Tobin's Q Does Not Measure Performance: Theory, Empirics, and Alternative Measures*

Philip H. Dybvig† and Mitch Warachka‡

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†Boatmens Bancshares Professor of Banking and Finance, Washington University in Saint Louis, Olin School of Business, Campus Box 1133, One Brookings Drive, Saint Louis, MO 63130-4899. Email: phild@dybfin.wustl.edu

‡Singapore Management University, L.K.C. School of Business, 50 Stamford Road, 178899, Singapore. Email: mitchell@smu.edu.sg

Abstract

Many empirical studies use Tobin's Q as a proxy for firm performance. However, our theoretical framework illustrates that the relationship between firm performance and Tobin's Q is confounded by endogeneity. In particular, underinvestment lowers firm performance while increasing Tobin's Q. Our framework then provides two measures of operating efficiency that unambiguously capture firm performance: a revenue-based measure that assesses managerial decisions regarding a firm's level of output and a cost-based measure to assess its cost discipline. These measures are justified by the maximization of firm value net of invested capital. Their estimation indicates that better governance improves firm performance, but better firm performance does not increase Tobin's Q.

1 Introduction

Empirical finance often requires proxies for variables of interest. However, proxies must be chosen carefully since inappropriate proxies can cause a hypothesis to be spuriously rejected or accepted. Indeed, the need for proxies results in joint tests of the stated hypotheses and the validity of the chosen proxies. Ideally, empirical proxies would originate from a theoretical framework that justifies their use under reasonable assumptions.

Tobin's Q is widely used as a proxy for firm performance when studying the relationship between firm performance and corporate governance. For example, Gompers, Ishii and Metrick (2003) conclude that firms with more shareholder rights are better governed since these firms have a higher Tobin's Q. Yermack (1996) also analyzes board performance using Tobin's Q, while Anderson and Reeb (2003) employ Tobin's Q to examine the governance of family firms.

This paper provides a theoretical framework to highlight an endogeneity problem when Tobin's Q is used to measure firm performance. This endogeneity problem results in better performance having an ambiguous effect on Tobin's Q. Our framework then offers a solution to the endogeneity problem by examining managerial decisions regarding scale and cost discipline. For the single-product firm in our framework, scale is defined as the quantity produced. The operating efficiency measures we propose to measure firm performance are based on revenue, to assess scale decisions, and costs, to assess cost discipline. These theoretically-motivated measures originate from a benchmark maximization of firm value net of invested capital, hence the maximization of a firm's net present value. Our measures are also consistent with recent empirical research that documents underinvestment by entrenched managers. Moreover, our theoretical framework enables us to re-examine the empirical relationship between corporate governance and firm performance without the endogeneity problem that afflicts Tobin's Q.

Intuitively, the denominator of Tobin's Q normalizes firm value by a proxy for capital to correct for exogenous differences in scale across firms. This normalization also accounts for the resources transferred from investors to management. However, capital is endogenous because of its dependence on corporate governance. Intuitively, firms with the same natural scale can produce different quantities depending on the quality of managerial decisions. In particular, as documented by Bertrand and Mullainathan (2003), entrenched managers *enjoy the quiet life* and underinvest since "the best of all monopoly profits is a quiet life" according to Hicks (1935). Firms that underinvest operate below their firm's profit-maximizing scale. Higher profit margins, a lower likelihood of being fired due to negative demand shocks, and the need for less monitoring make underinvestment attractive to managers while lowering the denominator of Tobin's Q. Our framework demonstrates that underinvestment, which corresponds to poor operating efficiency, increases Tobin's Q.

More formally, the ideal manager in our framework maximizes their firm's market value net of invested capital. Operating at a suboptimal scale and lax cost discipline result in deviations from this objective. Underinvestment restricts output below the firm's optimal scale. This results in a proportional reduction in capital but a less than proportional reduction in revenue since demand curves are downward sloping. Specifically, because marginal revenue decreases with output, operating at a suboptimal scale increases the ratio of market value divided by capital, Tobin's Q, beyond its optimal value. Indeed, while investment is optimal until its marginal benefit is zero, restricting investment increases its average benefit.

As a simple numerical illustration, consider a firm with a Tobin's Q of 1.5 whose $15 market value is based on a capital investment of $10. If the firm initiates a new project requiring $20 of additional capital that increases its market value by $24, Tobin's Q decreases to 1.3 instead of increasing.[1] Thus, despite its positive net present value of $4, this investment lowers Tobin's Q.

Even if better corporate governance improves operating efficiency, our framework highlights two conflicting implications of better operating efficiency on Tobin's Q. First, better operating efficiency can decrease Tobin's Q by mitigating underinvestment. Second, better operating efficiency can increase Tobin's Q by improving cost discipline. Therefore, despite improved firm performance, the net impact of better operating efficiency on Tobin's Q is ambiguous since its impact depends on the relative importance of scale decisions versus cost discipline. The existing literature ignores the possibility of underinvestment when interpreting a high Tobin's Q as evidence of good firm performance.

[1] With the new project, Tobin's Q equals $\frac{\$15+\$24}{\$10+\$20} = 1.3$.

Similarly, return on assets can either increase or decrease following managerial decisions that improve firm performance. Indeed, a high return on assets can either be attributed to underinvestment or stringent cost discipline, respectively. The similarity between return on assets and Tobin's Q is not surprising since the numerator of Tobin's Q in our framework capitalizes the cash flows underlying the numerator of return on assets.

The ambiguous relationship between operating efficiency and Tobin's Q as well as return on assets leads us to propose two separate measures of operating efficiency that proxy for firm performance. These measures are based on revenue and costs to capture the quality of scale decisions and cost discipline, respectively. Although these operating efficiency measures normalize revenue and costs by capital, they both decrease unambiguously as operating efficiency improves. In particular, a low revenue-to-capital ratio is consistent with managers choosing an output level that equates marginal revenue with marginal cost.

Graham, Lemmon, and Wolf (2002) report that target firms have lower normalized valuations than acquiring firms. This finding challenges the assumption that acquisitions destroy value simply by lowering the combined entity's *average* valuation. Instead, this finding parallels our framework's implication that increasing output until marginal profits are zero reduces Tobin's Q but maximizes firm value net of invested capital. The theoretical framework of Maksimovic and Phillips (2001, 2002) also has managers allocating resources to ensure that marginal profits are zero.

Our operating efficiency measures are able to capture the benefits of increased scale and cost-savings arising from acquisitions. Alternatively, if a manager assembles a collection of inefficient enterprises that increase firm size without improving operating efficiency, our measures will correctly identify the conglomerate as inefficient. Indeed, absent synergy gains, the operating efficiency of a conglomerate is a weighted average of the operating efficiencies of its separate divisions.

The endogeneity problem afflicting Tobin's Q is motivated by recent empirical research. Bertrand and Mullainathan (2003) report that entrenched managers enjoy the quiet life by underinvesting. Following the exogenous increase in managerial entrenchment attributable to increased takeover protection, Low (2009) also finds evidence of greater managerial conservatism. Furthermore, Giroud and Mueller (2010a) find support for the quiet life hypothesis following changes in state-level business combination laws that affect external governance. Aggarwal and Samwick (2006) along with John and Knyazeva (2006) also report that poor governance allows managers to underinvest. Our second assumption that poor governance results in poor cost discipline is justified by Giroud and Mueller (2010a)'s evidence that poor governance leads to higher costs. Cronqvist, Heyman, Nilsson, Svaleryd, and Vlachos (2009) also conclude that entrenched managers obtain private benefits by paying higher wages, and Core, Holthausen, and Larcker (1999) find that weaker corporate governance results in higher CEO compensation.

Although our operating efficiency measures reflect firm performance, they are not intended to replace existing proxies for corporate governance. Specifically, when testing whether better governance improves firm performance, we propose new proxies for measuring firm performance, not new proxies for governance. The corporate governance index of Gompers, Ishii, and Metrick (2003), abbreviated as the G index hereafter, assigns firms a score between zero and twenty-four by counting the number of their charter provisions that inhibit the replacement of management. Intuitively, shareholders in firms with a high G index have fewer rights. Gompers, Ishii, and Metrick (2003) report that firms with a higher G index have a lower Tobin's Q. However, the G index is not theoretically-justified and does not capture important dimensions of internal governance such as board independence or external governance. Nonetheless, this popular governance proxy enables us to re-examine the relationship between governance and firm performance. Giroud and Mueller (2010b) use the G index as their primary proxy for firm-level governance and highlight its high correlations with the entrenchment index of Bebchuk, Cohen, and Ferrell (2009) as well as the anti-takeover index of Cremers and Nair (2005). Besides the G index, we also use institutional ownership to proxy for corporate governance. Although institutional investors may invest in firms with better governance rather than improve governance, Shleifer and Vishny (1986) argue that institutional investors enhance the market for corporate control by facilitating takeovers.

The empirical implementation of our proxies for firm performance addresses two main questions. Given the ambiguous theoretical relationship between operating efficiency and Tobin's Q, we first examine whether greater operating efficiency increases or decreases Tobin's Q. Second, using our operating efficiency measures to proxy for firm performance, we re-examine the relationship between firm performance and corporate governance. This re-examination is not confounded by the endogeneity afflicting Tobin's Q.

Our empirical implementation reveals that Tobin's Q is lower for firms with better operating efficiency. This finding indicates that scale decisions are crucially important as underinvestment inflates Tobin's Q. Moreover, a high G index and low institutional ownership, which correspond to poor governance, are associated with underinvestment. Overall, while better governance improves operating efficiency, firms that operate more efficiently have a lower Tobin's Q. Consequently, we conclude that our proposed operating efficiency measures are more suitable proxies for firm performance than Tobin's Q.

The remainder of this paper formalizes our framework in Section 2. The operating efficiency measures derived from this framework are then estimated in Section 3. Section 4 contains our conclusions and suggestions for future research.

2 Theoretical Framework

The intent of this section is to provide a general framework for analyzing the relationship between corporate governance and firm performance, not to provide a detailed structural model describing the mechanism through which corporate governance affects firm performance. In this framework, corporate managers are entrusted with two crucial tasks. They determine their firm's scale and control its costs. Therefore, management determines the number of units of output denoted y and per unit costs denoted c, where $c_0 > 0$ denotes the lowest possible cost to produce a single unit of output. With c being constant, the firm's total cost equals cy.

The amount of capital required to produce one unit of output equals $k > 0$. A linear production function implies the total amount of required capital to produce y units of output is ky. Consequently, capital and output are proportional, with decisions regarding capital and output treated as a single decision regarding the quantity of output to produce. Although y and c are not stochastic, viewing them as expected values does not change our framework's economic implications.

The price of the firm's output is determined by managerial decisions regarding its level of output since firms are assumed to earn some monopoly rents in their respective product market. The following demand function determines the price (per unit) of the firm's output

$$\text{Price}(y) \quad = \quad P_0 - \frac{y}{2a} \,. \tag{1}$$

The a parameter in this downward-sloping demand function links prices with output and indicates the potential size of a firm's market for a given price. For example, if a doubles, the firm can sell twice as much output for the same price.

Although $1/a$ is the slope of the demand function, the a parameter is not sufficient to capture product market competition since $P_0 - c$ in equation (3) also reflects competition. Intuitively, a smaller value of P_0 leads to negative profits when cost discipline is lax and c is far above c_0. Moreover, whether product market competition acts as a substitute or complement to internal governance is an unresolved empirical issue. Giroud and Mueller (2010b) find that product market competition reduces the need for internal governance. However, Aghion, Van Reenen, and Zingales (2010) report that high institutional ownership (strong internal governance) is beneficial even when product markets are competitive since institutional investors can lower the career risk of managers and thereby allow managers to pursue risky innovative projects.

2.1 Tobin's Q

Revenue equals output y times Price(y) given by equation (1). Thus, revenue minus costs equals $y\left(P_0 - \frac{y}{2a}\right) - cy$, which represents the firm's cash flow in a single period. With the discount rate for future cash flows equaling r, this per period cash flow yields a market value of

$$M(y,c) \quad = \quad \sum_{i=1}^{\infty} \frac{y\left(P_0 - \frac{y}{2a}\right) - cy}{(1+r)^i} = \frac{y\left(P_0 - c\right) - \frac{y^2}{2a}}{r} \,. \tag{2}$$

Normalizing this market value by capital, ky, yields Tobin's Q[2]

$$Q(y,c) \;=\; \frac{P_0 - c - \frac{y}{2a}}{rk}\,. \tag{3}$$

Observe that Tobin's Q is a decreasing function of output, with the partial derivative $\frac{\partial Q}{\partial y}$ equaling $-\frac{1}{2a}$. Thus, Tobin's Q is more sensitive to output when a is small and prices are more sensitive to output. Moreover, better operating efficiency has an ambiguous influence on Tobin's Q. Specifically, better operating efficiency decreases c while increasing y, which causes Tobin's Q to increase and decrease, respectively. Indeed, provided scale decisions are important, better operating efficiency can decrease Tobin's Q. This possibility is not recognized in the existing literature, which assumes that a high Tobin's Q is evidence of better firm performance.

In general, any capital-adjusted profitability metric that attempts to capture firm performance is ambiguous. With operating profit being approximately equal to revenue minus costs, return on assets (ROA) is proportional to the *difference* between our operating efficiency measures

$$\text{ROA} \;=\; R_y - R_c\,, \tag{4}$$

since ROA is defined as operating profit normalized by total assets. Consequently, while R_y and R_c both decrease with improved operating efficiency, ROA evaluates the difference between these measures. Therefore, a high ROA can either be attributed to a high R_y, which signifies poor operating efficiency, or a low R_c, which signifies good operating efficiency.

2.2 Operating Efficiency

Our framework does not examine the managerial incentives required to mitigate underinvestment and improve cost discipline. This issue is examined in Aggarwal and Samwick (2006) as well as Low (2009). Instead, our analysis proposes operating efficiency metrics to detect underinvestment and lax cost discipline.

[2]This ratio represents the average, not marginal, Tobin's Q. In practice, the denominator of Tobin's Q often deviates from the true replacement cost of capital. Indeed, consistent with the usual construction of Tobin's Q, our framework abstracts from accounting procedures governing write-offs and non-economic features of depreciation that define the total assets recorded on balance sheets.

Our ideal manager maximizes the firm's market value minus the invested capital

$$\max_{c,y} \; M - ky \;\; = \;\; \max_{c,y} \; \frac{y\,(P_0 - c - rk) - \frac{y^2}{2a}}{r} \; . \tag{5}$$

This objective maximizes the firm's net present value. Equation (5) is concave and quadratic in y, and is maximized by

$$y^* \;\; = \;\; a\,(P_0 - c_0 - rk) \; . \tag{6}$$

Managers who underinvest produce less than y^* while managers who shirk their responsibility to control costs have have c exceeding c_0. The maximization in equation (5) is equivalent to maximizing

$$\frac{\text{Revenue - Costs - } \textit{rent} \text{ on Capital}}{r} \;\; = \;\; \frac{y\left(P_0 - \frac{y}{2a}\right) - cy - rky}{r} \, , \tag{7}$$

where the rental cost for capital equals rky.[3] Investors prefer managers to produce a level of output y^* that exploits the firm's monopoly power and sets marginal revenue equal to marginal cost. However, this optimal level of output is too high from the perspective of entrenched managers who underinvest by producing below y^*.

Using the maximization in equation (5), we propose two operating efficiency ratios to measure the firm performance. The first operating efficiency measure is derived from revenue, which equals $y\left(P_0 - \frac{y}{2a}\right)$. The second measure is derived from the firm's cost of producing y units of output, which equals cy.

The first operating efficiency ratio, R_y, isolates the impact of managerial decisions regarding scale through revenue

$$R_y \;\; = \frac{\text{Revenue}}{\text{Capital}} \;\; = \frac{y\left(P_0 - \frac{y}{2a}\right)}{ky} = \frac{P_0 - \frac{y}{2a}}{k} \geq \frac{P_0 + c_0 + rk}{2k} \, , \tag{8}$$

with the lower bound being independent of a after invoking y^* from equation (6). The normalization of revenue by capital ensures that R_y is a decreasing function of y. Observe that R_y is not complicated by costs. Furthermore, while y^* defines the lower bound in

[3]Observe that y^* in equation (6) differs from the level of output $a\,(P_0 - c_0)$ that maximizes (Revenue - Costs)/ r. This higher level of output maximizes the firm's market value in equation (2) but ignores the amount of capital consumed by the firm.

equation (8), this lower bound is not required for empirical tests since R_y is decreasing with better operating efficiency. Thus, measuring deviations between y and y^* is unnecessary. This property is important since underinvestment pertains to the difference between a firm's optimal scale and the scale chosen by management, while only proxies for the latter are observable.

The second operating efficiency ratio, R_c, focuses on costs

$$R_c \quad = \frac{\text{Costs}}{\text{Capital}} \quad = \frac{cy}{ky} = \frac{c}{k} \geq \frac{c_0}{k} \,. \tag{9}$$

The normalization of costs by capital ensures that R_c is not complicated by management decisions regarding output. This ratio is smaller for firms with better operating efficiency. Consequently, measuring deviations between c and c_0 is unnecessary.

Ang, Cole, and Lin (2000) estimate a sales-to-assets ratio that parallels R_y. However, as this ratio is not theoretically motivated, these authors interpret a high sales-to-assets ratio as evidence of low agency costs due to high managerial effort. This interpretation does not recognize that marginal revenue is a decreasing function of output. Moreover, they assume that firms owned entirely by management have zero agency costs. Therefore, despite the high concentration of managerial wealth in these benchmark firms, Ang, Cole, and Lin (2000) do not allow managerial conservatism and a limited market for corporate control to induce underinvestment. Morck, Shleifer, and Vishny (1988) find evidence that managerial ownership has countervailing influences on corporate governance. In particular, while managerial ownership can mitigate agency problems, high levels of managerial ownership inhibit the market for corporate control.

2.3 Robustness of the Framework

Thus far, our framework has ignored the choice of capital structure and focused exclusively on managerial decisions regarding the level of output, hence capital investment. The incorporation of capital structure into our framework is left for further research since empirical evidence on the relationship between leverage and corporate governance is unresolved. Berger, Ofek, and Yermack (1997) find evidence that entrenched managers *play it safe* by issuing a suboptimal amount of debt. However, John and Litov (2010) report that entrenched managers issue more debt and interpret this finding as evidence that entrenched managers have better access to debt markets because of their conservative investment strategies.

However, we can easily extend our results to a simplistic model with both debt and equity. Ignoring the effect of taxes, when a fraction $0 \leq f < 1$ of the firm's capital is financed by debt, its cash flows are reduced by an interest expense equaling $frky$. The remaining per period cash flows equal

$$y\left(P_0 - \frac{y}{2a} - c - frk\right)$$

and are obtained from an equity-financed capital investment of $(1-f)ky$. Therefore, the firm's return on equity (ROE) is

$$\text{ROE} \;=\; \frac{y\left(P_0 - \frac{y}{2a} - c - frk\right)}{(1-f)ky} = \frac{R_y - R_c - rf}{1-f}\,, \tag{10}$$

which equals its ROA when $f = 0$. More importantly, better operating efficiency does not necessarily increase a firm's return on equity since ROE also involves the difference between R_y and R_c.

Our framework is not intended to estimate a firm's optimal Tobin's Q denoted

$$Q^* \;=\; \frac{P_0 - c_0 - \frac{y^*}{2a}}{rk}\,. \tag{11}$$

Managers are expected to have better information regarding demand than investors. Indeed, one motivation for managers to underinvest is the inability of investors to accurately differentiate between reductions in demand and poor management. If investors knew y^* and c_0, then they could simply devise a contract that requires managers to produce the optimal number of units at the lowest possible cost. In contrast, our operating efficiency ratios don't require the estimation of y^* and c_0.

Poor operating efficiency may also arise from managers utilizing an excess amount of capital to simultaneously produce a suboptimal amount of output. This "overinvestment" in unproductive capital is identifiable through a normalization of capital by output to facilitate a comparison of k across firms. However, units of output y are not reported in standard financial databases and are difficult to compare across firms. The identifying restriction in our framework that managerial entrenchment leads to underinvestment is supported by the empirical evidence in Giroud and Mueller (2010a), Low (2009), Aggarwal and Samwick (2006), John and Knyazeva (2006), and Bertrand and Mullainathan (2003).

Mergers and acquisitions can improve operating efficiency through synergies and cost-savings. Conversely, acquisitions can reduce operating efficiency by creating a collection of diverse enterprises with insufficient scale. While our framework investigates a single-product firm, the combined operating efficiency of separate divisions equals their combined efficiency. Specifically, the combined revenue-based operating efficiency measure for two divisions equals

$$\begin{aligned}\frac{y_1\left(P_0-\frac{y_1}{2a_1}\right)+y_2\left(P_0-\frac{y_2}{2a_2}\right)}{ky_1+ky_2} &\geq \left(\frac{y_1}{y_1+y_2}\right)\frac{P_0+c_0+rk}{2k}+\left(\frac{y_2}{y_1+y_2}\right)\frac{P_0+c_0+rk}{2k}\\ &= \frac{P_0+c_0+rk}{2k}.\end{aligned}$$

Thus, for a conglomerate, a lower R_y measure continues to signify better operating efficiency in terms of scale. Similarly, the following holds for our cost-based measure of operating efficiency

$$\frac{c_1y_1+c_2y_2}{ky_1+ky_2} \geq \frac{c_0}{k}\left(\frac{y_1}{y_1+y_2}\right)+\frac{c_0}{k}\left(\frac{y_2}{y_1+y_2}\right)=\frac{c_0}{k}.$$

In summary, our operating efficiency measures are valid for conglomerates with multiple divisions.

Finally, the maximization in equation (5) provides an alternative measure of operating efficiency as the difference between a firm's market value and its capital. Specifically, our objective function implies that firms with better operating efficiency have higher values of $M-ky$. However, market valuations manifest a multitude of economic factors such as discount rates whose relationship with corporate governance is less clear.[4] Core, Guay, and Rusticus (2006) document that expected stock returns are not sensitive to governance. Therefore, we focus on realized operating efficiency using observed revenue and costs.

[4]According to equation (2), the earnings-to-price ratio equals r, with operating efficiency influencing both its numerator and denominator. Therefore, this ratio also cannot proxy for firm performance.

3 Empirical Implementation

We focus our empirical investigation on the relationships between Tobin's Q, operating efficiency, and corporate governance. COMPUSTAT data is used to estimate our operating efficiency measures and Tobin's Q. The numerator of Tobin's Q is computed as total assets plus the market value of equity minus the book value of equity. As the standard definition of Tobin's Q has total assets in its denominator, we also use total assets as a proxy for capital in the denominator of our operating efficiency measures for consistency.

Revenue (REVT) proxies the numerator of R_y in equation (8) while several expenses comprise the numerator of R_c in equation (9). These expenses include advertising (XAD), sales and administration (XSGA), staff (XLR), and rent (XRENT). Cost of goods sold (COGS) is excluded from the numerator of R_c given its high correlation with revenue in the numerator of R_y. Thus, a firm's total cost cy consists of two components; COGS plus expenses, with R_c defined by expenses to prevent R_c and R_y from being highly correlated. Our main dataset consists of annual COMPUSTAT data involving 94,318 firm-year observations from 1980 to 2008.

The G index is obtained from the Investor Responsibility Research Center (IRRC) and is available from 1990. Quarterly institutional ownership data is obtained from 13f filings with the SEC and are averaged within each year. The availability of institutional ownership data imposes a slight constraint on our sample, resulting in the availability of 94,200 firm-year observations while the availability of the G index limits our sample to 7,550 firm-year observations.

Four digit SIC codes are obtained from CRSP to implement the 49 industry classifications in Fama and French (1997). Bizjak, Lemmon, and Nguyen (2010) also use these industry classifications in their study of CEO compensation and relative performance. Firms in the banking, insurance, real estate, and financial trading industries are removed from our sample. In our empirical tests, industry dummy variables are constructed for the remaining industries to relax the assumption that k and c are identical across firms, and to account for differences in product market competition.

Table 1 reports industry-level averages for Tobin's Q, the G index, institutional ownership (IO), and our operating efficiency measures. The results in Panel A confirm that Tobin's Q and operating efficiency vary across industries, while the corporate governance proxies exhibit less industry-level variation. Moreover, the standard deviations in Panel B reveal considerable variation in operating efficiency and governance within individual industries that motivates our re-examination of the relationship between firm performance and corporate governance.

Panel A of Table 2 summarizes the distribution of Tobin's Q, the G index, institutional ownership, and our proxies for operating efficiency across firms. Panel B reports on the correlations between these variables and also evaluates their respective correlations with firm size (Size). As documented in the prior literature, unreported results find a high positive correlation of 0.25 between Tobin's Q and return on assets (ROA). Therefore, for brevity, we focus our empirical analysis on Tobin's Q. Nonetheless, we address ROA at the end of this section since its numerator is determined by cost of goods sold data.

Panel B also indicates that greater shareholder rights (lower G index) and higher institutional ownership coincide with lower R_y measures, hence better operating efficiency. A lower G index and higher institutional ownership also coincide with a larger Tobin's Q, although a larger Tobin's Q corresponds to a higher R_y measure that is consistent with underinvestment inflating Tobin's Q. The positive correlation of 0.12 between R_y and R_c indicates that underinvestment coincides with lax cost discipline. This evidence suggests that a common firm characteristic, such as weak governance, is responsible for underinvestment and lax cost discipline. Finally, the correlations in Panel B suggest that large firms have better operating efficiency in terms of scale and cost discipline.

3.1 Does Better Operating Efficiency Increase Tobin's Q?

We first examine the theoretically-ambiguous relationship between Tobin's Q and operating efficiency to determine the economic importance of scale decisions. This analysis implicitly evaluates the appropriateness of the existing literature's assumption that a high Tobin's Q is the result of good firm performance. After normalizing the market value in equation (2) by capital ky, equations (8) and (9) yield the following relationship

$$Q(y,c) \;=\; \frac{y\,(P_0 - c) - \frac{y^2}{2a}}{rky} = \frac{R_y}{r} - \frac{R_c}{r}\,. \tag{12}$$

Thus, our framework has Tobin's Q equaling the *expected* difference between our two operating measures when y and c are stochastic, while return on assets (ROA) is the difference between realized values of R_y and R_c. We evaluate the relationship between Tobin's Q and operating efficiency over a long time series to mitigate the errors-in-variables problem associated with comparing realized operating efficiency measures and Tobin's Q. Time-variation in the discount rates is also mitigated through the use of a long time series when estimating the following regression

$$Q \;=\; \beta_0 + \beta_y\, R_y + \beta_c\, R_c + \gamma\, X + \epsilon\,, \tag{13}$$

where the X vector includes industry dummy variables. The standard errors of the regression coefficients are clustered at the firm level.

The assumptions underlying Tobin's Q in equation (3) are justified by a positive β_y coefficient and negative β_c coefficient. A positive β_y coefficient is consistent with underinvestment, specifically the ability of poor scale decisions to increase Tobin's Q. Indeed, a positive β_y coefficient indicates that a high Tobin's Q cannot be interpreted as evidence of good firm performance. A negative β_c coefficient is consistent with better cost discipline increasing Tobin's Q.

Table 3 reports on the estimated β coefficients from equation (13). When R_y and R_c are both independent variables, the β_y and β_c coefficients equal 0.58 and -0.34, respectively, both of which are highly significant. Furthermore, the magnitude and significance of the β_y coefficient is not sensitive to the removal of R_c from the regression. Overall, the positive β_y coefficients indicate that Tobin's Q is higher for firms with lower operating efficiency in terms of scale. This finding is inconsistent with the prior literature's interpretation of a high Tobin's Q being evidence of good firm performance. Instead, Tobin's Q appears to be inflated by underinvestment.

The adjusted R^2 of 7.01% indicates that a significant portion of the variability in Tobin's Q is attributable to variation in operating efficiency. The adjusted R^2 is only reduced slightly by the removal of R_c from the regression. However, equation (13) contains industry dummy variables that obscure the economic significance of the β coefficients. Therefore, we assess the economic significance of these coefficients using an alternative procedure. With σ_Q^2 and $\sigma_{R_y}^2$ denoting the variance of Tobin's Q and R_y, respectively, the proportion of the variance in Tobin's Q attributable to variation in R_y equals

$$\sqrt{\frac{\beta_y^2 \ \ \sigma_{R_y}^2}{\sigma_Q^2}}\,. \tag{14}$$

The variance in Tobin's Q attributable to variation in R_c is computed in a similar fashion conditional on β_c and $\sigma_{R_c}^2$ as

$$\sqrt{\frac{\beta_c^2 \ \ \sigma_{R_c}^2}{\sigma_Q^2}}\,. \tag{15}$$

According to Panel B of Table 1, the standard deviations σ_Q, σ_{R_y}, and σ_{R_c} average 1.07, 0.51, and 0.11, respectively, across the various industries. Along with the β_y estimate of 0.58 and β_c estimate of -0.34 in Table 3, these standard deviations imply that equations (14) and (15) are 0.276 and 0.035, respectively. Thus, a large component of the variability in Tobin's Q can be attributed to variation in operating efficiency pertaining to scale decisions.

3.2 Robustness Tests

Several robustness tests confirm our main empirical conclusion that lower operating efficiency in terms of underinvestment corresponds to a higher Tobin's Q. In particular, the β_y coefficients remain positive and significant in several alternative specifications for the dependent and independent variables in equation (13).

The first robustness test re-estimates the regression in equation (13) using time series averages of Tobin's Q, R_y, and R_c at the firm-level. This robustness test mitigates the errors-in-variables problem that arises from estimating a relationship between the expectations underlying the numerator of Tobin's Q and realized operating efficiency. For each firm, we first compute the time series averages of the dependent and independent variables. The beta coefficients are then estimated cross-sectionally from these time series averages, which generate 14,723 unique firm-level observations.[5] This robustness test also yields a significantly positive β_y coefficient of 0.38.

The results from the remaining robustness tests are unreported as they lead to nearly identical results as those in Table 3. Our second robustness test recognizes that total assets define the denominators of Tobin's Q as well as our operating efficiency measures. To mitigate the effect of outliers, we remove firms whose total assets are either below the 2^{nd} percentile or above the 98^{th} percentile. The β_y coefficient continues to be positive and significant after the removal of these firms. Thus, the relationship between operating efficiency and Tobin's Q is not driven by firms with extremely low or high assets. Our third robustness test uses property, plant, and equipment (PPE) to proxy for capital in the denominators of R_y and R_c. Using PPE instead of total assets as a proxy for capital also yields a significantly positive β_y coefficient. Lindenberg and Ross (1981) document considerable variation in Tobin's Q across different industries. Therefore, besides the use of industry dummies, our fourth robustness test examines industry-adjusted Tobin's Q measures. These measures normalize firm-level Tobin's Q metrics by their industry's respective mean and standard deviation. However, the β_y coefficient remains significantly positive when industry-adjusted Tobin's Q metrics are used as the dependent variable.

Finally, underinvestment is unlikely to be caused by financing constraints since firms with high R_y measures do not have abnormally low credit ratings. John and Litov (2010) also find that entrenched managers have better access to debt markets as a consequence of their conservative investment strategies.

Overall, better operating efficiency decreases rather than increases Tobin's Q. Therefore, our theoretical framework and empirical analysis both caution that a high Tobin's Q can result from underinvestment. As a consequence, the next subsection re-examines the relationship between corporate governance and firm performance using our operating efficiency measures that proxy for firm performance while avoiding the endogeneity problem underlying Tobin's Q.

[5] There are 13,082 unique firms in our sample, some of which change industries within the 1980 to 2008 sample period. A firm that changes industry is classified as a new firm and assigned a different industry dummy variable.

3.3 Does Better Governance Improve Firm Performance?

To evaluate the relationship between corporate governance and firm performance captured by our operating efficiency measures, we estimate the following regression specification

$$R_y = \alpha_0 + \alpha_1 \, \mathrm{G} + \alpha_2 \, \mathrm{IO} + \gamma \, X + \epsilon \,, \tag{16}$$

where G and IO denote the G index and institutional ownership, respectively. The X vector denotes industry dummy variables along with the log of total assets and the log of market capitalization that serve as control variables. Standard errors are clustered at the firm level. The above regression is also repeated with R_c as the dependent variable instead of R_y.

In contrast to equation (13), our framework does not specify an explicit function between governance, output, and costs. Nonetheless, a positive α_1 coefficient indicates that a high G index coincides with poor operating inefficiency, while a negative α_2 coefficient indicates that lower institutional ownership coincides with poor operating inefficiency. Naturally, conclusions based on equation (16) are derived from a joint hypothesis involving the ability of the G index and institutional ownership to correctly proxy for governance. Indeed, our framework provides theoretically-justified operating efficiency proxies for measuring firm performance but does not justify existing proxies for corporate governance.

Table 4 reports on the coefficient estimates in equation (16). With regards to the regression specifications that have R_y are the dependent variable, the positive α_1 coefficients for the G index and the negative α_2 coefficients for institutional ownership indicate that firms with weaker corporate governance underinvest. Evidence of underinvestment by firms with weak governance is not sensitive to the inclusion of size and total assets as control variables. Another specification removes the G index and focuses exclusively on institutional ownership to circumvent the limited availability of the G index. Once again, high institutional ownership continues to coincide with better operating efficiency in terms of scale. Overall, the empirical results in Table 4 suggest that better governance improves operating efficiency, hence firm performance.

However, the impact of corporate governance on cost discipline is not significant. Indeed, in the regression specifications that have R_c as the dependent variable, both the α_1 and α_2 coefficients are insignificant. The lack of empirical support for better governance improving cost discipline may result from the exclusion of cost of goods sold (COGS) from the numerator of R_c due to its high correlation with revenue in the numerator of R_y.

For emphasis, the novel implications of our framework arise from underinvestment not cost discipline. Moreover, regardless of the exact definition for total costs, our framework and its empirical implementation demonstrate that underinvestment confounds the relationship between Tobin's Q and firm performance. Our empirical evidence on underinvestment is obtained from revenue data that can extracted from COMPUSTAT without any uncertainty regarding its composition. In contrast, a variety of different costs are available and their sensitivity to governance can vary.

We briefly re-visit the issue of cost of goods sold to better understand its relationship with governance and to better interpret our results in the context of prior empirical studies. The numerator of return of assets (ROA) is defined as revenue minus COGS minus the numerator of R_c. In unreported results, a regression of ROA on the G index

$$\text{ROA} \;=\; \alpha_0 + \alpha_{\text{ROA}}\,\text{G} + \epsilon\,, \tag{17}$$

produces a negative α_{ROA}. This negative coefficient is consistent with the existing literature's finding that firms with more shareholder rights have a higher ROA, as in Gompers, Ishii, and Metrick (2003). By definition, ROA equals $R_y - R_{\tilde{c}}$ where $R_{\tilde{c}} = \frac{\text{COGS}}{\text{Capital}} + R_c$. When ROA in equation (17) is replaced with R_y and $R_{\tilde{c}}$ in two subsequent regressions

$$\begin{aligned} R_y &= \alpha_0 + \alpha_{R_y}\,\text{G} + \epsilon \\ R_{\tilde{c}} &= \alpha_0 + \alpha_{R_{\tilde{c}}}\,\text{G} + \epsilon \end{aligned}$$

the definition of ROA implies that α_{ROA} equals $\alpha_{R_y} - \alpha_{R_{\tilde{c}}}$. Empirically, we find that both coefficients are positive and significant, with α_{R_y} being lower than $\alpha_{R_{\tilde{c}}}$. Therefore, a lower G index coincides with better operating efficiency in terms of scale and cost discipline.

4 Conclusion

We provide a simple theoretical framework to demonstrate that underinvestment confounds the relationship between Tobin's Q and firm performance. In particular, better operating efficiency can either decrease or increase Tobin's Q depending on the relative importance of managerial decisions regarding scale and cost discipline, respectively. The existing literature's interpretation of a high Tobin's Q being evidence of good firm performance assumes that underinvestment is irrelevant, despite mounting empirical evidence to the contrary.

Our framework then develops two separate measures of operating efficiency that provide unambiguous proxies for firm performance. The first measure uses revenue to assess managerial decisions regarding scale, while the second measure uses costs to assess cost discipline. These operating efficiency measures are derived from the maximization of firm value net of invested capital, hence the maximization of a firm's net present value.

Empirically, the corporate governance index in Gompers, Ishii, and Metrick (2003) and institutional ownership indicate that better governance improves operating efficiency by mitigating underinvestment. However, better operating efficiency lowers Tobin's Q. This finding is consistent with underinvestment's ability to inflate Tobin's Q but is inconsistent with the prior literature's assumption that a high Tobin's Q is evidence of good firm performance.

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Table 1: Summary Statistics within Industries

Panel A and Panel B of this table reports industry-level averages and standard deviations, respectively, for Tobin's Q, the G index in Gompers, Ishii, and Metrick (2003), institutional ownership (IO), and our operating efficiency measures denoted R_y and R_c within the industry classifications of Fama and French (1997). The number of firms (N) within each industry is also reported. Our operating efficiency measures R_y and R_c are defined in equation (8) and equation (9) as $\frac{P_0 - \frac{y}{2a}}{k}$ and $\frac{c}{k}$, respectively. The demand curve $P_0 - \frac{y}{2a}$ determines the output price, hence revenue, corresponding to output y conditional on its intercept P_0 and the sensitivity of prices to output denoted a. The cost and capital associated with producing a single unit of output are denoted c and k, respectively.

Panel A: Average firm characteristics by industry

Industry	N	Tobin's Q	G	IO	R_y	R_c
Agriculture	38	2.77	7.95	0.59	0.91	0.02
Food Products	171	1.86	9.44	0.50	1.53	0.08
Confectionery	48	3.19	6.96	0.43	1.05	0.11
Liqueur	20	1.80	8.60	0.48	0.91	0.11
Tobacco	19	3.04	8.68	0.53	0.96	0.03
Toys	58	1.51	8.72	0.58	1.25	0.08
Entertainment	56	1.80	8.55	0.60	0.78	0.07
Publishing	157	1.87	9.34	0.63	0.92	0.12
Consumer Goods	209	2.06	10.26	0.58	1.33	0.10
Apparel	120	1.57	9.25	0.64	1.74	0.12
Healthcare	116	2.06	8.46	0.73	1.39	0.14
Medical Equipment	177	2.70	9.25	0.64	0.91	0.03
Pharmaceutical	301	3.41	9.00	0.60	0.67	0.03
Chemicals	243	1.74	9.94	0.64	1.01	0.04
Rubber and Plastic	48	1.78	10.04	0.63	1.08	0.03
Textiles	62	1.18	7.19	0.60	1.37	0.06
Construction Materials	251	1.62	9.82	0.59	1.20	0.03
Construction	94	1.33	8.98	0.64	1.35	0.02
Steel	190	1.27	9.65	0.62	1.09	0.03
Fabricated Products	29	1.35	9.38	0.57	1.13	0.01
Machinery	348	1.67	9.81	0.65	1.10	0.02
Electrical Equipment	169	2.03	9.38	0.58	0.91	0.05
Automobiles	201	1.45	9.92	0.58	1.56	0.04
Areospace	64	1.35	9.02	0.59	1.09	0.10
Railroads	30	1.33	7.90	0.62	0.99	0.03
Defense	24	1.78	8.42	0.62	1.02	0.09
Precious Metals	23	1.82	10.70	0.43	0.44	0.00
Mining	46	1.22	8.59	0.48	1.01	0.01
Coal	12	1.27	8.08	0.59	1.00	0.03
Petroleum and Natural Gas	350	1.59	9.01	0.63	0.83	0.03
Utilities	473	1.20	9.57	0.40	0.47	0.02
Communications	194	1.71	7.89	0.56	0.44	0.02
Personal Services	83	2.37	9.30	0.66	0.96	0.13
Business Services	399	2.30	8.68	0.66	1.35	0.17
Computer Hardware	264	1.96	8.54	0.61	1.09	0.03
Software	412	2.78	8.19	0.64	0.90	0.05
Semiconductors	473	2.16	7.91	0.65	0.91	0.02
Measurement Equipment	104	2.29	9.07	0.70	1.01	0.03
Paper	186	1.50	9.98	0.60	1.04	0.05
Shipping	55	1.59	9.40	0.62	1.24	0.06
Transportation	183	1.53	8.26	0.59	1.10	0.27
Wholesale	339	1.58	9.14	0.62	2.29	0.04
Retail	521	1.90	8.82	0.64	2.08	0.14
Restaurants and Hotels	190	1.93	8.84	0.61	1.14	0.15
Average	172	1.87	8.95	0.59	1.10	0.06

Panel B: Standard deviation of firm characteristics within industries

Industry	Tobin's Q	G	IO	R_y	R_c
Agriculture	1.74	2.46	0.24	0.59	0.03
Food Products	0.98	2.71	0.20	0.80	0.11
Confectionery	1.95	2.22	0.15	0.30	0.12
Liqueur	0.94	2.44	0.19	0.17	0.10
Tobacco	2.87	2.81	0.20	0.71	0.03
Toys	0.78	2.82	0.22	0.53	0.09
Entertainment	0.84	2.66	0.23	0.44	0.10
Publishing	0.74	2.68	0.17	0.38	0.13
Consumer Goods	1.28	2.59	0.23	0.57	0.12
Apparel	0.73	3.04	0.22	0.53	0.12
Healthcare	0.95	2.51	0.22	0.85	0.22
Medical Equipment	1.72	3.06	0.21	0.26	0.05
Pharmaceutical	2.30	2.58	0.23	0.59	0.05
Chemicals	0.78	2.58	0.17	0.38	0.07
Rubber and Plastic	0.83	2.46	0.20	0.32	0.05
Textiles	0.41	2.09	0.20	0.52	0.11
Construction Materials	0.77	2.77	0.20	0.44	0.04
Construction	0.48	3.31	0.24	0.77	0.02
Steel	0.48	3.01	0.19	0.41	0.08
Fabricated Products	0.38	3.54	0.22	0.23	0.01
Machinery	0.77	2.82	0.21	0.40	0.05
Electrical Equipment	1.60	3.11	0.23	0.38	0.10
Automobiles	0.64	2.60	0.20	0.59	0.09
Areospace	0.48	3.20	0.17	0.37	0.17
Railroads	0.46	1.73	0.25	0.50	0.10
Defense	0.87	3.09	0.25	0.22	0.20
Precious Metals	0.68	2.05	0.19	0.13	0.01
Mining	0.47	2.05	0.20	0.60	0.01
Coal	0.27	1.88	0.32	0.57	0.02
Petroleum and Natural Gas	0.69	2.66	0.23	0.72	0.08
Utilities	0.16	2.43	0.20	0.22	0.03
Communications	0.85	2.72	0.27	0.29	0.03
Personal Services	2.20	2.39	0.19	0.49	0.13
Business Services	1.64	2.34	0.23	1.06	1.07
Computer Hardware	1.87	2.45	0.20	0.49	0.02
Software	2.45	2.12	0.24	0.53	0.06
Semiconductors	1.71	2.64	0.23	0.45	0.04
Measurement Equipment	1.76	2.39	0.19	0.39	0.05
Paper	0.61	2.84	0.19	0.45	0.08
Shipping	0.93	2.32	0.17	0.40	0.09
Transportation	0.77	2.92	0.23	0.83	0.29
Wholesale	1.04	2.75	0.22	1.21	0.06
Retail	1.18	2.76	0.23	0.77	0.11
Restaurants and Hotels	1.18	2.68	0.23	0.56	0.20
Average	1.07	2.62	0.21	0.51	0.11

Table 2: Summary Statistics and Correlations

Panel A of this table reports on the distribution for Tobin's Q, the G index in Gompers, Ishii, and Metrick (2003), institutional ownership (IO), and our operating efficiency measures. The operating efficiency measures R_y and R_c are defined in equation (8) and equation (9), respectively, as $\frac{P_0 - \frac{y}{2a}}{k}$ and $\frac{c}{k}$. The demand curve $P_0 - \frac{y}{2a}$ determines the output price, hence revenue, corresponding to output y conditional on its intercept P_0 and the sensitivity of prices to output denoted a. The cost and capital associated with producing a single unit of output are denoted c and k, respectively. The correlations between the variables in Panel A along with market capitalization (Size) are reported in Panel B.

Panel A: Summary statistics

	Percentiles				
Variable	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}
Tobin's Q	0.970	1.152	1.474	2.121	3.295
G	5.000	7.000	9.000	11.000	13.000
IO	0.293	0.458	0.623	0.766	0.880
R_y	0.371	0.634	1.003	1.455	2.062
R_c	0.002	0.008	0.019	0.055	0.173

Panel B: Correlations

Variable	Size	Tobin's Q	G	IO	R_y	R_c
Size	1	0.270	-0.010	-0.010	-0.050	-0.010
Tobin's Q		1	-0.090	0.120	0.010	0.000
G			1	0.100	0.030	-0.020
IO				1	-0.010	0.020
R_y					1	0.120
R_c						1

Table 3: Tobin's Q and Operating Efficiency

This table reports the β coefficients from the regression specification in equation (13), $Q = \beta_0 + \beta_y R_y + \beta_c R_c + \gamma X + \epsilon$, which examines the relationship between Tobin's Q and operating efficiency. The X vector contains industry dummy variables according to the industry classifications of Fama and French (1997). Below each regression coefficient, t-statistics are reported in italics with the standard errors of the regression coefficients clustered at the firm level. The operating efficiency measures R_y and R_c are defined in equation (8) and equation (9), respectively, as $\frac{P_0 - \frac{y}{2a}}{k}$ and $\frac{c}{k}$. The demand curve $P_0 - \frac{y}{2a}$ determines the output price, hence revenue, corresponding to output y conditional on its intercept P_0 and the sensitivity of prices to output denoted a. The cost and capital associated with producing a single unit of output are denoted c and k, respectively.

	Dependent variable	Intercept β_0	Scale β_y	Costs β_c	Industry dummies	Adjusted R^2	Number of observations
Coefficient	Tobin's Q	0.95	0.58	-0.34	Yes	7.01%	95,318
t-statistic		*14.16*	*57.17*	*-7.74*			
Coefficient	Tobin's Q	0.90	0.57	-	Yes	6.95%	95,318
t-statistic		*13.47*	*56.77*	-			
Coefficient	time series	1.55	0.38	-	Yes	5.64%	14,723
t-statistic	averages	*13.47*	*46.77*	-			

Table 4: Firm Performance and Corporate Governance

This table reports the coefficient estimates from the regression specification in equation (16), $R_y = \alpha_0 + \alpha_1\,\mathrm{G} + \alpha_2\,\mathrm{IO} + \gamma\,X + \epsilon$, that examines the relationship between our operating efficiency proxies and corporate governance. The X vector contains the log of total assets and the log of market capitalization as well as industry dummy variables defined by the industry classifications of Fama and French (1997). Below each regression coefficient, t-statistics are reported in italics with the standard errors of the regression coefficients clustered at the firm level. Besides the G index of Gompers, Ishii, and Metrick (2003), institutional ownership (IO) proxies for corporate governance. The regression is also repeated by replacing the dependent variable R_y with R_c. The operating efficiency measures R_y and R_c are defined in equation (8) and equation (9), respectively, as $\frac{P_0 - \frac{y}{2a}}{k}$ and $\frac{c}{k}$. The demand curve $P_0 - \frac{y}{2a}$ determines the output price, hence revenue, corresponding to output y conditional on its intercept P_0 and the sensitivity of prices to output denoted a. The cost and capital associated with producing a single unit of output are denoted c and k, respectively.

	Dependent variable	Intercept α_0	G index α_1	IO α_2	log(size) γ_1	log(assets) γ_2	Industry dummies	Adjusted R^2	Number of observations
Coefficient	R_y	1.0754	0.0148	-0.2348	0.0377	-0.1030	Yes	37.19%	7,550
t-statistic		*-8.17*	*5.46*	*-6.82*	*4.44*	*-10.63*			
Coefficient	R_c	0.1905	-0.0005	0.0089	-0.0007	-0.0032	Yes	3.95%	7,550
t-statistic		*3.33*	*-0.44*	*0.60*	*-0.20*	*-0.75*			
Coefficient	R_y	1.2492	0.0089	-0.3089	-	-	Yes	36.08%	7,550
t-statistic		*23.44*	*3.29*	*-9.35*					
Coefficient	R_c	0.1605	-0.0008	0.0023	-	-	Yes	3.91%	7,550
t-statistic		*7.00*	*-0.69*	*0.16*					
Coefficient	R_y	1.3122	-	-0.0117	-	-	Yes	15.68%	94,200
t-statistic		*61.14*		*-4.50*					
Coefficient	R_c	0.2098	-	-0.0005	-	-	Yes	5.51%	94,200
t-statistic		*42.19*		*-0.77*					