Management power, corporate performance, and over/underinvestment

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Abstract

We investigate whether managers over- or underinvest by generalizing a model of Dybvig and Warachka (2012) to allow variation in the ratio of output to capital stock, variation in the unit cost of goods sold, and the possibility of pure competition as s market structure. Through an iterative empirical procedure we estimate the industry-adjusted capital stock that minimizes average cost. More than 95 percent of firms underinvest relative to the optimal capital stock. Estimates of models for corporate performance on cost, controlling for scale, imply statistically significant U-shaped relations to deviations between actual and optimal capital, with the minimum occurring where the deviation is zero. Costs are also significantly higher where managers have greater power as measured by the E index of Bebchuk, Cohen, and Ferrell (2009). We find weak evidence that the squared deviation between actual and optimal capacity is larger with greater management power. Scaled revenue cannot be interpreted as a performance variable in our generalized model. A descriptive model shows a significantly positive nonlinear relation to the E index. As in Dybvig and Warachka (2012), Tobin's Q is not a proper measure of corporate performance. Estimation of a descriptive model shows that Q is significantly positively related to scaled revenue and significantly negatively associated with scaled cost.

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1. Introduction

Managers prefer to underinvest so they can enjoy “a quiet life,” according to Bertrand and Mullainathan (2003), citing Hicks (1935), that “the best of all monopoly profits is a quiet life.” Managers prefer to overinvest because they are megalomaniacal empire builders (Kumar and Rabinovitch 2012). Managers prefer to underinvest due to risk aversion and severely concentrated personal wealth, both financial and human capital (John, Litov, and Yeung 2008). Managers prefer to overinvest because management compensation is higher in larger firms (Edmunds, Gabaix, and Lardier 2009). All of the studies cited above, and numerous others, provide empirical evidence designed to test competing hypotheses about over/underinvestment. No clear consensus emerges from that empirical literature, which is reviewed below.

We generalize a novel structural modeling approach of Dybvig and Warachka (2012) in which managers underinvest. The researchers show that Tobin’s Q cannot be regarded as a meaningful measure of corporate performance, precisely because underinvestment has the effect of raising Q. They propose unambiguous measures of corporate performance on two dimensions, control of corporate cost and scale of output and capital stock. In their origination of Tobin’s Q, Brainard and Tobin (1968) and Tobin (1969), working in models with perfect competition, regard deviations between Q and 1.0 as short-run disequilibria. Long-run equilibrium is characterized by Q = 1.0. Otherwise managers leave money on the table, contrary to stockholders’ interests.

The model of Dybvig and Warachka (2012) makes two very restrictive assumptions. First, every firm possesses monopoly power. No firm is a competitive price-taker, but rather each selects a price-quantity combination from a downward sloping demand curve. Second, the production technology is a fixed proportion between output and capital stock. Where two scale decisions would naturally have confronted managers—a long-term choice of size of capital stock and a short-term choice about output or capacity utilization—only one scale decision exists under fixed proportions technology. For example, there is no ability to substitute labor for capital, which firms might do if they are unsure whether a recent change in demand is permanent or temporary.

In this paper we relax and generalize these restrictive assumptions to produce more natural sets of cost curves. Long run average cost (LRAC) is constant, as shown in Figure 1. There is an infinity of U-shaped short run average cost curves (SRAC) corresponding to different levels of capital stock, all tangent at their minima to LRAC. Figure 1 illustrates three scales of plant all capable of producing various output levels. Consider y_0, the level of output at which SRC_2 reaches its minimum, the tangency with LRAC. "Quiet life" and risk-averse managers might choose the smaller capacity level corresponding to $SRAC_1$, which produces y_0 at an average cost of $14.50. Megalomaniacal or compensation-driven managers might choose the larger capacity represented by $SRAC_3$, for which the average cost of producing y_0 is $12. With the optimal capital scale, represented by $SRAC_2$, average cost is $10.

Managers may prefer to over- or underinvest for any of the reasons mentioned in the opening paragraph. But do they have enough power to do so in contravention to shareholders' best interests? Recent empirical investigations employ several measures of both investment and of management power. Among those papers whose results are consistent with underinvestment, Dybvig and Warachka (2012) use output, which is proportional to capital, as an investment indicator and the (poor) governance (G) index of Gompers, Ishii, and Metrick (2003) as a proxy for management power. John, Litov, and Yeung (2008) measure investment by the amount of risk undertaken, their principal proxy being the industry-adjusted standard deviation of the ratio of earnings before interest, taxes, depreciation, and amortization (EBITDA) to assets. Two other proxies produce similar results. Management power is represented variously by the G index, the entrenchment (E) index of Bebchuk, Cohen, and Ferrell (2009), and the quality of investor protections from La Porta, Lopez-de-Slianes, Shleifer, and Vishny (1998). Bertrand and Mullainathan (2003) find that building of or acquisition of new plants is retarded in states which offer managers more power in the form of anti-takeover laws. Gompers, Ishii, and Metrick (2003) report that capital expenditures (CAPEX) scaled by assets or by sales and number of acquisitions relative to market value are inversely related to management power, represented by the G index. Finally, Bøhren, Ilan, and Priestly (2009) update and confirm the results of Gompers et al.

Recent empirical work consistent with the theory that more powerful managers overinvest includes Kumar and Rabinovitch (2012) and Giroud and Miller (2010). Management power proxies in Kumar and Rabinovitch (2012) comprise length of CEO tenure, an indicator variable for change in CEO, and percent of outside investors. Managers derive private benefits from greater investment and thus prefer to overinvest compared to the level of value-maximizing investment. To foster their ability to make future overinvestments, more powerful managers engage to a greater extent in financial hedging to minimize cash flow shortfalls. The sample consists entirely of firms in the oil and gas exploration and production industry. Giroud and Miller (2010) examine the relation among governance, industry competitiveness, and various managerial behaviors. Poor governance is measured by the G index. In industries with low competitiveness, but not in competitive industries, poorly governed firms make a greater number of value-destroying investments than better governed firms.

Dybvig and Warachka (2012) show that firms with fixed coefficient technologies and monopoly power are subject to an inverse relation between capital and Tobin's Q. Expanding output reduces the average revenue product of capital (revenue/capital) and profits/capital, because product price declines along a demand curve as scale expands. Larger output thus reduces Q, one form of which is (profits/capital)/discount rate. Quiet life managers prefer not to expand output as far as value-maximizing levels. The ancillary effect is to push Q above the level consistent with value maximization. What Dybvig and Warachka (2012) gain by assuming fixed coefficients technology between output and capital is a clean distinction between two unambiguously meaningful performance measures to replace the inadequacies of Q. One depends on the joint output/capital stock scale decision. The other is a measure of cost discipline relative to a theoretical minimum average cost level. Management discretion on cost discipline applies only to selected operating expenses: advertising; sales, general, and administrative; staff expenses; and rent. The unit cost of goods sold (COGS) is not affected by either cost indiscipline or by capacity and capacity utilization decisions. Unit COGS is a constant, a third very restrictive assumption.

It is more usually the case that the scale of the capital stock affects average cost, including both COGS and non-COGS operating expenses. Our model incorporates that possibility. Average cost is quadratic in the industry-adjusted deviation of a firm's capital stock (say, K) from the cost-minimizing capital stock (K*) for the firm's output level (y*). We can estimate K* empirically through an iterative procedure. Let a firm's relative capital stock be Krel, and set it equal to (K – K*). In quadratic average cost models, the coefficients of Krel and $Krel^2$ imply an industry-adjusted capital stock deviation at which average cost is minimized.[1] By making iterative additive adjustments to our estimate of K* from which Krel is calculated, we can determine its numerical value. K* is the estimated value of Krel from iteration i-1 that produces in iteration i Krel and K* values identical to those from iteration i-1. Once we have a converged estimate for K*, we can compare it to the frequency distribution of K, which implies the proportions of firms that over- and underinvest.

Because our model assumes that managers exercise discretion over the ratio of output to capital and the ratio of COGS to output (or the gross profit margin), our performance measures differ slightly from those derived by Dybvig and Warachka (2012): (1) the ratio of gross margin to capital and (2) the ratio of

[1] In Cost = $aKrel^2 + bKrel + c$, minimum cost occurs where Krel = $-b/(2a)$.

selected operating expenses to capital.[2] Our model gives rise to these performance measures: (1) total cost discipline; (2) COGS discipline; (3) non-COGS cost discipline; and (4) capital stock relative to the industry-adjusted optimal capital stock. For reasons we discuss below, our generalized framework cannot generate a definitive hypothesis about the output decision independently from the capacity decision, either in competitive or monopolistic markets. For purely descriptive purposes, and to provide a parallel to the work of Dybvig and Warachka (2012), we provide an empirical examination of the output decision. We also present empirical evidence relating Tobin's Q to our performance measures. But like Dybvig and Warachka, Brainard and Tobin (1968), and Tobin (1969), we contend that Q is not itself a meaningful performance measure.

Our empirical results support our main conjectures. We find that the performance variables total cost, total COGS, and total non-COGS expenses, controlling for size, are significantly related to the square of the deviation of a firm's capital stock (K) from the industry-adjusted cost-minimizing capital stock (K*). Costs are also significantly related to the entrenchment (E) index of Bebchuk et al. (2009). (Both cost and the capital stock are scaled for estimation purposes.) The squared discrepancy from optimal capital, $(K - K^*)^2$ is related to the E index at the 10 percent level. Comparing K* with the empirical distribution of K shows that more than 95 percent of firms underinvest.

In a descriptive model, the ratio of revenue to capital stock is significantly positively related to the E index. In further descriptive models, Tobin's Q is positively related to scaled revenue and negatively related to scaled total cost, both at better than the 1 percent level. The capital stock deviation from the cost-minimizing level is not significant in explaining Q.

We present out theoretical framework in Section 2. Section 3 identifies our data and discusses estimation methods. Section 4 presents out empirical results and addresses robustness. Finally, Section 5 provides a summary.

[2] In an earlier version of their paper, Dybvig and Warachka equated only the output and capital stock decisions. They noted that COGS was highly correlated with output but did not assume a constant ratio of the two. Their first performance measure in that model was revenue relative to capital, identical to our output measure.

2. Theoretical framework

We adopt the standard introductory economics textbook model of cost in the short and long run. See, for example Frank and Bernanke (2013), especially chapters 6 and 7. The capital stock (K) and perhaps some other factors of production are predetermined in the short run, giving rise to fixed cost. In addition, production is subject to diminishing marginal returns in the variable factors of production. Consequently short-run average cost (SRAC) is U-shaped in output (y), given K, as in Equation (1).

$$\mathrm{SRAC}(y|K) = c_0 + \theta(y - y^*)^2 \qquad (1)$$

Here y* is the output level at which SRAC reaches a minimum. The SRAC curves in Figure 1 are generated by equation (1). c_0 equals long-run average cost (LRAC).

In the long run, all factors of production are variable. Assuming free entry and exit, all suppliers can adopt the optimal scale of plant and achieve the minimum minimorum LRAC, c_0. We do not require constant returns to scale. A firm whose sales (y) are ten times larger than those of a competitor does not necessarily decide on a plant that is ten times larger. If there is a unique optimal plant scale, the large firm has ten times as many plants as the smaller firm, but both select optimally scaled plants in the long run.

2.1 Over/underinvestment and average cost

A firm's capital stock (K) can be adjusted in the long run, but it is fixed in the short run. Thus the firm does not make simultaneous decisions about K, Y, and variable factors of production, which we represent here as L for labor. Instead there is a temporal hierarchy of decision-making. In the short run K is already determined. Managers next decide on output (y), cost, represented here by SRAC, and, in imperfectly competitive markets, on their output price (P). We discuss this nexus of decisions below. For now, note that with K fixed and y already chosen, the decision about variable inputs (L) is relegated to third in the order. Let F(K, L) represent the production function. Setting this equal to y and noting that K and y are given, we can invert F to solve for L, as in Equation (2).

$$L = F^{-1}(y, K) \qquad (2)$$

Figure 1 depicts three cost curves for three scales of plant. Each curve shows how SRAC varies as y departs from y*, the cost-minimizing output level for each K. Over/underinvestment must be judged by the size of K, which is determined before y is selected. One candidate for optimal K is K**, the level of capital stock that produces SRAC equal to LRAC (c_0) when y is at its average or expected level y^e.

$$\mathrm{SRAC}(K|\ y^e) = c_0 + \Phi(K - K^{**})^2 \tag{3}$$

If y^e coincides with y_0 in Figure 1, then SRAC(K| y^e) plots on a vertical line above y_0. As indicated above, the values of SRAC(K| y^e) for plant scales 1-3 are respectively \$14.50, \$10 (minimum SRAC), and \$12. Charted in the (K, SRAC) plane, Equation (3) takes the shape depicted in Figure 2. Equations (1) and (3) are necessarily related. In Equation (1), SRAC equals minimum SRAC when y equals y*, which implies that K equals K*. That is, the actual capital stock chosen coincides with the optimal capital stock for y_0. Comparing over competitor firm-years,[3] the average value of y_0 is y^e, so K* and K** are equal. Let μ represent the common ratios y_0/K^* and y^e/K^{**}. Then $K^{**} = y^e/\mu = y_0/\mu$. There is no comparability between y in Equation (1) and K in Equation (3). They are both hypothetical values any one of which might prevail. But in both Equation (1) and Equation (3), the minimum of SRAC, equal to LRAC or c_0, must be attained when y = y* or K = K**. Thus neither y in Equation (1) nor K in Equation (3) can have a multiplicative coefficient inside the parentheses. Therefore $\theta = \Phi/\mu^2$.

2.2 Total cost, COGS, and non-COGS cost

In our generalized framework, we have no need to assume that unit COGS is a constant, the third of Dybvig and Warachka's (2012) restrictive assumptions. It is plausible that managers elect the degree of cost discipline for COGs as well as for non-COGS cost, making the issue amenable to empirical testing. We thus estimate three cost performance models, one for total cost, one for COGS, and another for operating expenses or non-COGS cost. We also investigated, but do not report here, the less comprehensive Dybvig-Warachka version of operating expenses and found little difference from including all non-COGS cost. Applying the more comprehensive definition here facilitates comparisons between models of total cost discipline and separate degrees of discipline for COGS and non-COGS cost.

Let TC represent total cost, the product of output (y) and SRAC. Define R_{cj} as the ratio of cost of type j to the capital stock (K), where j represents alternatively total cost (j = t), COGS (j = c), or other (non-

[3] All dollar variables are scaled for estimation purposes and compared only with firms in the same Fama-French industry.

COGS) cost (j = o). In the short-run when K and average or expected output y^e are predetermined, applying Equation (3) produces Equation (4).

$$R_{cj} = TC/K = ySRAC(K|y^e)_j/K = (y^e/K)[c_o + (K - K^{**})^2] \tag{4}$$

Here over/underinvestment affects total cost scaled by the capital stock, which seems natural. In contrast, in Dybvig and Warachka (2012), R_c is constant, the ratio of unit operating expenses (c) to the technological constant (k) that determines the amount of capital (K) necessary to produce a unit of output (y). The constant k is also the inverse of the average product of capital. Managers select c, with the degree of cost discipline measured by its divergence from c_o, the minimum LRAC. That is, $c \geq c_o$.

Let Krel represent the deviation of the actual capital stock chosen by management (K) from the optimal capital stock (K**) conditional on expected output (y^e). Negative Krel indicates underinvestment while positive Krel corresponds to overinvestment.

Krel, R_{ct}, R_{cc}, and R_{co} constitute performance variables, dependent variables in our empirical models below. The interests of stockholders are best served when Krel is zero and the R_{cj} are low. Management behavior affects cost ratios in two ways. First, as illustrated in Figures 1 and 2 and Equation (4), the over/underinvestment raises cost ratios above the feasible minimum when K equals K**. In addition, at any level of K, managers may impose laxer or stricter cost discipline. Examples include inventory management, wastage, use of employee time for non-firm activities, inadequate management information systems, and others. Quiet life and risk averse managers, for example, may prefer to avoid conflicts with employees, vendors, customers, and other stake holders by adopting a lax attitude to cost discipline. Managers interested in their own perquisites may divert company resources to their personal use, such as country club memberships, corporate jets, and drafting employees to work on managers' personal interests. Megalomaniacal managers, as another example, might prefer an overly elaborate corporate headquarters and an unnecessarily large headquarters staff reminiscent of a regal court.

2.3 Management power and cost performance

Whether managers can realize private preferences unaligned with shareholders' interests depends on the degree of power they possess. Good corporate governance can check management power and provide incentives for managers to opt for behaviors aligned with shareholders' interests. One widely used measure of the extent to which managers have eroded good governance is the entrenchment (E) index of

Bebchuk et al. (2009).[4] The six components of the E index are staggered elections for board membership, limits to bylaw amendments offered by shareholders, poison pills, golden parachutes, and supermajority requirements for mergers and charter amendments.

Higher E values denote greater management entrenchment, greater power, enhanced latitude for managers to act in their own interest, and more divergence of corporate performance variables from desirable ranges. We expect a negative relation between E and our performance measures, Krel, R_{ct}, R_{cc}, and R_{co}. Poorer governance and greater management power are associated with greater over/underinvestment and higher cost ratios.

2.4 Output, revenue, and capital

To foster comparisons between our models and those of Dybvig and Warachka (2012) we require an empirical investigation of revenue or gross margin scaled by the capital stock, say R_y and R_{gm} respectively. These output and gross margin ratios are related by $R_{gm} = R_y - R_{cc}$. In our model R_{cc} is U-shaped in the capital stock (K). In Dybvig and Warchka it is a constant due to the fixed coefficients technology and the constant value of unit COGS. Since we examine cost ratios separately, as detailed above, here we consider only the ratio of output scaled by capital.

In thinking about the ratio of revenue to capital, we must analyze four cases corresponding to each of two bifurcations. First, does a firm operate in a perfectly competitive market or does it have some monopoly power? Second, does it operate on or interior to the efficient frontier characterized by the production technology? Said another way, given fixed and variable inputs, K and L, and the production function F(K, L), do we have $y = F(K, L)$ or $y < F(K, L)$?

Consider first the case of perfect competition. P is constant, so R_y varies only with y, given management's choice of K. A firm that operates interior to the efficient frontier produces less y than an efficient firm deploying identical levels of K and L. Poor technological performance is associated with lower R_y. Comparing two firms with the same output level shows that the technologically inefficient firm has higher cost ratios, R_{ct}, R_{cc}, and/or R_{co}, which we have already seen to be poor performance. Besides technological inefficiency, other possible sources of high cost ratios are compensating labor at above-market rates (Giroud and Mueller 2011) and unaggressive price-bargaining with vendors.

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[4] The discussion of data sources in Section 3 explains our preference for the E index over the Gompers, Ishii, and Metrick (2003) G index.

In a market characterized by some degree of monopoly power, a firm's selling price declines as output rises; the demand curve between P and y slopes downward. Revenue (Py) may rise or fall depending on whether the elasticity of demand exceeds or falls short of 1.0. A profit-maximizing firm chooses a price high enough to operate in the elastic region of the demand curve. Suppose on the contrary that a firm chooses a (y, P) pair where demand is inelastic. Then by raising P, revenue rises even though y declines. Costs decline with output, a second boost to profits. Assume then that the firm produces where demand is elastic. A technologically inefficient producer generates less output and lower revenue than an efficient firm using identical input levels. Just as in competitive markets, low R_y is an indicator of poor performance.

The preceding discussion compares R_y between firms that choose different output levels, given commitments of K and L. That is, the discussion so far examines only performance implications of the numerator of R_y. The denominator of R_y the scaling factor, is K. Clearly R_y declines in K, given revenue. A firm that underinvests, one that chooses $K < K^{**}$, the cost-minimizing capital stock, inflates R_y. Poor investment performance in the form of underinvestment is associated with higher R_y. Our empirical work indicates that the great majority of firms underinvest. For most firms then, R_y is an ambiguous performance indicator because managerial decisions in contravention to shareholder interests may either raise or lower R_y.

Gross margin scaled by the capital stock, R_{gm}, declines in both capital and output in Dybvig and Warachka (2012). Recall that K and y are linked by a fixed coefficient of proportionality in their model. Therefore $R_{gm} = P/k - G_0/k$, where k is the technological constant (K/y) and G_0 is constant unit COGS. With a normal demand curve, P and thus R_{gm} decline unambiguously in scale. But is R_{gm} an unambiguous performance measure as Dybvig and Warachka (2012) state? The answer is affirmative if all managements underinvest. But if some managers expand scale beyond the value-maximizing level, then further scale expansions and declines in R_{gm} are contrary to shareholders' interests and R_{gm} is no longer an unambiguous performance variable. Our empirical work suggests that an overwhelming proportion of managements underinvests, but that a small percentage overinvests, as determined by our direct estimate of the size of the optimal industry-adjusted capital stock.

2.5 Ambiguity of Tobin's Q as a performance measure

From the beginning (Brainard and Tobin 1968, Tobin 1969), Tobin's Q is equivalently the ratio of the profit rate on capital, (revenue – COGS – other costs)/K, to the required return on equity, say r, or the market value of capital, (revenue – COGS – other costs)/r, relative to replacement cost, K, treating a firm's economic profits as a perpetuity.[5] Both of these ratios simplify in our model to Equation (5).

$$Q = [R_y - R_{cc} - R_{co}]/r = [R_y - R_{ct}]/r \tag{5}$$

As discussed above, the cost ratios are unambiguous performance measures for all firms. Achieving the lower bound coincides with shareholder interests. Thus superior corporate performance on costs tends to raise Q. But poor manager performance may either elevate or depress R_y, as demonstrated in section 2.4, leaving the effect on Q ambiguous. Below we estimate a model for Q for descriptive purposes only.

2.6 Summary of testable hypotheses and descriptive investigations

The theoretical framework presented in this section generates testable hypotheses about cost ratios and the size of the capital stock. To foster comparability with other studies, particularly Dybvig and Warachka (2012), we also investigate descriptive models of revenue and Tobin's Q. Appendix A compiles variable definitions and Section 3 provides greater detail on empirical implementation. It is convenient to preview here two aspects of the empirical proxies for the capital stock. First, for robustness we employ three alternatives to measure the capital stock (K). Call them K_1, K_2, and K_3. K_1 is total assets excluding cash and equivalents; K_2 is total assets; and K_3 is long-term assets. This triplicity then gives us three sets of each cost ratio, for example R_{ct1}, R_{ct2}, and R_{ct3} for the ratio of total costs to K in Equation 4. The same applies to R_{cci}, R_{coi}., and R_{yi}.

For econometric purposes it is necessary to scale Krel, the divergence of K from the industry-specific cost-minimizing K**. The cost and revenue ratios are naturally scaled, as is Q. We use L, the number of employees, for a scaling factor for Krel. Define KiLrel for capital stock proxy i as in Equation (6).

$$KiLrel = K_i/L - (K_i^{**}/L) = (K_i - K_i^{**})/L \tag{6}$$

[5] The equivalence also holds for constant-percentage-growth perpetuities.

Hypothesis 1: Ratios of various measures of cost to the capital stock are U-shaped in the divergence of the capital stock from the industry-specific optimal capital stock.

Hypothesis 2: Ratios of various measures of cost to the capital stock are lower with better corporate governance.

These hypotheses give rise to nine models, three capital stock proxies applied to each of three cost measures, total cost, COGS, and non-COGS cost. The typical regression equation has R_{cji} as the dependent variable, where j runs over total, COGS, and non-COGS cost and i runs over capital stock proxies. Explanatory variables are KiLrel, $KiLrel^2$, the entrenchment (E) index, Fama-French industry dummies, and year dummies. Variable coefficients consistent with theory are, respectively, negative, positive, and positive for the capacity variables and E. In a converged solution for K_i**, the coefficient of the linear term KiLrel vanishes.

Hypothesis 3: The capital stock is closer to the industry-specific optimal capital stock with better corporate governance.

We estimate three regression models, one for each K proxy. The dependent variable is $KiLrel^2$ and the explanatory variables are E, industry dummies, and year dummies. Theory implies that the coefficient of E is positive.

Descriptive model for the ratio of revenue to the capital stock

In our model y and K are not linked by a fixed coefficient. Further, unit COGS is not a constant. Thus K, y, and unit COGS are all subject to separate management decisions. As demonstrated in Section 2.4, capacity, cost, and output chocies contrary to shareholder interests may either suppress or inflate R_y or R_{gm}. The denominator of R_y is a capital stock measure; thus there are three dependent variables and models for R_{yi}. The E index and industry and year controls are explanatory variables. The regression is descriptive only. A positive E coefficient suggests that the over/underinvestment decision dominates R_{yi}. A negative coefficient is consistent with producing inside the efficient frontier ($y < F(K, L)$ and/or above-market compensation or overpayment of vendors.

Descriptive model for Tobin's Q

Equation (5) relates Q to revenue and cost scaled by capital. Cost may be represented as total cost or as the components COGS and non-COGS cost. We estimate both aggregated cost and disaggregated models. Because we have three capital proxies, we estimate three aggregated cost models and three disaggregated models. Q is the dependent variable in all cases. Given the ambiguity in judging management performance from R_{yi}, explanatory variables include both a linear and a squared term, thereby allowing for nonlinearity and perhaps even nonmonotonicity. For symmetry we include a quadratic form in R_{cji}. Theory suggests Q declines monotonically in R_{cji}, but the quadratic form allows for a nonlinear relation. The descriptive models also investigate whether there is a relation between Q and over/underinvestment by including $KiLrel^2$ as an explanatory variable.

Thus there are three aggregated cost models with Q as the dependent variable and explanatory variables R_{yi}, R_{yi}^2, R_{cti}, R_{cti}^2, $KiLrel^2$, and industry and year controls. Theory suggests that the quadratic form in R_{cti} should imply a negative relation to Q over the observed range of data. That occurs if both coefficients are negative, but could also occur with one positive coefficient if the implied maximum or minimum lies outside the range of observed Q and costs. Theory makes no prediction about the signs of R_{yi}, R_{yi}^2, and $KiLrel^2$. We estimate them for descriptive purposes.

Three analogous disaggregated cost models regress Q on R_{yi}, R_{yi}^2, R_{cci}, R_{cci}^2, R_{coi}, R_{coi}^2, $KiLrel^2$, and industry and year dummies. Theory suggests coefficients on the quadratic forms in COGS and non-COGS to produce negative relations in the range of observed Q and costs, but has no implications for the signs of the remaining variables.

3. Data and estimation method

[THIS SECTION IS ROUGH AND NEEDS WORK]

We start with the firms covered in RiskMetrics IRRC database from 1990 to 2006. During this time, IRRC database collected several proxies of anti-takeover provisions in 1990, 1993, 1995, 1998, 2000, 2002, 2004 and 2006 for approximately up to 2000 firms. Following the literature we replace IRRC provisions for missing years using those from the nearest past year, e.g. using data from 1995 for years 1996 and 1997, and from 2006 for year 2007. In 2007 RiskMetrics changed methodology for collecting these provisions such that data for limited number of provisions became available in an annual basis. We add data available provisions to our dataset for the firms covered in years 2008, 2009, 2010 and 2011 and compute Bebchuck entrenchment index (EINDEX) as our proxy of management power. This index includes six anti-takeover provisions, namely, classified board, golden parachutes, supermajority requirement, poison pills, ability to amend bylaws and ability to amend charter. Our choice of Bebchuck et al. (2009) EINDEX, instead of Gompers et al. (2003) GINDEX lies on two key facts i) literature suggests that EINDEX includes provisions that better proxy the managerial entrenchment (managerial power) and ii) after 2007 RiskMetrics does not collect data on some provisions that are required to construct GINDEX. In total, we are able to estimate EINDEX from 1990 to 2011 for 36,857 firm-years.

We merge this dataset with Compustat database and S&P Domestic Long Term Issuer Credit Ratings and construct several proxies of our dependent and control variables using data items available in Compustat. These proxies are firms Tobin's Q (Q), non-cash assets (K1), total assets (K2), long term assets (K3), number of employees (L), total cost (Ctotal), cost of goods sold (Ccogs), other costs (Cother), revenue as percentage Ki ($Ry_{1\text{-}3}$), Ctotal as percentage of Ki ($RCT_{1\text{-}3}$), Ccogs as percentage of Ki($RCC_{1\text{-}3}$), Cother as percentage of Ki ($RCO_{1\text{-}3}$), and industry adjusted 'Ki as percentage of number of employees' ($KiLrel_{1\text{-}3}$) as defined in Appendix A.1. We Winsorize all regression variables constructed using Compustat data items at 1st and 99th percentile to account for potential extreme values.

Finally, we obtain 7,858 firm-years of final sample, which requires that an observation i) must not have current or historical SIC code between 6000 to 6999 or greater than 9000, ii) must have non-missing values for Q and cost of goods sold, iii) be in one of the 48 Fama-French industries that are not excluded due to requirement (i) above, and iv) must have S&P Domestic Long Term Issuer Credit Ratings of BBB or higher consistent with Dybvig and Warachka (2012).

Table 1 provides mean values for key variables by Fama-French industries and Table 2 provides descriptive statistics of regression variables. By construction our sample includes relatively large firms, with median firm featuring slightly below 5 billion dollars in assets and over 16 thousand employees. This was expected as IRRC database mostly includes S&P 1500 firms, exception being some additional large cap firms. Table 3 reports pairwise correlation coefficients. Apart from those of the proxies of the related constructs, within proxies of costs or proxies of over/underinvestment, correlation coefficients are not generally too high.

[NEED DISCUSSION OF ECONOMETRICS; YEAR AND INDUSTRY DUMMIES; ITERATIVE PROCEDURE TO ESTIMATE Ki**)

4. Empirical results

In this section we discuss empirical tests of the hypotheses and descriptive relations formulated in Section 2.6.

4.1 Tests about cost discipline, over/underinvestment, and management power

Table 4 presents estimates of models explaining cost discipline, measured alternatively as total cost, COGS, or non-COGS cost, in each case scaled by one of three measures of the capital stock, non-cash assets, total assets, or long-term assets. With three proxies each for cost and capital, we estimate nine models in all. With rare exceptions, coefficient signs and significance levels are robust to which capital stock proxy enters the model. Similarly, the models for total cost and COGS discipline produce comparable signs and significance levels and are consistent with Hypotheses 1 and 2. Results for non-COGS cost are mixed.

The dependent variable for each model in Table 4 is the ratio (R_{cji}, j = t, c, o) of a cost measure to a capital stock proxy (K_i, I = 1 (noncash assets), 2 (total assets), 3 (long-term assets)). The dependent variable appears at the top of each column, just below the model number.

Linear and squared terms in the divergence of the capital stock (K_i) from the industry-adjusted capital stock (K_i**) comprise the first two explanatory variables. It is necessary to scale the over/underinvestment divergence for econometric purposes. Neither K_i nor revenues (y) are suitable. The size of a firm's labor force (L) is the best choice. Thus the first two explanatory variables are a linear term and a squared term in KiLrel, the ratio of the divergence between K_i and K_i** to L (see Equation 6). The quadratic form in KiLrel tests Hypothesis 1, that costs are U-shaped in K_i with a minimum at K_i**, which is also KiLrel = 0. Results in Table 4 represent a converged solution determined iteratively as explained in Section 3. The capital level that minimizes the total cost ratio (K_i**) is not necessarily the same as the level that would minimize COGS or non-COGS costs. Coefficient estimates in Table 4 correspond to the minimization of total cost scaled by capital (R_{ct}). Theory predicts a positive coefficient on the square term and a negative or negligible coefficient on the linear term. The linear term coefficient vanishes when K_i and K_i** coincide.

The models in Table 4 also provide a test of Hypothesis 2, that cost ratios are lower in firms with better governance, stronger checks on management power. Our explanatory variable is the E index, higher values of which indicate greater opportunities for management behavior to diverge from the interests of shareholders. The models in Table 4 also control for industry and year effects. The industry control is important because of the disparate cost structures and natural capital intensities across industries. Median K/L in Table 2 is $299,080 per employee, with a range in Table 1 from $49,870 for restaurants to $1,806,790 in the oil industry.

Eight of the nine models in Table 4 are consistent with Hypothesis 1, that cost ratios are U-shaped in the size of the capital stock. The coefficients $KiLrel^2$ (denoted KiLrel2 in Table 4) are all positive and statistically significant with t statistics ranging from 2.0 to 7.7, with the exception of model 7 for non-COGS costs with non-cash assets as the capital stock proxy. The KiLrel variables, the difference between actual scaled capital stock and cost-minimizing capital stock are defined and estimated to minimize total costs (Models 1-3), not COGS or non-COGS costs. The cost-minimizing value of KiLrel can be estimated from the coefficients of the linear and square terms in each model. For the total cost models (1-3), cost is minimized when Kilrel equals zero. Note that the coefficients of the linear terms in models (1-3) are essentially zero; the linear terms vanish. In such a quadratic form, the minimum occurs when the argument is zero if, as here, the coefficient of the squared term is positive. Since Kilrel = KiL – KiL** and we know the distribution of KiL from Table 2, we can infer that the average cost-minimizing capital labor ratios are respectively $12,901,000, $13,315,000, and $10,413,000 for non-cash assets, total assets, and long-term assets. All of these KiL** lie above the 95^{th} percentile, meaning the more than 95 percent of firms underinvest.

For the COGS Models 4-6, cost-minimizing KiLrel values are not zero, but are lower by $364,000 to $989,000. Thus for COGS, as with total cost, 95 percent of firms underinvest. In contrast, non-COGS costs do not reach a minimum in KiL within the range of observed values. The non-COGS cost ratio declines in KiL with a slope that becomes less negative. This is suggestive of a true overhead cost component of non-COGS costs subject to economies of scale.

Corporate governance that permits greater management power, as indicated by a higher E index, produces significantly poorer cost discipline for total cost and GOGS, consistent with Hypothesis 2. E coefficients are positive and significant at better than the 0.01 level in all of Models 1-2 and 4-6. The coefficient is Model 3 is positive but not significant. E coefficients are significant as well for all non-COGS cost models (7-9), but the signs are negative, contrary to theory.

In summary, results of empirical tests are consistent with Hypotheses 1 and 2 for models of total cost and COGS ratios. Both types of cost are U-shaped in choice of capacity and better governance is associated with greater cost discipline. All twelve critical coefficients exhibit the hypothesized sign and eleven of them are statistically significant. Non-COGS cost has a different structure from total cost and COGS. It declines and its slope flattens for the observed range of capital levels. Unexpectedly, stricter cost discipline is associated with poorer governance.

The explanatory power of the models is quite high, with adjusted R^2s of about 0.5. For comparison purposes, Dybvig and Warachka (2012) report an adjusted R^2 equal to 0.0544.

4.2 Tests about over/underinvestment and management power

Results of tests of Hypothesis 3, that deviations between the actual and cost-minimizing capital stock are smaller in firms with better governance appear in Table 5. The dependent variable is the square of KiLrel, the difference between a firm's capacity and industry-adjusted cost-minimizing capacity. There are three models, one for non-cash capital, one for total capital, and one for long-term capital. The E index is the main explanatory variable. Controls consist of year and industry dummies.

In each model the coefficient of E takes the conjectured positive sign. Only in Model 2 for total assets, however, is the coefficient significantly nonzero ($p = 0.09$). The adjusted R^2 for Model 2 is 0.054.

4.3 Descriptive models about revenue and management power

Dybvig and Warachka (2012) estimate a model for gross margin scaled by the capital stock, R_{gm}, which equals (Py – COGS)/K. In their model R_{gm} is an unambiguous performance measure for management scale decisions. Our model allows substitutability between fixed and variable factors of production and, therefore, variability in the ratio of output to capital. In addition, we do not assume constant unit COGS but rather test a model for management's COGS discipline. Thus R_{gm} cannot be a performance measure in a generalized model and, in particular, it cannot be a measure of over/underinvestment. A restricted model with a constant ratio y/K, constant unit COGS, and every firm possessing some monopoly power, predicts that superior management is associated with lower R_{gm}. Underinvestment corresponds to lower y and thus, along a downward sloping demand curve, higher P, higher Py/K, and higher R_{gm}.

We treat the COGS cost discipline part of R_{gm} separately in Sections 2.1, 2.2, and 4.1 above. For comparability on the revenue portion, we estimate a descriptive model explaining R_y, defined as Py/K.[6] Table 5 presents results of our empirical results on scaled revenues and management power. R_y exists in three versions corresponding to three capital stock proxies. Management power is the principal explanatory variable, represented by the E index of management protections against shareholder activism. The models also include controls for industry and year effects. Models 1 (K = noncash assets) and 2 (K = total assets) exhibit a significantly positive relation between management power and a higher ratio of revenue to capital. A greater number of management protections is associated with higher revenue relative to capital or, equivalently, utilization of a lower capital stock to generate a given amount of revenue. In Model 3 the E coefficient is positive but not significant. Adjusted R^2s are about 0.51.

4.3 Descriptive models about Tobin's Q, cost performance, over/underinvestment, and revenue

Tobin's Q is an identity in R_y, R_{ct}, and the required rate of return (r) for an individual firm, as indicated in Equation 5. With cost disaggregated between COGS and non-COGS cost, Q is an identity in R_y, R_{cc}, R_{co}, and r. Since R_y is not a proper performance variable, neither is Q.

In a panel of firm-years, it is interesting to examine whether and how Q varies with scaled revenue, costs, and deviation of capital stock from industry-adjusted cost-minimizing capital stock. As discussed in Section 2.6, the relation among Q and these variables may be nonlinear or even nonmonotonic. To allow for and capture potential nonlinearities, we estimate quadratic forms in R_y and either R_{ct} or R_{cc} and R_{co}. Results appear in Tables 7 and 8. In each case Tobin's Q is the dependent variable. Explanatory variables in Table 7 are linear and squared terms in both R_y and R_{ct}, KiLrel squared, and industry and year dummies. In Table 8 quadratic forms in both R_{cc} and R_{co} replace the terms in R_{ct}.

For the empirically observed ranges of R_y and R_{cj} in Table 2 (0.0 to 4.5),[7] Tobin's Q rises in scaled revenue in all three models in Table 7. In Models 1 and 2 the slope increases throughout the range, though the coefficient of the squared term is not statistically significant in Model 1. All other R_y and R_y^2 coefficients are significant at p levels of 0.012 or better. The relation in Model 3 also exhibits a positive slope, but the slope decreases at higher levels of R_y. Dybvig and Warachka (2012) report a significantly

[6] An earlier version of Dybvig and Warachka estimated a model of R_y. See footnote 2 above.
[7] A small number of firm exhibit ratios above 15 for capital stock proxy K_3, long-term assets, indicating an asset mix that is almost entirely short-term.

positive linear relation between Q and their scale performance measure, the ratio of gross margin to capital.

The coefficients of all cost variables, linear and squared, are significant at a p value of 0.017 or better, with the exception of the squared term in Model 1. The estimates in Models 1 and 2 are negative, implying a declining relation and a slope that becomes more negative throughout the observed range of Q, like the right-hand side of an inverted U. In Model 3 the relation between Q and costs is negative with a flattening slope (left-hand side of a U). Thus for all three models, Tobin's Q declines in scaled total cost, a proper measure of management performance on cost discipline. Dybvig and Warachka report a significantly negative linear relation. Their adjusted R^2 is 0.34 compared to ours of about 0.60.

Larger squared deviations between capacity and optimal capacity (KiLrel2) are associated with lower values of Q in all three models, but none of the coefficients is significantly non-zero. Perhaps the effects of over/underinvestment are captured in their effects on cost ratios relative to the minimum achievable cost ratio.

The models in Table 8 disaggregate total cost into COGS and non-COGS cost. In all other respects they are identical to the models in Table 7. The estimates are for quadratic forms in R_y, R_{cc}, and R_{co}, with controls for industry and year. In no case in Table 8 do the coefficients imply a minimum or maximum for Q within the empirically observed ranges of R_y and R_{cj} (0.0 to 4.5). Thus all the relations to Q are monotone for the sample data. Sixteen of the eighteen coefficients of these quadratics forms are significant with p values of 0.012 or better. In all models in Table 8, Q rises in scaled revenue and declines in both cost variables, the same sign relations observed in Table 7. The pattern of changes in slopes differs, however, between Table 7 and Table 8. Here Q rises in R_y but with a flattening slope in all three models. In Table 7, the slopes become steeper for Models 1 and 2. In Table 8 Q declines in R_{cc} and the slope becomes flatter in all three models. The signs of the second derivatives differ between Table 7 (for R_{ct}) and Table 8 for (R_{cc}) in Models 1 and 2, but agree for Model 3. The coefficients of R_{co} in Table 8 imply that Q falls in all three models, with a flattening slope in Model 3 and a steepening slope in the first two models, for which the coefficient of the squared term are not significant. Q declines in R_{co} in all three models, the slope becoming steeper in Models 1 and 2 and flatter in Model 3.

In the disaggregated cost models of Table 8, larger squared deviations of actual capacity from cost-minimizing capacity (KiLrel2) are associated with higher values of Tobin's Q, in contrast to the aggregated cost models in Table 7, but none of the coefficients are statistically significant. The adjusted R^2s of the disaggregated models is slightly lower than for the aggregated model, about 0.58 versus 0.60.

In summary, we have robust significant results that higher Tobin's Q is associated with higher revenue relative to capital—or lower capital to produce a given amount of revenue—and lower cost relative to capital. For most combinations of cost and capital measures the scaled revenue and cost relations to Q are nonlinear.

5. Conclusions

We investigate whether managers over- or underinvest by generalizing a model of Dybvig and Warachka (2012) to allow variation in the ratio of output to capital stock, variation in the unit cost of goods sold, and the possibility of pure competition as s market structure. Through an iterative empirical procedure we estimate the industry-adjusted capital stock that minimizes average cost. More than 95 percent of firms underinvest relative to the optimal capital stock. Estimates of models for corporate performance on cost, controlling for scale, imply statistically significant U-shaped relations to deviations between actual and optimal capital, with the minimum occurring where the deviation is zero. Costs are also significantly higher where managers have greater power as measured by the E index of Bebchuk, Cohen, and Ferrell (2009). We find weak evidence that the squared deviation between actual and optimal capacity is larger with greater management power. Scaled revenue cannot be interpreted as a performance variable in our generalized model. A descriptive model shows a significantly positive nonlinear relation to the E index. As in Dybvig and Warachka (2012), Tobin's Q is not a proper measure of corporate performance. Estimation of a descriptive model shows that Q is significantly positively related to scaled revenue and significantly negatively associated with scaled cost.

Appendix A.1
Variable Definitions

Variable	Definition	Source
K_1	Total Assets (AT) *less* cash and equivalents (CHE)	Compustat/ Authors' Estimation
K_2	Total Assets (AT)	Compustat
K_3	Long Term Assets estimated as total assets (AT) *less* total current assets (ACT)	Compustat/ Authors' Estimation
L	Number of employees (EMP)	Compustat
Revenue	Revenue (REVT)	Compustat
Ctotal	Total cost estimated as total revenue (REVT) *less* Earnings Before Interest and Taxes (EBIT)	Compustat
Ccogs	Cost of goods sold (COGS)	Compustat
Cother	Ctotal *less* Ccogs	Authors' Estimation
Ry_i (1, 2, 3 depending on K)	Revenue *divided by* K_i (i=1, 2, 3)	Authors' Estimation
Rct_i (1, 2, 3 depending on K)	Ctotal *divided by* Ki (i=1, 2, 3)	Authors' Estimation
Rcc_i (1, 2, 3 depending on K)	Ccogs *divided by* Ki (i=1, 2, 3)	Authors' Estimation
Rco_i (1, 2, 3 depending on K)	Cother *divided by* Ki (i=1, 2, 3)	Authors' Estimation
$KiLrel\_5_i$ (i=1, 2, 3 depending on K)	Ki (i=1, 2, 3) *divided by* L, relative to industry average Ki *divided by* L, iteration 5	Authors' Estimation
Eindex	Bebchuck Governance (managerial entrenchment) index	Risk Metrics/IRRC
Q	Tobin's Q estimated as (Total assets (AT) *plus* MV equity (PRCC_F*CSHO) *less* BV equity (CEQ)) *divided by* Total assets (AT)	Compustat /Authors' Estimation

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Figure 1

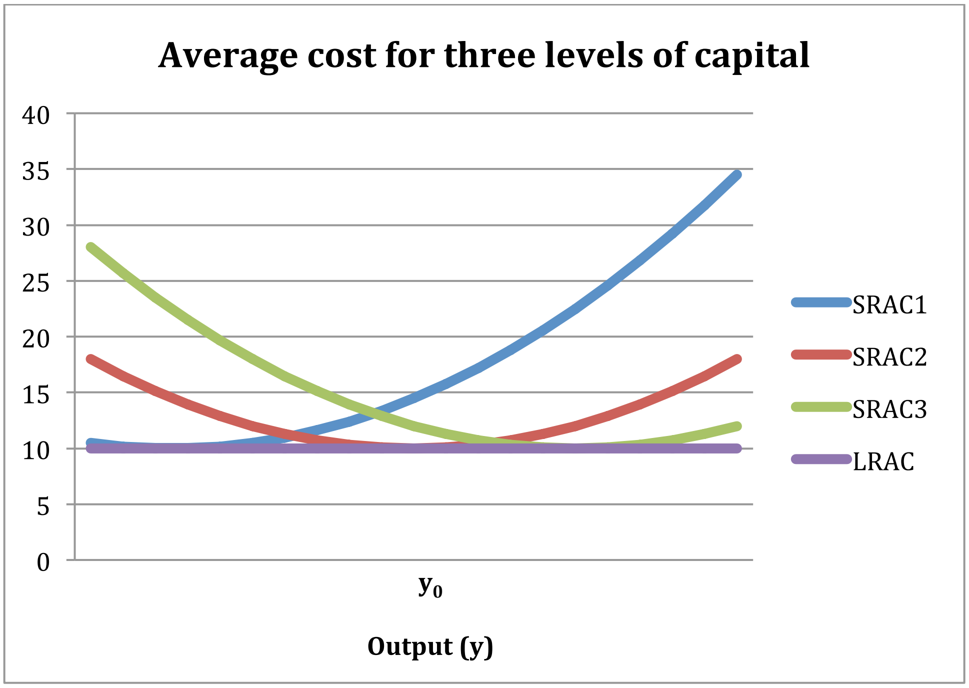

Figure 2

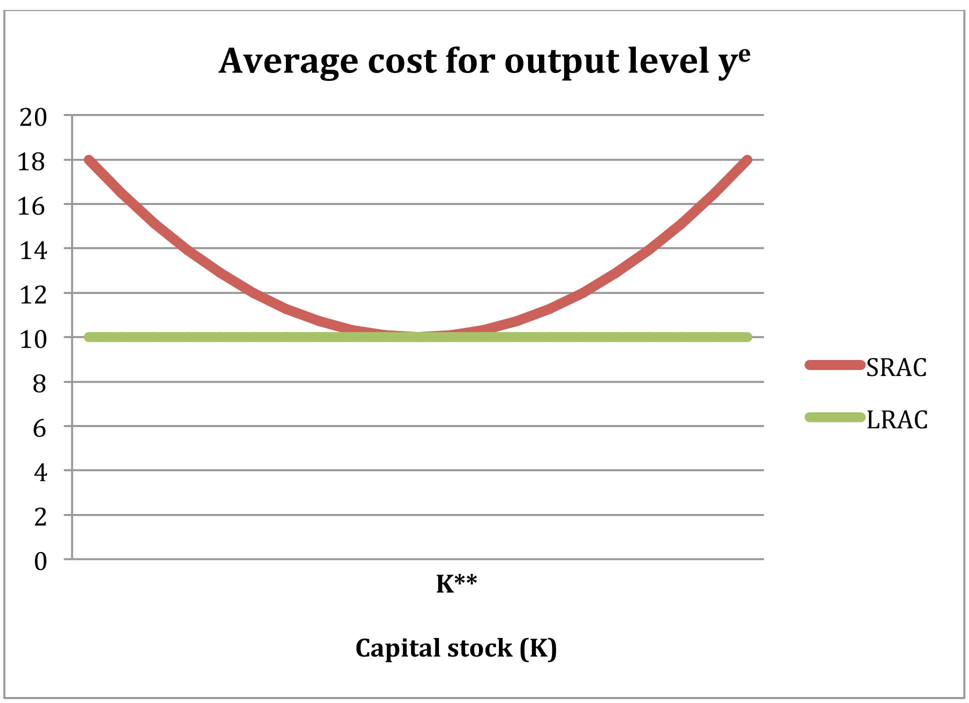

Table 1
Mean of Selected Variables by Industry

Industry	N	K2	L	K2L	EINDEX	Rct2	Rcc2	Ry2	Q
Agric	13	9638.96	16.28	502.38	3.00	0.66	0.33	0.82	3.04
Food	267	6925.43	29.30	282.60	1.99	1.31	0.96	1.46	2.29
Soda	62	8862.74	33.36	254.98	2.37	0.82	0.49	0.90	1.40
Beer	114	14341.02	66.65	384.54	0.70	0.81	0.43	0.97	2.95
Smoke	34	44442.48	94.01	768.04	1.35	0.58	0.32	0.87	3.08
Toys	33	3418.34	17.26	256.81	2.64	1.00	0.54	1.16	2.13
Fun	33	5621.52	15.19	477.50	0.97	0.47	0.29	0.60	2.24
Books	156	3958.82	19.16	218.30	1.96	0.78	0.44	0.91	2.07
Hshld	251	9606.63	34.78	238.14	2.69	1.14	0.68	1.30	2.55
Clths	92	4117.35	29.26	169.07	2.45	1.29	0.85	1.44	1.94
Hlth	55	4031.47	37.36	116.98	2.38	0.85	0.70	0.99	2.02
MedEq	147	5629.60	17.00	328.24	2.83	0.64	0.33	0.79	2.73
Drugs	351	19725.83	36.96	574.58	2.46	0.57	0.22	0.73	3.23
Chems	428	7378.87	18.70	378.31	2.82	0.90	0.68	1.01	1.64
Rubbr	35	2162.68	12.77	175.91	3.17	1.03	0.73	1.17	2.03
Txtls	39	1450.24	15.60	106.27	1.85	1.20	1.00	1.30	1.37
BldMt	218	4880.30	21.63	223.49	2.70	0.92	0.67	1.04	1.73
Cnstr	47	5339.58	15.71	457.50	2.87	1.51	1.43	1.59	1.36
Steel	154	5685.28	22.93	269.75	2.79	0.96	0.82	1.06	1.44
Mach	342	8351.97	27.57	262.64	2.61	0.89	0.67	0.99	1.72
ElecE	124	6550.01	44.96	152.83	2.41	0.94	0.69	1.06	1.79
Autos	153	51072.39	115.69	297.13	2.43	0.99	0.85	1.07	1.38
Aero	141	19762.53	88.44	233.24	2.47	0.89	0.73	0.99	1.69
Ships	18	3042.97	29.65	101.46	1.44	1.20	1.05	1.31	1.31
Guns	23	20609.39	118.17	160.56	1.22	1.21	1.15	1.32	1.50
Gold	27	7570.05	8.21	754.02	2.59	0.38	0.27	0.44	2.23
Mines	38	3602.35	7.69	413.31	2.95	0.70	0.56	0.81	1.84
Coal	3	1951.82	2.97	779.15	1.00	0.44	0.33	0.51	1.09
Oil	497	24415.01	20.91	1806.79	2.12	0.82	0.69	0.92	1.61
Utils	1358	9179.10	5.97	1362.03	2.34	0.41	0.38	0.49	1.21
Telcm	350	37304.90	62.21	636.06	2.13	0.46	0.31	0.55	1.66
PerSv	62	4258.66	42.06	180.86	3.52	0.64	0.48	0.74	1.48
BusSv	295	17786.34	55.67	462.82	1.99	0.79	0.56	0.92	2.28
Comps	162	20314.42	57.36	347.47	2.03	0.99	0.69	1.10	2.25
Chips	190	14830.82	51.05	307.27	1.91	0.86	0.62	0.97	2.18
LabEq	106	5214.67	18.90	284.53	2.70	0.72	0.46	0.83	1.84
Paper	284	8739.67	33.86	308.13	2.74	0.91	0.71	1.02	1.67
Boxes	41	3427.47	17.00	199.41	1.29	0.98	0.82	1.09	1.60
Trans	234	11302.88	56.39	440.00	2.09	0.83	0.73	0.92	1.46
Whlsl	212	6082.14	18.61	340.78	2.15	2.45	2.10	2.55	1.58
Retai	509	14299.23	159.05	106.48	1.92	1.95	1.49	2.08	2.07
Meals	89	8638.95	161.50	49.87	3.25	1.05	0.93	1.18	2.13
Other	71	9155.47	32.14	344.28	2.27	0.50	0.38	0.59	1.62

The table presents industry averages of selected variables. K2 is capital stock measured using total assets, L is number employees, K2L is capital stock per employee, EINDEX is Bebchuck et al. (2009) entrenchment index - our proxy of managerial power, Ry2 is the proxy of revenue per unit of capital stock, Rcc2, Rct2 and Rco2 are costs per unit of capital stock. Q is Tobin's Q. All variables are defined in Appendix A.1.

Table 2

Descriptive Statistics

Variable	Mean	STDEV	Min	p5	p10	Q1	Median	Q3	p90	p95	Max	N
K1	12180.65	25331.49	161.93	752.75	1085.97	1989.79	4400.95	12114.80	27811.98	42040.00	415953.00	7858
K2	13114.98	27018.51	165.22	796.86	1169.77	2131.24	4730.71	13029.10	29954.00	45474.00	448507.00	7858
K3	9626.07	23146.97	62.86	455.05	662.79	1317.57	3098.86	8753.50	21860.00	33479.00	448507.00	7858
L	41.54	96.20	0.03	1.64	2.87	6.63	16.96	43.00	96.50	144.00	2200.00	7811
K1L	562.59	846.65	19.41	59.46	81.85	142.06	274.88	621.93	1387.90	2036.68	16224.07	7811
K2L	594.73	876.51	21.84	62.95	85.85	151.71	299.08	680.64	1443.48	2120.32	17686.50	7811
K3L	464.33	777.50	9.40	31.35	44.61	84.05	188.79	522.77	1209.51	1764.99	17519.32	7811
k1Lrel_5	-12338.79	597.91	-16866.93	-12921.04	-12637.27	-12436.24	-12338.54	-12241.83	-12023.44	-11765.79	3403.14	7811
k2Lrel_5	-12720.61	623.62	-17468.67	-13333.04	-13054.26	-12836.25	-12717.86	-12615.97	-12376.10	-12111.99	4434.88	7811
k3Lrel_5	-9948.36	565.07	-14258.57	-10481.47	-10236.50	-10026.96	-9944.63	-9870.78	-9671.02	-9414.14	7100.73	7811
EINDEX	2.32	1.37	0.00	0.00	0.00	1.00	2.00	3.00	4.00	4.00	6.00	7858
Rct1	0.98	0.71	0.04	0.24	0.30	0.51	0.84	1.20	1.76	2.33	4.48	7727
Rct2	0.90	0.64	0.04	0.23	0.28	0.47	0.77	1.12	1.62	2.14	3.76	7727
Rct3	1.71	1.96	0.04	0.26	0.34	0.60	1.20	1.99	3.39	5.19	15.48	7727
Rcc1	0.73	0.63	0.01	0.15	0.20	0.33	0.57	0.90	1.38	1.92	3.93	7858
Rcc2	0.68	0.56	0.01	0.14	0.19	0.31	0.54	0.85	1.29	1.77	3.29	7858
Rcc3	1.27	1.64	0.01	0.17	0.23	0.41	0.81	1.47	2.52	4.01	12.86	7858
Rco1	0.24	0.20	0.00	0.03	0.03	0.08	0.19	0.34	0.51	0.62	1.49	7727
Rco2	0.22	0.17	0.00	0.03	0.03	0.08	0.18	0.31	0.46	0.55	1.01	7727
Rco3	0.42	0.46	0.00	0.03	0.04	0.10	0.28	0.57	0.94	1.29	4.00	7727
Ry1	1.09	0.73	0.09	0.32	0.38	0.60	0.96	1.33	1.91	2.44	4.52	7858
Ry2	1.01	0.65	0.09	0.31	0.36	0.56	0.89	1.24	1.74	2.24	3.82	7858
Ry3	1.88	2.02	0.10	0.34	0.42	0.70	1.36	2.20	3.65	5.55	15.80	7858
Q	1.83	0.94	0.76	1.04	1.09	1.23	1.52	2.10	2.95	3.67	6.83	7858

The table presents descriptive statistics of regression variables. K1 is total assets excluding cash and equivalents, K2 is total assets, K3 is long-term assets and L is number employees. KiL are proxies of capital stock per employee, KiLrel are proxies of deviation of capital stock from industry average capital stock, EINDEX is Bebchuck et al. (2009) entrenchment index - our proxy of managerial power, Ryi are the proxies of revenue per unit of capital stock, Rcci, Rcti and Rcoi are proxies of costs per unit of capital stock. Q is Tobin's Q. All variables are defined in Appendix A.1.

Table 3

Pairwise Correlation Coefficients

Variable	K1	K2	K3	L	K1L	K2L	K3L	K1Lrel_5	K2Lrel_5	K3Lrel_5	EINDEX	Rct1	Rct2	Rct3	Rcc1	Rcc2	Rcc3	Rco1	Rco2	Rco3	Ry1	Ry2	Ry3
K2	0.996																						
K3	0.98	0.98																					
L	0.51	0.51	0.46																				
K1L	0.19	0.18	0.20	-0.14																			
K2L	0.19	0.19	0.20	-0.14	1.00																		
K3L	0.18	0.18	0.20	-0.13	0.99	0.99																	
K1Lrel_5	0.06	0.06	0.07	-0.02	0.56	0.56	0.57																
K2Lrel_5	0.05	0.05	0.06	-0.02	0.56	0.57	0.57	0.99															
K3Lrel_5	0.05	0.05	0.07	-0.01	0.54	0.55	0.57	0.99	0.98														
EINDEX	-0.19	-0.20	-0.17	-0.15	0.01	0.01	0.01	-0.01	-0.02	-0.01													
Rct1	-0.10	-0.09	-0.13	0.16	-0.35	-0.34	-0.37	-0.13	-0.12	-0.15	-0.02												
Rct2	-0.10	-0.10	-0.13	0.17	-0.35	-0.35	-0.36	-0.14	-0.13	-0.16	-0.01	0.99											
Rct3	-0.11	-0.10	-0.14	0.07	-0.27	-0.26	-0.29	-0.07	-0.06	-0.09	-0.03	0.89	0.86										
Rcc1	-0.07	-0.07	-0.10	0.15	-0.28	-0.28	-0.30	-0.15	-0.13	-0.17	0.00	0.96	0.96	0.85									
Rcc2	-0.07	-0.08	-0.10	0.16	-0.28	-0.29	-0.30	-0.15	-0.14	-0.17	0.01	0.95	0.97	0.83	0.99								
Rcc3	-0.09	-0.09	-0.12	0.07	-0.23	-0.23	-0.26	-0.08	-0.07	-0.10	-0.02	0.88	0.86	0.98	0.90	0.88							
Rco1	-0.11	-0.09	-0.13	0.11	-0.36	-0.34	-0.36	-0.02	-0.02	-0.02	-0.07	0.49	0.46	0.43	0.24	0.22	0.27						
Rco2	-0.11	-0.10	-0.13	0.12	-0.37	-0.36	-0.37	-0.02	-0.03	-0.02	-0.06	0.50	0.50	0.44	0.26	0.26	0.28	0.98					
Rco3	-0.13	-0.12	-0.15	0.06	-0.32	-0.30	-0.33	-0.02	-0.02	-0.03	-0.07	0.55	0.51	0.64	0.34	0.31	0.48	0.89	0.87				
Ry1	-0.10	-0.09	-0.13	0.16	-0.36	-0.35	-0.38	-0.14	-0.13	-0.16	-0.02	0.99	0.97	0.88	0.94	0.92	0.87	0.54	0.54	0.58			
Ry2	-0.10	-0.10	-0.13	0.18	-0.36	-0.36	-0.38	-0.14	-0.13	-0.16	-0.01	0.98	1.00	0.86	0.94	0.95	0.85	0.50	0.54	0.54	0.98		
Ry3	-0.11	-0.10	-0.14	0.07	-0.28	-0.27	-0.31	-0.07	-0.06	-0.10	-0.03	0.88	0.85	1.00	0.84	0.81	0.97	0.47	0.46	0.67	0.88	0.86	
Q	-0.05	-0.03	-0.07	0.06	-0.19	-0.17	-0.20	-0.02	-0.03	-0.03	-0.09	0.13	0.09	0.10	0.00	-0.03	0.02	0.51	0.46	0.38	0.21	0.16	0.15
N	7858	7858	7858	7811	7811	7811	7811	7811	7811	7811	7858	7727	7727	7727	7858	7858	7858	7727	7727	7727	7858	7858	7858

The table presents pairwise correlation coefficients of regression variables. K1 is total assets excluding cash and equivalents, K2 is total assets, K3 is long-term assets and L is number employees. KiL are proxies of capital stock per employee, KiLrel are proxies of deviation of capital stock from industry average capital stock, EINDEX is Bebchuck et al. (2009) entrenchment index - our proxy of managerial power, Ryi are the proxies of revenue per unit of capital stock, Rcci, Rcti and Rcoi are proxies of costs per unit of capital stock. Q is Tobin's Q. All variables are defined in Appendix A.1.

Table 4
Management power, Over/Underinvestment and Costs

VARIABLES	(1) Rct1	(2) Rct2	(3) Rct3	(4) Rcc1	(5) Rcc2	(6) Rcc3	(7) Rco1	(8) Rco2	(9) Rco3
K1lrel_5	-2.307e-12			1.696e-05			-1.592e-05***		
	(-0.00)			(0.44)			(-2.80)		
K1lrel2_5	8.859e-09***			8.572e-09***			3.600e-10		
	(4.30)			(4.56)			(1.40)		
K2lrel_5		-5.593e-14			1.261e-05			-1.144e-05***	
		(-0.00)			(0.42)			(-2.77)	
K2lrel2_5		7.665e-09***			7.382e-09***			3.788e-10**	
		(4.83)			(5.07)			(2.02)	
K3lrel_5			-3.013e-12			1.685e-05			-1.477e-05
			(-0.00)			(0.34)			(-1.27)
K3lrel2_5			2.594e-08***			2.317e-08***			2.916e-09***
			(7.48)			(7.69)			(4.69)
EINDEX	1.220e-02***	1.645e-02***	1.160e-02	1.780e-02***	1.963e-02***	2.253e-02**	-4.682e-03***	-2.618e-03***	-1.163e-02***
	(2.64)	(3.97)	(0.95)	(4.18)	(5.18)	(2.15)	(-4.07)	(-2.63)	(-4.18)
Constant	-3.027e-01	-2.758e-01	-6.715e-01**	-3.339e-01	-3.278e-01**	-7.544e-01***	1.934e-02	4.115e-02	6.929e-02
	(-1.28)	(-1.48)	(-2.12)	(-1.59)	(-1.97)	(-2.90)	(0.54)	(1.50)	(1.04)
Observations	7,683	7,683	7,683	7,811	7,811	7,811	7,683	7,683	7,683
Adjusted R-squared	0.538	0.554	0.534	0.492	0.506	0.517	0.527	0.545	0.454
Industry Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The table presents results of the regression of the proxies of costs per unit of capital stock on deviation of capital stock and management power. KiLrel are proxies of deviation of capital stock from industry average capital stock, EINDEX is Bebchuck et al. (2009) entrenchment index - our proxy of managerial power, Rcci, Rcti and Rcoi are proxies of costs per unit of capital stock. Q is Tobin's Q. All variables are defined in Appendix A.1. T-stats based on robust standard errors corrected for Hubert-White errors are presented inside the parenthesis. ***, **, * refer to significance level at $p < 0.01$, $p < 0.05$, and $p < 0.1$ respectively.

Table 5

Management power and Over/Underinvestment

	(1)	(2)	(3)
VARIABLES	K1lrel2_5	K2lrel2_5	K3lrel2_5
EINDEX	1.220e+05	2.225e+05*	6.467e+04
	(0.98)	(1.69)	(0.71)
Constant	1.516e+08***	1.608e+08***	9.879e+07***
	(240.01)	(244.45)	(251.10)
Observations	7,811	7,811	7,811
Adjusted R-squared	0.054	0.054	0.065
Year Effect	Yes	Yes	Yes
Industry Effect	Yes	Yes	Yes

The table presents results of the regression of the proxies of the deviation of capital stock on management power. KiLrel are proxies of deviation of capital stock from industry average capital stock, EINDEX is Bebchuck et al. (2009) entrenchment index - our proxy of managerial power. All variables are defined in Appendix A.1. T-stats based on robust standard errors corrected for Hubert-White errors are presented inside the parenthesis. ***, **, * refer to significance level at $p < 0.01$, $p < 0.05$, and $p < 0.1$ respectively.

Table 6

Management power & Revenue

	(1)	(2)	(3)
VARIABLES	Ry1	Ry2	Ry3
EINDEX	1.140e-02**	1.777e-02***	8.709e-03
	(2.41)	(4.22)	(0.69)
Constant	1.142e+00***	1.050e+00***	2.060e+00***
	(36.97)	(38.91)	(25.30)
Observations	7,858	7,858	7,858
Adjusted R-squared	0.510	0.527	0.515
Year Effect	Yes	Yes	Yes
Industry Effect	Yes	Yes	Yes

The table presents results of the regression of the proxies of revenue per unit of capital stock on management power. Ryi are proxies of revenue per unit of capital stock, EINDEX is Bebchuck et al. (2009) entrenchment index - our proxy of managerial power. All variables are defined in Appendix A.1. T-stats based on robust standard errors corrected for Hubert-White errors are presented inside the parenthesis. ***, **, * refer to significance level at $p < 0.01$, $p < 0.05$, and $p < 0.1$ respectively.

Table 7

Q, Over/Underinvestment, revenue and costs

VARIABLES	(1) Q	(2) Q	(3) Q
Ry1	6.772e+00***		
	(16.24)		
$Ry1^2$	1.827e-01		
	(1.22)		
Rct1	-6.907e+00***		
	(-17.37)		
$Rct1^2$	-1.469e-01		
	(-0.98)		
$K1lrel^2\_5$	-1.071e-10		
	(-0.20)		
Ry2		8.188e+00***	
		(15.26)	
$Ry2^2$		4.894e-01**	
		(2.51)	
Rct2		-8.507e+00***	
		(-16.57)	
$Rct2^2$		-4.173e-01**	
		(-2.14)	
$K2lrel^2\_5$		-3.881e-10	
		(-0.69)	
Ry3			5.077e+00***
			(28.69)
$Ry3^2$			-2.295e-01***
			(-13.59)
Rct3			-5.128e+00***
			(-28.13)
$Rct3^2$			2.395e-01***
			(13.78)
$K3lrel^2\_5$			-7.502e-10
			(-1.11)
Constant	7.466e-01***	7.559e-01***	8.385e-01***
	(8.75)	(7.90)	(12.63)
Observations	7,683	7,683	7,683
Adjusted R-squared	0.612	0.602	0.581
Year Effect	Yes	Yes	Yes
Industry Effect	Yes	Yes	Yes

The table presents results of the regression of Q on proxies of the deviation from capital stock, revenue and cost. Ryi are proxies of revenue per unit of capital stock, Rcti are proxies of costs relative to capital stock. $KiLrel^2$ are squires of the proxies of deviation of capital stock from industry average capital stock. All variables are defined in Appendix A.1. T-stats based on robust standard errors corrected for Hubert-White errors are presented inside the parenthesis. ***, **, * refer to significance level at $p < 0.01$, $p < 0.05$, and $p < 0.1$ respectively.

Table 8
Q, Over/Underinvestment, Revenue and Costs

VARIABLES	(1) Q	(2) Q	(3) Q
Ry1	6.314e+00***		
	(27.96)		
$Ry1^2$	-9.079e-02**		
	(-2.39)		
Rcc1	-6.452e+00***		
	(-28.24)		
$Rcc1^2$	1.234e-01***		
	(2.96)		
Rco1	-4.802e+00***		
	(-16.86)		
$Rco1^2$	-2.817e-01		
	(-1.59)		
$K1lrel^2$_5	3.002e-10		
	(0.56)		
Ry2		7.634e+00***	
		(28.08)	
$Ry2^2$		-2.094e-01***	
		(-4.17)	
Rcc2		-7.830e+00***	
		(-28.79)	
$Rcc2^2$		2.680e-01***	
		(4.47)	
Rco2		-5.659e+00***	
		(-17.08)	
$Rco2^2$		-1.753e-01	
		(-0.69)	
$K2lrel^2$_5		2.287e-10	
		(0.42)	
Ry3			2.754e+00***
			(18.21)
$Ry3^2$			-8.673e-02***
			(-13.49)
Rcc3			-2.858e+00***
			(-19.41)
$Rcc3^2$			1.082e-01***
			(11.28)
Rco3			-1.951e+00***
			(-10.60)
$Rco3^2$			1.489e-01**
			(2.53)
$K3lrel^2$_5			9.910e-10
			(1.46)
Constant	4.889e-01***	4.125e-01***	7.813e-01***
	(6.16)	(4.80)	(12.23)
Observations	7,683	7,683	7,683
Adjusted R-squared	0.609	0.581	0.534
Year Effect	Yes	Yes	Yes
Industry Effect	Yes	Yes	Yes

The table presents results of the regression of Q on proxies of the deviation from capital stock, revenue and cost. Ryi are proxies of revenue per unit of capital stock, Rcci and Rcoi are proxies of costs relative to capital stock. $KiLrel^2$ are squires of the proxies of deviation of capital stock from industry average capital stock. All variables are defined in Appendix A.1. T-stats based on robust standard errors corrected for Hubert-White errors are presented inside the parenthesis. ***, **, * refer to significance level at $p < 0.01$, $p < 0.05$, and $p < 0.1$ respectively.