.058)</td>
<td>(26.169)</td>
<td></td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.056</td>
<td>0.134</td>
<td>0.325</td>
<td>0.173</td>
</tr>
</tbody>
</table>

Note: The estimation technique is OLS. Time and firm dummies are included. t-statistics are given in the parenthesis. The dependent variable is the investment rate. ait is the first-order profitability shocks, rait is the profitability shocks (residuals), kit is the mandated investment rate, and qit is Tobin's q. CF_K stands for the cash-flow-to-capital ratio, Sales_K stands for the net sales to capital ratio, WorkingK_K is the ratio of working capital to capital. The data source is the COMPUSTAT firm-level database. The data set, covering the period from 1983 to 1996, includes U.S. manufacturing firms with a SIC code between 2000-3999. The total number of firms is 463 and the total number of panel observations is 6450.
Table 3  
Average Values of Variables When Firms are Classified with Respect to Different Firm Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Size of capital stock</th>
<th>Number of employees</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firms with small capital stock</td>
<td>Firms with large capital stock</td>
</tr>
<tr>
<td>Plant, Property, and Equipment (PPE, in millions of 1992 dollars)</td>
<td>27.71</td>
<td>3034.49</td>
</tr>
<tr>
<td>PPE (gross book value, in millions of dollars)</td>
<td>33.05</td>
<td>3322.61</td>
</tr>
<tr>
<td>Investment rate</td>
<td>0.13</td>
<td>0.12</td>
</tr>
<tr>
<td>Employees (in thousands)</td>
<td>0.86</td>
<td>25.24</td>
</tr>
<tr>
<td>Growth rate of real (net) sales</td>
<td>0.21</td>
<td>0.07</td>
</tr>
<tr>
<td>Earnings retention rate</td>
<td>0.81</td>
<td>0.56</td>
</tr>
<tr>
<td>Total Debt over PPE</td>
<td>0.41</td>
<td>0.35</td>
</tr>
<tr>
<td>Dividends payout ratio</td>
<td>0.22</td>
<td>0.40</td>
</tr>
<tr>
<td>Dividends over PPE</td>
<td>0.05</td>
<td>0.04</td>
</tr>
<tr>
<td>Cash flow to PPE ratio</td>
<td>0.22</td>
<td>0.20</td>
</tr>
<tr>
<td>Sales (net) to PPE ratio</td>
<td>3.25</td>
<td>2.33</td>
</tr>
<tr>
<td>Working capital to PPE ratio</td>
<td>1.13</td>
<td>0.47</td>
</tr>
</tbody>
</table>

**Fundamentals**

- Profitability shocks (first-order) | 0.00 | 0.00 | 0.00 | 0.00 |
- Profitability shocks (residuals) | 0.01 | 0.00 | 0.01 | 0.00 |
- Mandated inv. rate | 0.02 | 0.01 | 0.01 | 0.02 |
- Log of Tobin's q | 0.37 | 0.13 | 0.37 | 0.14 |

Note: The data source is the COMPUSTAT firm-level database. The data set, covering the period from 1983 to 1996, includes U.S. manufacturing firms with a SIC code between 2000-3999. The total number of firms is 463 and the total number of panel observations is 6450. Small firms are defined as the ones with the average capital stock or employment level in the lower half of the empirical distribution.
Table 4
Small versus Large Firms: Investment, Fundamentals, Revenue Indicators, and Financial Variables (Firms are grouped by the size of their capital stock)

<table>
<thead>
<tr>
<th>Financial Variables</th>
<th>Class 1: small capital stock</th>
<th>Class 2: large capital stock</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class 1 (1)</td>
<td>Class 2 (2)</td>
</tr>
<tr>
<td>Profitability Shocks (first-order)</td>
<td>ait 0.260 0.155</td>
<td>0.241 0.148</td>
</tr>
<tr>
<td></td>
<td>ait² 0.198 0.263</td>
<td>0.167 0.271</td>
</tr>
<tr>
<td>Financial variable</td>
<td>0.064 0.138</td>
<td>0.022 0.058</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.221 0.256</td>
<td>0.233 0.272</td>
</tr>
<tr>
<td>Profitability Shocks (residuals)</td>
<td>rait 0.130 0.116</td>
<td>0.127 0.100</td>
</tr>
<tr>
<td></td>
<td>rait² 0.105 0.139</td>
<td>0.086 0.130</td>
</tr>
<tr>
<td>Financial variable</td>
<td>0.032 0.100</td>
<td>0.029 0.063</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.181 0.237</td>
<td>0.194 0.244</td>
</tr>
<tr>
<td>Mandated inv. Rate</td>
<td>kit 0.200 0.185</td>
<td>0.202 0.176</td>
</tr>
<tr>
<td></td>
<td>kit² 0.083 0.050</td>
<td>0.082 0.054</td>
</tr>
<tr>
<td>Financial variable</td>
<td>-0.017 0.070</td>
<td>0.002 0.029</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.223 0.313</td>
<td>0.229 0.316</td>
</tr>
<tr>
<td>Tobin’s q</td>
<td>qit 0.282 0.105</td>
<td>0.236 0.095</td>
</tr>
<tr>
<td></td>
<td>qit² 0.010 0.037</td>
<td>0.005 0.027</td>
</tr>
<tr>
<td>Financial variable</td>
<td>0.535 0.151</td>
<td>0.181 0.057</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.047 0.263</td>
<td>0.135 0.280</td>
</tr>
</tbody>
</table>

Note: The estimation technique is OLS. Time and firm dummies are included. t-statistics are given in the parenthesis. The dependent variable is the investment rate. ait is the first-order profitability shocks, rait is the profitability shocks (residuals), kit is the mandated investment rate, and qit is Tobin's q. CF_K stands for the cash-flow-to-capital ratio, Sales_K stands for the net sales to capital ratio, WorkingK_K is the ratio of working capital to capital. The data source is the COMPUSTAT firm-level database. The data set, covering the period from 1983 to 1996, includes U.S. manufacturing firms with a SIC code between 2000-3999. The total number of firms is 463 and the total number of panel observations is 6450. Class 1 (Class 2) firms are defined as the lower (higher) 50 percentile of the firms when they are sorted by their average capital stock size.
Table 5  
Small versus Large Firms: Investment, Fundamentals, Revenue Indicators, and Financial Variables (Firms are grouped by the number of employees)

<table>
<thead>
<tr>
<th>Financial Variables</th>
<th>Class 1: low number of employees</th>
<th>Class 2: high number of employees</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class 1 (1)</td>
<td>Class 2 (2)</td>
</tr>
<tr>
<td>Profitability Shocks (first-order)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ait</td>
<td>0.256</td>
<td>0.165</td>
</tr>
<tr>
<td>ait^2</td>
<td>0.177</td>
<td>0.304</td>
</tr>
<tr>
<td>Financial variable</td>
<td>0.054</td>
<td>0.210</td>
</tr>
<tr>
<td>Adj. R^2</td>
<td>0.224</td>
<td>0.246</td>
</tr>
<tr>
<td>Profitability Shocks (residuals)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rait</td>
<td>0.126</td>
<td>0.126</td>
</tr>
<tr>
<td>rait^2</td>
<td>0.104</td>
<td>0.148</td>
</tr>
<tr>
<td>Financial variable</td>
<td>0.019</td>
<td>0.175</td>
</tr>
<tr>
<td>Adj. R^2</td>
<td>0.186</td>
<td>0.225</td>
</tr>
<tr>
<td>Mandated inv. Rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>kit</td>
<td>0.199</td>
<td>0.187</td>
</tr>
<tr>
<td>kit^2</td>
<td>0.071</td>
<td>0.069</td>
</tr>
<tr>
<td>(3.452)</td>
<td>(3.458)</td>
<td>(3.463)</td>
</tr>
<tr>
<td>Financial variable</td>
<td>-0.021</td>
<td>0.111</td>
</tr>
<tr>
<td>Adj. R^2</td>
<td>0.228</td>
<td>0.305</td>
</tr>
<tr>
<td>Tobin’s q</td>
<td></td>
<td></td>
</tr>
<tr>
<td>qit</td>
<td>0.303</td>
<td>0.093</td>
</tr>
<tr>
<td>qit^2</td>
<td>0.001</td>
<td>0.046</td>
</tr>
<tr>
<td>(0.018)</td>
<td>(3.036)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>Financial variable</td>
<td>0.491</td>
<td>0.329</td>
</tr>
<tr>
<td>Adj. R^2</td>
<td>0.050</td>
<td>0.238</td>
</tr>
</tbody>
</table>

Note: The estimation technique is OLS. Time and firm dummies are included. t-statistics are given in the parenthesis. The dependent variable is the investment rate. ait is the first-order profitability shocks, rait is the profitability shocks (residuals), kit is the mandated investment rate, and qit is Tobin’s q. CF_K stands for the cash-flow-to-capital ratio, Sales_K stands for the net sales to capital ratio, WorkingK_K is the ratio of working capital to capital. The data source is the COMPSTAT firm-level database. The data set, covering the period from 1983 to 1996, includes U.S. manufacturing firms with a SIC code between 2000-3999. The total number of firms is 463 and the total number of panel observations is 6450. Class 1 (Class 2) firms are defined as the lower (higher) 50 percentile of the firms when they are sorted by their average capital stock size.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Description and data Source</th>
<th>Average value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\psi$</td>
<td>elasticity of capital with respect to its cost</td>
<td>2-digit industry level (panel regression of log of real profit to cost of capital for each industry)</td>
<td>-0.68</td>
</tr>
<tr>
<td>$\eta$</td>
<td>$\frac{1}{(1-\alpha)}$ where $\alpha$ is cost share of capital</td>
<td>$\alpha = \frac{\text{rental price of capital \times capital stock}}{\text{total cost of production}}$. Firm-level. Data source for rental price: BLS database Data source for total cost of production: COMPUSTAT</td>
<td>1.37</td>
</tr>
<tr>
<td>$c$</td>
<td>Cost of capital</td>
<td>$(r_t + \delta_t)(\pi_t / p_t)[T_t / (1-\tau)]$</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$r$: real interest rate $\delta$: depreciation rate (2-digit form BLS database) $(\pi_t / p_t)$: ratio of new capital deflator to shipment price index (4-digit Gary and Bartelsman data set) $[T_t / (1-\tau)]$: tax parameter (2-digit BLS database)</td>
<td></td>
</tr>
</tbody>
</table>
Table A2 - Appendix  
Calibration of the Parameters used in Calculation of Profitability Shocks 1/

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Description and data Source</th>
<th>Average value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_L$</td>
<td>Cost share of labor</td>
<td>Same for each firm. Ratio of wages times employment level to the sum of the rental price of capital times capital level and wages times employment level. Employment and capital data: COMPUSTAT. Rental price of capital: BLS database. Wage: Gray and Bartelsman 4-digit dataset.</td>
<td>0.73</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Profit function coefficient</td>
<td>Estimated coefficient by regressing profit function on capital Source: COMPUSTAT</td>
<td>0.61</td>
</tr>
<tr>
<td>$\xi$</td>
<td>Elasticity of demand</td>
<td>$\xi = [(\theta-1)(1-\alpha_L)]/ [\alpha_L(\theta-1)+1]$ Same for each firm</td>
<td>-0.15</td>
</tr>
</tbody>
</table>

1/ These shocks are obtained from the first order condition for profit maximization with respect to labor.