Are Investors Aware of Relative Operational Inefficiency?

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Abstract:

Theory suggests that relatively inefficient firms should have lower and more uncertain future cash flows, which should lead to lower current equity values and higher future equity returns. However, the literature provides contradictory evidence on the relationship between operational efficiency and future stock performance. We provide evidence that investors are not fully aware of firms' operational inefficiencies and are negatively surprised when future negative earnings are announced, resulting in a significant negative drift in returns for these firms. Furthermore, we provide evidence that analysts do not properly incorporate information about operational inefficiency into their earnings forecasts and target prices, and do not seem to care about the issue during conference calls.

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I. Introduction

Firms use a mixture of inputs to produce and deliver output to their customers. Relative operational efficiency is an assessment of whether the mixture of inputs by a given firm is optimal. If the firm can produce and deliver the same outputs using a cheaper combination of inputs, then that firm is operationally inefficient. Similarly, a firm is inefficient if it can produce and deliver more outputs using its current mixture of inputs. Because of these wasted inputs, relatively inefficient firms generate lower cash flows than do efficient firms. In addition, their future cash flows are likely to be inferior to operationally efficient firms if their inefficiency persists in the future or if inefficient firms use future resources to address these inefficiencies. For example, upgrading production or distribution channels would require additional future cash flow that efficient firms would not need to spend. Future cash flows of inefficient firms are also likely to be riskier than those of efficient firms because adverse changes in input costs will likely affect inefficient firms more negatively than efficient firms. Thus, we expect that firms with low operational efficiency have a lower value than efficient firms because of their lower future cash flows and higher risk. The lower value, together with the higher risk, should result in future higher returns on the stocks of inefficient firms than those of efficient firms.

Notwithstanding the importance of operational inefficiency, only a handful of studies have examined this issue, and the results are contradictory. Nguyen and Swanson (2009) find that the stock returns of inefficient firms outperform those of efficient ones. In stark contrast, Frijns et al. (2012) document that the future returns on stocks of inefficient firms underperform those of efficient firms. Baik et al. (2012) find that changes in efficiency are positively associated with current and future equity returns and firm profitability.

Given this conflicting evidence, we investigate whether investors properly understand the implications of relative operational inefficiency on future returns. We provide evidence that investors seem to underestimate the importance of operational inefficiency on future cash flows and are seemingly "surprised" when future earnings of operationally inefficient firms disappoint, leading to negative future abnormal returns. We also show that sophisticated investors tend to set the forecasts of future earnings of inefficient firms too high and then revise them downwards. In addition, financial analysts set the target prices of inefficient firms during the year after measuring operational efficiency to imply a higher rate of return than those of efficient firms. Finally, we

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provide evidence that analysts do not consider operational efficiency an important issue; they do not discuss efficiency issues extensively in earnings conference calls, and even less so for the most inefficient firms.

Thus, taking all of our evidence together, it seems that investors and analysts do not adequately incorporate the implications of relative operational inefficiency into their assessments of cash flows and stock returns. We do not provide any reason for this failure by analysts or investors to incorporate inefficiency into their forecasts or prices, but can only conjecture that one plausible reason is that the measurement of relative inefficiency is not trivial.

This study contributes to the literature in several ways. First, only a few large-scale studies examine the issue of relative operational efficiency using production frontier analysis, and they provide contradictory results. We offer a fresh look using more current samples and employ additional analyses that were not used in prior studies. Second, we focus not only on immediate and subsequent returns but also on the potential persistent bias of sophisticated investors, that is, financial analysts. Finally, we provide additional direct evidence of efficiency by examining efficiency-related topics in earnings conference calls.

The following section provides a brief review of efficiency measurements and a discussion of studies on the relationship between efficiency and stock returns. Section 3 describes the outputs, inputs, and other data used to estimate operational inefficiency. Section 4 provides and discusses the empirical results, and Section 5 concludes the paper.

II. Efficiency: Background and Literature Review

1. Efficiency Measurement

The most common efficiency analysis involves comparing the observed and optimal output and input values. The analysis can be output-oriented, that is, the ratio of actual output to the maximum obtainable output given the level of actual inputs. Alternatively, it can be input-oriented, that is, the ratio of actual inputs to the minimum level of inputs required to produce a given level of actual outputs. In both instances, inefficiency is termed "technical inefficiency" or TE. Debreu (1951) and Farrel (1957) (DF) suggested measuring technical inefficiency as the largest possible *proportional* reduction in inputs that allows the firm to attain the same level of output.

The economics literature offers two broad methods to estimate inefficiency: Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA). SFA involves estimating a

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production frontier as a function of inputs, where deviations from the frontier are assumed to be related to production inefficiency and statistical noise. A firm's specific mean inefficiency is estimated based on the total deviation of actual production from the frontier. DEA requires only input-output quantity data and involves linear programming methods to construct a non-parametric piecewise linear frontier over the data. Any deviation from the frontier is solely attributed to inefficiency in production. The construction of the frontier also requires an assumption of economies of scale – constant, increasing, decreasing, or variable returns to scale. In this study, we estimate the production inefficiency using DEA.

DEA was first proposed by Farrel (1957) but did not receive much attention until the publication of Charnes, Cooper, and Rhodes (1978) (henceforth, CCR). Since then, more than 40,000 articles citing CCR have appeared in the literature. Such rapid growth and widespread acceptance of the methodology are testimony to its strength and applicability. The primary purpose of DEA is to measure the relative inefficiency of groups of firms in the same industry. CCR proposed a model with an input orientation and assumed constant returns to scale (CRS). Subsequent studies have considered alternative sets of assumptions, such as Bankers, Charnes, and Cooper (1984), in which a variable returns to scale (VRS) model was proposed. We used the VRS model for our analysis.

We start with notation. Assume that there is data on K inputs and M outputs for N firms. The firms are indexed by i and the matrices of inputs and outputs are represented by **X** and **Y**, respectively. The inputs and outputs of the ith firm are represented by $\underline{x}_i$ and $\underline{y}_i$, respectively.

Consider the mathematical programming problem of an input-oriented model:

$$\min_{q,l} \quad q_{it} \qquad \text{(A1)}$$

$$\text{st} \quad -\underline{y}_{it} + \mathbf{Y}_t\underline{l}_t \geq 0, \qquad \text{(OC)}$$

$$q\underline{x}_{it} - \mathbf{X}_t\underline{l}_t \geq 0, \qquad \text{(IC)}$$

$$\underline{e}'\underline{l}_t = 1, \qquad \text{(ES)}$$

where q is a scalar that equals the inefficiency score of firm i, t is a time index, $\underline{l}$ is a vector of constants, and e is an N´1 vector of ones. The value of the obtained q, $0<=q<=1$, is the efficiency score for the i-th firm, where q=1 indicates a point on the frontier, and hence, an efficient firm. The linear programming problem is solved N times once for each firm in the sample, and a value of q is obtained for each firm. The problem first determines the most efficient firms and the firms that comprise the frontier. Next, for each inefficient firm, the problem minimizes q subject to the

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Output Constraint (OC), Input Constraints (IC), and Economies of Scale (ES) constraints. The first two constraints seek to radially contract the input vector $\underline{x}_i$ as much as possible while still remaining within the feasible input set and producing output vector $\underline{y}_i$. Radial contraction is a result of a convex combination, where $\underline{l}$ is the vector of weights of efficient firms'[1] inputs and outputs. The vector of weights, $\underline{l}$, is constructed such that the convex combination of the efficient firms' outputs yields the same vector of outputs of the inefficient firm while producing it with the minimum feasible inputs. The third constraint, ES, restricts the solution to the variable returns to scale assumption by imposing a convexity constraint, whereby the projected point of an inefficient firm will always be a convex combination of observed firms.

Efficiency is measured in a Pareto sense: an efficient firm cannot improve efficiency by changing the combination of inputs; that is, there is no alternative weighting scheme that could yield a higher relative efficiency score for that firm. The inefficiency score of an inefficient firm measures the degree of inefficiency relative to the nearest (efficient) firm on the frontier and indicates the extent to which the firm should increase output (for a given level of inputs) or reduce inputs (for a given level of outputs).

2. Literature Review

As discussed, three studies examine the relationship between efficiency and stock returns. However, the results of these studies are contradictory and leave us with ambiguity that needs to be resolved using additional evidence. Nguyen and Swanson (2009) use SFA to estimate efficiency in a sample covering 1980-2003. The output variable is the market-to-book ratio. Hence, their efficiency measure is not an operational efficiency measure but rather a measure of the distance of the firm's market-to-book ratio from the highest possible market-to-book ratio for a given choice of input. They provide evidence that the deciles of the most inefficient firms have higher excess and characteristic-based returns than those of efficient firms. [2] Furthermore, a direct regression of future returns on the efficiency score shows that the coefficient of the efficiency score is negative and significantly different from zero. Thus, their results are consistent with the expected risk premium for investors in inefficient firms.

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[1] The convex combination may also be of observed firm and the origin.

[2] Their results hold for equally weighted returns. Using value weighted returns, there is no difference in the returns across efficiency deciles. In addition, they also provide evidence that efficient firms earn abnormal returns. While this result is potentially intuitive, there is no reason to expect that the market rewards firms for being efficient.

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However, there are several issues when using market-to-book ratio as a measure of output. First, the denominator is affected by accounting standards (e.g., non-recognition of internally generated intangibles), the application of accounting standards (e.g., differences in conditional conservatism), and incentives (e.g., earnings management). Second, market value is affected by many variables unrelated to the efficient use of assets such as industry or economic factors. Third, the choice of inputs is ad hoc and includes a mix of assets, liabilities, revenues, and expenses with overlapping variables (e.g., they use both total assets and property, plant, and equipment as inputs).

Frijns et al. (2012) use DEA to estimate efficiency in 1988-2007. They estimate the frontier using the sales and market values of equity as outputs. Their results are diametrically opposite to those of Nguyen and Swenson (2009) and are inconsistent with the risk premium explanation for inefficient firms. Specifically, they show that the most efficient firms earn a positive and significantly higher return than inefficient firms, and that there is a positive and significant relationship between efficiency and future returns, indicating that more efficient firms earn higher future returns. However, they do not explain their internally inconsistent results or the different results from those of Nguyen and Swenson (2009). It should be noted that in their DEA estimation, they do not control for intangibles and off-balance sheet assets–assets under operating leases.

Baik et al. (2012) use both DEA and SFA to measure *changes in efficiency* using the Malmquist index for the years 1976-2008. They report a high correlation between the two efficiency measures of DEA and SFA and a positive and significant relationship between changes in efficiency and contemporaneous and one-year ahead profits, indicating that improving efficiency also enhances profitability. They also find that changes in efficiency are associated with both current and future returns, suggesting that investors immediately impound efficiency changes into prices and increase current market values for firms that have efficiency improvements. However, inconsistent with the explanation of the risk premium for inefficient firms, they find that future returns are also positively and significantly associated with efficiency improvements, suggesting that investors partially incorporate efficiency information into prices. Baik et al. (2012) also provide evidence that analysts revise their earnings forecasts after witnessing the change in efficiency in the same direction as the change in efficiency. An important feature of the analysis by Baik et al. (2012) is that they show that the DEA and SFA measures of

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operational inefficiency contain incremental information about inefficiency relative to simple financial ratios, indicating that the latter do not provide a comprehensive measure of inefficiency.

Overall, while theory suggests that investors should require higher returns to invest in inefficient firms to compensate for additional risk, the evidence in the literature is contradictory. The evidence that supports this theory (Nguyen et al., 2009) is not based on operational efficiency per se, but rather on efficiency relative to the market-to-book frontier. The evidence in Frijns et al. (2012) is opposite to the theory, yet they stop short of explaining their findings.

III. Data and Efficiency Estimation

We obtain accounting data from Compustat, returns from the CRSP, and forecast data from the IBES. Our sample begin in 1996 and ends in 2020. The merged dataset included 137,992 firm-year observations. We exclude small firms from the sample–firm-year observations with total sales or market caps less than 10M. In addition, we exclude firms with zero or missing property, plant, and equipment (PPENT) and firms with missing income before extraordinary items (IB), total assets (AT), stockholders' equity (CEQ), or some of the variables used in the DEA estimation. The sample used for the efficiency estimation is 114,215 firm-years.

There are three empirical choices for efficiency estimation. First, the choice of outputs and inputs; second, the cross-section; third, the time period. In theory, DEA should be estimated using the observed quantities of outputs and inputs. As quantities are not observed, we use total revenue as a single output, which measures the total value of all outputs produced. The definitions of the outputs and inputs vary considerably in the literature. For example, Demerijian et al. (2012) use sales revenues as output and seven inputs (net PP&E, net operating leases, net capitalized R&D, purchased goodwill, other intangible assets, cost of goods sold, and SG&A expenses); Nguyen and Swanson (2009) use the market value of equity as output and various financial statement variables (such stockholders equity, debt, capex, and EBITDA); and Frijns et al. (2012) use sales revenues as output and five inputs (net PP&E, assets other than net PP&E, cost of goods sold, capex, and SG&A expenses). We use a combination of long-term and intermediate assets. Specifically, long-term assets comprise tangible and intangible assets. Tangible assets include property, plant, and equipment, net (PPENT), and assets under operating lease, where the latter are computed as the present value of the next five years of required operating lease payments (MRC1-MRC5), using a

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10% discount rate. Intangible assets include reported intangibles (INTAN) and R&D capital. We follow Lev and Sougiannis (1996) and Demerijian et al. (2012) and compute R&D capital as the sum of R&D expenses (XRD) over the past five years net of accumulated amortization, assuming a yearly amortization rate of 20%. Intermediate assets include inventory sold during the year (COGS). In addition, we use selling, general, and administrative expenses (XSGA) as another input because it includes other intangible-related expenses (advertising), as well as the cost of employees. Since the XSGA includes R&D expenses, we use the XSGA net of current-year R&D expenditures.

We estimate the efficiency at the industry-year level. This is because industries differ considerably in their technology and asset mix. Further, to ensure that our efficiency measure reflects the most relevant operating performance, we estimate DEA based on the most recent accounting data available in May each year.[3] The industry-year estimation requires us to use a wide definition of industry to obtain a sufficient number of observations per industry-year group. For this reason, we opt to use the 2-digit level GIC code because a finer classification (such as 4-digit level GIC or Fama-French industry classification) would result in an insufficient number of observations for certain industry-year cross-sections.[4] The number of observations per industry year varies from 23 to 1,249, with a mean (median) of 418 (310).[5]

Table 1 presents descriptive statistics for the main variables. Panel A shows statistics related to the efficiency score by industry. The overall mean (median) efficiency is 0.68 (0.72). These statistics are between those reported by Demerijian et al. (2012) - 0.57 (0.59) and Nguyen and Swanson (2009) - 0.7 (0.72). There is a variation in firm efficiency across industries. The mean efficiency ranges from 0.43 in the Financials industry to 0.87 in the Utilities industry. Untabulated

[3] Since over 80% of Compustat firms have December or January as their fiscal year-end, annual data for the prior year is typically updated in the Compustat database by the end of May for most firms.

[4] See Demerijian (2018) for an extensive and comprehensive discussion of measurement issues related to DEA.

[5] The issue of the number of observations naturally affects the properties of SFA estimation. The economics literature provides numerous production functions, such as Cobb-Douglas, Leontief, CES, and Linear functions. These functions, however, place a-priori restrictions on either the substitution possibilities among the factors of production or on scale economies. To avoid these restrictions, one can use the translog production function, which is a flexible functional form that can be used to approximate any twice-differentiable function without placing a-priori restrictions on the production technology. However, the translog function includes n*(n+3)/2 parameters to be estimated where n is the number of inputs, and the regression variables include interactions among the inputs. Consequently, the translog requires a large number of degrees of freedom as well as multicollinearity considerations. The sample size is obviously an issue if one is interested in estimating efficiency on an annual level.

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results indicate that, with the exception of 1996, the mean and median efficiency across years are fairly stable and ranges from 0.66 0.7. Mean efficiency in 1996 was 0.78.

Panel B presents the descriptive statistics for the main variables used in the analyses. Similar to the findings reported in the extant literature, the panel shows that the sample suffers from right skewness, and there is large variation across the sample observations, indicating that the sample is diverse and consists of firms with different characteristics. Panel C reports the mean (median) of the firm characteristics using efficiency quintiles. Efficiency is positively associated with size; large firms are more efficient than small firms. In addition, return on equity (ROE) and profit margin increase monotonically with efficiency. For example, the mean (median) ROE in the lowest efficiency quintile was -0.067 (0.007), whereas that for the highest efficiency quintile was 0.046 (0.052). The mean book-to-market ratio is the highest for the most and least efficient firms, but the median book-to-market ratio indicates a monotonic decrease with efficiency. Except for the lowest efficiency quintile, we observe an increasing relationship between DEA efficiency and asset turnover, a commonly used measure of efficiency. Taken together, the panel shows that efficiency is positively associated with firm size, profitability, and asset turnover.

IV. Results

1. Efficiency and Future Stock Returns

We start by analyzing the relationship between efficiency and future returns using a simple univariate analysis. Table 2, Panel A presents the mean and median equally weighted and value-weighted monthly returns in the 12 months from June of year t to May of year t+1. The table shows an increasing pattern in returns across quintiles up to quintile 4: the mean return for the least efficient firms is 0.6%, whereas for quintile 4, the mean return is 1.1%. The mean return for most efficient firms was 0.9%. Although the mean and median raw returns of the lowest-efficiency quintiles are smaller than the corresponding statistics for the most efficient firms, the difference is not significant.

Given the results in Table 1, where we observe that efficiency is positively associated with firm size and the book-to-market ratio, we report the mean of equally weighted monthly returns for portfolios formed on the basis of the intersection of independently formed quintiles of efficiency and quintiles of size (Panel B), and the intersection of independently formed quintiles of efficiency and quintiles of book-to-market (Panel C). The results indicate that the least efficient

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firms earn significantly lower returns than the most efficient firms for the smallest firms (quintile 1) as well as for the largest firms (quintiles 4 and 5). The results are similar for book-to-market; efficient firms significantly outperform inefficient firms in the lowest B/M quintiles and the two top B/M quintiles, and the difference is the most pronounced for the highest B/M (value) quintile at 0.6%. Overall, the results in Table 2 are consistent with the evidence in Frinjns et al. (2012) and suggest that, compared to efficient firms, inefficient firms earn lower returns in subsequent periods, but more so for large and value firms.

Table 3, Panel A presents results of the five-factor Jensen's alpha for equally and value weighted portfolios. We use as factors the market risk premium, size premium, value premium, investment factor, and the momentum factor.[6] The alpha for the most inefficient firms is negative for both equal and value weighted returns, -0.34% and -0.30%, respectively, and is highly significant (p-value<1%). The alphas increase almost monotonically across the efficiency quintiles for both equal and value-weighted returns, but is not statistically significant, except for quintile 2 where it is still negative and significant at the 10% level. The alpha of the hedge portfolio is 0.32% and 0.35% (p-value<1%) per month for the equal weighted and value weighted returns, respectively, but the returns on the hedge portfolio are attributed to the short side (inefficient firms). The coefficients on the risk factors are quite similar across efficiency quintiles for equal-weighted returns. The negative coefficient on SMB for the hedge portfolio indicates that the inefficient quintile is tilted to smaller firms. Taken together the results appear to suggest that investors do not appreciate [in]efficiency sufficiently - inefficient firms tend to underperform in subsequent periods.

Although the results indicate a relationship between efficiency and future monthly returns, it is conceivable that the results may be attributed to other correlated factors that are unrelated to efficiency. We explore this possibility by creating an efficiency factor and examining whether returns are sensitive to this factor (controlling for other risk factors). The efficiency factor is computed in a manner similar to that of the Fama – French factors. We first identify the quintiles of the most and least efficient firms in each month based on their most recent efficiency scores. We then compute the difference between the equal-weighted returns on the most and least efficient portfolios. Untabulated results show that the mean and median monthly returns of the efficiency

[6] Profitability is another commonly used factor. However, given that efficiency is negatively associated with profitability almost by construction we do not include this factor in the regressions.

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factor are 0.34% and 0.23%, respectively, and range from -8% to 5%. Panel B of Table 3 shows the results for the equal-weighted returns (the results are similar for value-weighted returns). What is striking is that the efficiency factor loads negatively and significantly for the least efficient firms but loads positively and significantly for the more efficient firms. This indicates that for inefficient firms, the more inefficient they are, the lower their returns. The opposite is true for more efficient firms; the more efficient they are, the higher their returns. This is contrary to the risk-premium explanation of inefficiency. As before, we continue to observe a negative and significant alpha for the least efficient firms, although the alpha is about 50% lower than that reported in Panel A (-0.17% compared with -0.344%). We continue to see that there is no significant alpha in the quintile of the most efficient firms, although its alpha is positive.

To further examine the robustness of our results, we follow Daniel et al. (1997) methodology and report the time-series mean of the benchmark-adjusted return. We compute benchmark-adjusted returns as the buy and hold monthly returns on a stock minus the buy and hold monthly returns on a portfolio of similar stocks in terms of size (three groups), B/M (three groups), and momentum (three groups). Panel A of Table 4 shows the mean benchmark-adjusted returns across the efficiency quintiles. The returns for the lowest efficiency quintile are negative and increase almost monotonically across quintiles of efficiency. The difference between the returns of the most efficient and least efficient portfolios is 0.3% per month, which is highly significant ($p < 0.01$). While, in theory, benchmark-adjusted returns are adjusted for risk factors, quintiles may still covary with risk factors. Hence, we regress benchmark-adjusted returns against the Fama-French and Carhart (1997) factors. The results are presented in Panel B. Consistent with the univariate returns, we observe that the alpha is the most negative for the least efficient firms (-0.04%). In addition, alpha increases across quintiles and remains negative and significant for quintiles 2 and 3. The alpha of the hedge portfolio is positive and significant at 0.03% per month. These results further corroborate the finding that inefficient firms do not have risk premiums. In fact, they have lower subsequent returns, which is consistent with investors not fully appreciating the impact of efficiency on future returns.

As an additional analysis, we regress monthly returns in excess of the risk-free rate on size, book-to-market ratio, and efficiency. Untabulated results show that monthly returns increase with efficiency and efficiency rank.

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Taken together, we find that inefficient firms earn negative returns in the subsequent periods. This result is puzzling; given that these companies are riskier, one would expect investors to demand higher equity returns to compensate for additional risk. We posit that investors are somewhat myopic with respect to efficiency, and seem to ignore its importance. We test this conjecture by (a) showing that efficiency is highly persistent and has a strong effect on profitability; and (b) analysts fail to fully recognize the effect of efficiency on earnings; hence, these firms tend to have more negative earnings surprises. In other words, negative returns to the least efficient firms may represent a delayed price reaction.

2. Efficiency: Persistence and Effect on Profitability

In this subsection, we examine the persistence of efficiency and its effects on profitability. Panel A of Table 5 presents the transition probability matrix over time. We observe that the efficient rank is stable over time, especially for the least and most efficient firms. In both extremes, the probability of remaining in the same efficiency rank in the subsequent period is 78% and 75% for the lowest and highest efficiency ranks, respectively. Table 5, Panel B presents the results of regressions of each of the level efficiency and efficiency quintiles in year t on their corresponding variables in year t-1, controlling for firm size, book-to-market ratio, and combinations of firm, year, and industry fixed effects. The results indicate that both the level of efficiency and its rank are highly persistent. For example, the persistence of the efficiency score (rank) is 0.78 (0.73) when we control for industry- and year-fixed effects.

Table 5, Panel C presents the results of regressions of the Return on Assets (ROA) on current period and lagged efficiency. We control for factors that were shown to be related to profitability, namely, operating margin, size, book-to-market ratio, sales growth rate, and R&D intensity. Columns 1 examines the relation between contemporaneous ROA and efficiency. The coefficient on efficiency is positive and highly significant. The positive effect of efficiency on profitability is also economically significant - a change of one standard deviation in efficiency is associated with a 0.13 standard deviation change in ROA.[7] Columns 2-5 examine the predictive effect of efficiency and efficiency rank on *future* ROA. The regressions indicate that ROA is positively associated with lagged efficiency and lagged efficiency rank even after controlling for their contemporaneous

[7] For comparison purposes, the economic effect of operating margin, size, book-to-market ratio, R&D intensity, and sales growth rate is 0.55, 0.16, -0.001, 0.03, respectively.

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values. Taken together, the evidence in Table 5 suggests that efficiency is highly persistent and that efficiency in the current period is positively associated with future ROA, that is, efficiency has a predictable effect on future ROA.

3. Do analysts fully incorporate the implications of efficiency on future profitability?

One potential explanation for the negative future performance of inefficient firms is that analysts (and other market participants) do not fully incorporate the properties of efficiency when forming earnings expectations; consequently, when earnings are reported, a negative earnings surprise leads to negative stock returns.

3.a Conference Calls

We begin the analysis by examining the extent to which analysts and managers discuss the issue of efficiency during conference calls. If analysts and managers believe that a firm's efficiency is important, then we expect that there will be discussion of the issue during conference calls, especially for those firms that are the least efficient. To facilitate the analysis, we conduct a textual analysis of all conference calls of our sample firms to determine whether efficiency is discussed and how many times it is discussed during the call. We use 10 key concepts related to efficiency and then employ Natural Language Processing (NLP) to count the number of times these key concepts appear in the transcript of earnings calls. Our analysis of conference calls breaks down the text into management sentences and analysts' sentences. We extract efficiency-related concepts separately. Please refer to Appendix B for a detailed discussion of the data collection procedure and efficiency concepts.

Table 6, Panel A provides descriptive statistics related to the discussion of the efficiency key concepts during conference calls. The first and second columns show the mean of the number of times that efficiency key concepts are discussed by analysts and management, respectively. The third column shows the mean of Efficiency Discussed indicator, which takes the value of 1 if any of the efficiency key concepts is mentioned either by managers or analysts during the conference call and zero otherwise. The results suggest that efficiency is discussed in about 48% of the conference calls. In addition, somewhat surprisingly, there is an inverse relation between the level of efficiency and the extent to which it is discussed during the conference calls. Efficiency is discussed in 36.3% of the conference calls of the least efficient firms whereas the corresponding

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figure for all other firms is about 40% higher - 51.4% - and the difference is statistically significant. Interestingly, the mean of the variable is increasing monotonically up to quintile 4 where it is close to 57% but then drops to 44% in quintile 5.

While the data show that efficiency is discussed in almost 50% of conference calls, it appears that the discussion of efficiency is driven primarily by management. In fact, analysts appear to care less about efficiency than management. Whereas managers discuss on average 1.7 efficiency terms during conference calls, analysts discuss efficiency only 0.29 terms. The fourth and fifth columns show that when we restrict the sample to conference calls where efficiency is discussed, managers discuss the issue 3.5 times on average, whereas analysts discuss it 0.6 times only.

The panel also shows that the lowest frequency of efficiency discussions, both by managers and analysts, is for the most inefficient firms; efficiency is discussed 1.272 times (0.185 by analysts and 1.086 by management) for the least efficient firms, but 2.085 times (0.322 by analysts and 1.863 by management) for all other firms. The results may be affected by the fact that some firms and analysts are completely agnostic about operational efficiency. Furthermore, when we restrict the analysis to conference calls where efficiency is discussed at least once, we obtain very similar results: there is an inverse relationship between the level of inefficiency and its discussion during conference calls.

Notwithstanding the trend across efficiency quintiles, an average of 4.142 concepts (0.609 by analysts and 3.533 by management) (for firms that discussed efficiency at least once during the sample period) indicates that efficiency is not seriously discussed. Untabulated analysis shows that efficiency is discussed more than nine times during conference calls in approximately 10% of the sample firm-years. Even within this restrictive sample, efficiency is discussed on average 11.7 times overall, with 11.2 (11.9) times for the least efficient firm (all other firms), and the difference is highly significant. When we look at analysts and manager separately, we find that analysts (managers) discuss efficiency 1.87 (9.24) for the least efficient firms and 1.86 (9.98) for all other firms, and the difference is significant only for managers. Hence, even if we restrict the sample to cases in which efficiency is extensively discussed, we do not observe a positive relationship between the level of operational inefficiency and the number of times the issue is discussed. Similar to our observations for all conference calls, analysts seem to be oblivious to the issue even in conference calls where efficiency is extensively discussed.

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Panel B in Table 6 presents the regression results. To compare the extent of the efficiency discussion during conference calls between the least efficient firms and all other firms, we create an indicator for the least efficient firms that takes the value of one if the observation is in the lowest efficiency quintile. We control for size, book-to-market ratio, number of analysts covering the firm, sales growth rate, and R&D intensity. The dependent variables are the efficiency indicator and the number of times efficiency is discussed by managers or analysts. We estimate the regressions using probit and tobit, controlling for firm and year effects. The coefficients on the control variables indicate that efficiency is less of an issue for high-growth firms (high R&D intensity, high growth rate, and low book-to-market ratio) and profitable firms, but is an important issue for larger firms. More importantly, controlling for all these factors, we still observe that the issue of efficiency is discussed less for the least efficient firms than for all other firms.

The above results suggest that analysts do not consider operational efficiency to be an important aspect of performance that warrants further discussion in conference calls. Neither managers nor analysts seem to recognize differences in level efficiency, as the extent to which efficiency is discussed is *negatively* associated with the level of inefficiency. These results are surprising given the economic effect of efficiency on contemporaneous and future profitability. In addition, we find that efficiency is persistent and affects earnings in future periods. Hence, we next examine whether analysts consider the effect of efficiency on future earnings when forming earnings and target price forecasts.

3.b Analysts' Earnings and Target Price Forecasts

We start the analysis by examining forecast revisions, the proportion of negative earnings surprises, implied returns, and target price ratios by efficiency quintile. For each company, we select all revisions that occurred during the subsequent 365 days from June of year t to the end of May of year t+1. We calculate the forecast revision as (up-down)/(up+down+zero), where up (down) is the number of revisions upwards (downwards) and zero represents the number of forecasts that do not change. Hence, this variable shows whether analysts became more optimistic (i.e., positive sign) or pessimistic (negative sign) about a firm in the following year. The proportion of negative earnings surprises is computed based on the difference between the mean forecast and actual earnings of individual analysts for each firm quarter, where the mean forecast is the average of the most recent quarterly forecast of each analyst during the 90-day period prior to the earnings

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announcement date. Actual earnings are the IBES actual quarterly earnings. Thus, this variable measures the extent to which analysts are optimistic (or pessimistic) about a firm's earnings before the earnings announcement date. Together, these two variables capture whether analysts consider the effects of inefficiency on subsequent earnings when forming earnings expectations.

We compute the implied return as follows: For each target price made in the subsequent 365 days, we compute the implied return as the target price divided by the share price on the prior day. Implied returns are the average of all individual implied returns for the following year. The target price ratio is computed as the average of all target prices made during the following year scaled by the share price on the portfolio formation date. The latter two variables measure the extent to which analysts bullish a firm's value.

Table 7, Panel A, presents descriptive statistics. Looking at the overall mean, we observe that analysts on average revise their forecasts downwards during the year, consistent with the general evidence that analysts are on average too optimistic. In addition, the overall mean of the proportion of negative earnings surprise is 0.34. The implied returns and the Target Price Ratio are quite high, with an average implied return of 72% and target prices being higher than the price at the beginning of the year by 150%. The average number of analysts per firm is around 20.

More importantly, the panel shows variations in the variables across the efficiency quintiles. The number of analysts covering the least efficient firms is the smallest (14.5), and it increases monotonically with the efficiency quintile, consistent with the positive correlation between efficiency and size. While there is no discernible pattern in the forecast revision variable, it is more negative for quintiles 1-3 relative to quintiles 4 and 5. Additionally, there is a monotonic negative relationship between the proportion of negative earnings surprises and efficiency. The proportion is over 39% for the least efficient firms and decreases to 30% for the most efficient firms. The bottom row of the panel compares the variables between the least efficient and all the other firms. This shows that the earnings revisions (proportion of negative earnings surprises) for the least efficient firms are significantly more negative (higher) than for all other firms.

With the exception of quintile 5, we observe a decreasing monotonic relationship between each implied return and the target price ratio and efficiency. The implied return (target price ratio) for the least efficient firms is 101% (227%), which decreases to 49% (99%) for firms in quintile 4. In addition, the implied return (target price ratio) for the least efficient firms is approximately 36% (91%) higher than that for all other firms. One clear explanation for this evidence is the size

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effect, as the least efficient firms are smaller. However, ignoring the size effect, one could argue that the statistics imply that analysts forecast higher returns for the least efficient firms as compensation for the risk associated with inefficiency. However, if this argument is correct, we would expect more pessimism, contrary to what we find in their earnings expectations, as there are, on average, downwards revisions, which means that earnings expectations were too high. A more plausible explanation is that analysts are too optimistic about inefficient firms' prospects because they do not fully incorporate the effect of inefficiency on future earnings.

Table 7, Panel B shows the regression results which adjust for the potential effects of size and growth. As before, we create an indicator for the least efficient firms which takes the value of 1 if the observation is in the lowest efficiency quintile. We control for size, book-to-market ratio, number of analysts covering the firm, sales growth rate, and R&D intensity. The regressions also include firm and year fixed effects, and the standard errors are clustered at the firm level. The results are consistent with the univariate statistics; analysts are relatively more optimistic about the prospects of the least efficient firms - they predict higher target prices (and, consequently, higher implied returns) and more optimistic earnings forecasts which they then subsequently revise downwards. In addition, there is a higher likelihood of negative earnings surprise. Taken together, the evidence in Table 6 suggests that analysts do not fully incorporate the issue of inefficiency when forming earnings forecast or setting up their expectations for future stock prices either because they fail to recognize the issue of inefficiency altogether or alternatively consider the effect of inefficiency to be temporary.

d. Delayed Reaction Analysis

Thus far, the evidence provides an indirect explanation for the negative performance of least efficient firms. If investors do not fully consider the effect of inefficiency on future earnings, that is, if the negative abnormal returns represent a delayed response to the predicted negative earnings surprise, then the negative abnormal returns should be concentrated around future earnings announcements.

Table 8, Panel A shows the Cumulative Abnormal Returns (CAR) in the three days centered on the earnings announcement date for each of the quarters in the year following the portfolio formation (Q1-Q4) date. We compute abnormal returns as the 3-day returns on a stock minus the return on a portfolio of similar stocks in terms of size, B/M and momentum. In addition, the table

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reports the sum of the CARs - column labeled - All EA. This column measures the overall CAR earned around the earnings announcement dates during the year. Finally, the Annual column shows the buy and hold total abnormal returns for each efficiency quintile over the year.

The results across the four quarterly earnings announcement dates are similar: the least efficient returns earn the lowest CAR, and the hedge portfolio–long (short)–on the most (least) efficient firms earn a CAR of between 0.3% and 0.8% for each quarter. The total quarterly CARs of the hedge portfolio is 3.4%, whereas the total annual CAR of the portfolio is 4.4%. Hence, over 77 percent of the predictable stock returns are concentrated around subsequent earnings announcements for the hedge portfolio. Panel B shows the total quarterly CARs for the least and most efficient portfolios by year. The results are robust. The hedge portfolio earns positive returns in each year of the sample, which is inconsistent with the returns providing compensation for risk. In other words, the results are more consistent with a failure to fully incorporate efficiency information when forming expectations of future earnings.

e. Intensive Conference Calls Discussions and Delayed Reaction Analysis

The evidence in the previous sub-sections shows that analysts and managers do not discuss efficiency extensively in earnings conference calls, and that analysts and investors do not fully incorporate the effects of (in)efficiency in forming expectations about future earnings and performance. In this subsection, we focus on cases in which inefficiency is seriously discussed in earnings conference calls. If the extent of inefficiency discussion is a proxy for managers' and analysts' awareness of the importance of inefficiency in future performance, we expect analysts to properly incorporate inefficiency when forecasting future earnings in these cases.

To facilitate this analysis, we use the top quartile of the firm-year sample based on the number of times efficiency is discussed in the conference call. The sample includes 5,541 firm-years, and the mean (median) number of times efficiency is discussed is 9 (8).

Table 9, Panel A shows the regressions of forecast revisions and proportion of negative earnings surprise for this subsample. While there is still higher likelihood of negative earnings surprise for lowest efficiency firms relative to all other firms, the coefficient is significant at the 10% level (p-value=8%). In addition, in contrast to the results of the full sample (Table 7, Panel B), there is no difference in forecast revisions. Hence, when efficiency is seriously discussed during conference calls, analysts are less optimistic in their earnings forecast of inefficient firms

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relative to all other firms. Panel B shows the CAR around subsequent earnings announcements for these cases. The results are quite striking. First, there is no significant difference in CAR around the quarterly earnings announcement between the high and low efficiency portfolios. Furthermore, when we look at total abnormal returns over the year (column labeled Annual) we find that the least efficient firms earn a **higher** abnormal return relative to the most efficient firms. This result is of course consistent with theory - inefficient firms are expected to earn higher returns to compensate for the higher risk. Thus, these results provide additional support that analysts and investors generally do not fully incorporate (in)efficiency properly in their assessments of firms' future performance and are better at it only when attention is specifically directed to efficiency initiatives in conference calls.

4. Robustness Analyses

We conduct several sensitivity analyses that relate to the measurement of operational inefficiency:

1. We estimate operational inefficiency using either balance sheet variables, namely tangible assets (sum of PP&E net and assets under an operating lease) and intangible assets (reported intangibles plus R&D capital), or income statement variables: Cost of Goods Sold and SG&A. These results are similar to those reported, especially for income statement-based measures.
2. We attempted to estimate inefficiency using SFA. To compare the results with DEA, we estimated the frontier at the GIC sector level by year. However, the estimation does not work well at the sector-year level. Specifically, the estimation did not converge in many sectors. For the sector-years where the estimation converges, the resulting distribution of the inefficiency score is quite tight, with a mean and median inefficiency of 0.95. Even if we increase the estimation window to three years (e.g., the efficiency score for 2018 is based on all observations in the years 2016-18), we still get non-convergence for a non-trivial number of sector-years, and the resulting inefficiency distribution is tight.
3. One concern with the analysis is that our definition of industry (we use the GIC sector) is too broad, and consequently, we group together firms with different production technologies. Hence, we estimate efficiency using a finer definition of industry - 6-digits GIC. The results are similar.

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V. Conclusions

This study investigates whether market participants fully incorporate information about relative operational efficiency in forming expectations of future earnings and cash flows. Consistent with prior studies, we show that operational efficiency is positively and significantly correlated with future profitability even after controlling for prior profitability and efficiency. Theory suggests that the current valuations of inefficient firms should be lower because of their expected lower future profitability. Together with the higher risk associated with these firms, this suggests that their future stock returns should be higher. However, the literature provides conflicting evidence about the relationship between operational efficiency and future returns, where some studies show that the future returns of inefficient firms are indeed higher than those of efficient firms, while others show the opposite.

We provide evidence that the future stock returns of inefficient firms are significantly negative and lower than those of the other firms. We explain that these negative market reactions are likely caused by market participants, especially analysts who do not fully incorporate operational inefficiency into their assessments of future profits. We show that while around 50% of earnings conference calls contain discussions of efficiency, analysts hardly discuss the issue of operational efficiency. In addition, issues of efficiency should be more pronounced, that is, for inefficient firms, they are discussed significantly less often than for more efficient firms. We further show that financial analysts are significantly more optimistic about inefficient firms' future performance. They tend to revise their optimistic forecasts downwards more often and experience more negative earnings surprises for inefficient firms than for more efficient firms. Furthermore, they set up target prices that are significantly more optimistic for inefficient firms than efficient ones.

We also provide evidence that investors, like financial analysts, do not fully incorporate inefficiency into their future cash flow expectations. We show that the estimated monthly abnormal returns of inefficient firms in the year after efficiency is estimated are significantly negative and lower than those of efficient firms. We further show that investors are negatively surprised when the earnings of inefficient firms are announced in subsequent quarters, leading to significantly negative abnormal returns in the short windows around the subsequent earnings announcement dates. Additionally, most of the annual abnormal returns of inefficient firms are

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concentrated around the subsequent quarterly earnings announcement dates, indicating the extent of their failure to properly set their expectations about future cash flows.

In summary, we provide evidence that relative operational efficiency is important for properly setting expectations about future profitability and cash flows. Unfortunately, market participants, even sophisticated investors, such as financial analysts, do not fully incorporate this important information into their assessments of future cash flows. Whether this lack of awareness is due to the relative complexity of estimating operational inefficiency or due to inattention is an issue that warrants further research. We provide partial evidence about it in our study when we examine analysts' forecasts and market reactions when efficiency concepts are discussed more extensively in earnings conference calls. In such cases, analysts tend to forecast future earnings conservatively. However, further research on this topic can shed more light on the source of this less-than-full incorporation of operational inefficiency into future cash flows.

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Appendix A - Variable Definition

Asset Turnover - Total Revenues scaled by the sum tangible and intangible assets

Tangible Assets - sum of Property, Plant, and Equipment, Net (PPENT) and the present value of future minimum operating lease payments from year t+1 to year t+5 (MRC1-MRC5) discounted at 10%

Intangible Assets - sum of reported Intangibles (INTAN) and amortized R&D capital. The latter variable is computed as the sum of amortized R&D expenditures (XRD) from year t-4 to t-1. We assume 20% amortization rate

Efficiency Rank - Quintiles formed on the basis of the efficiency score in each year

Sales Growth Rate - percentage change in total annual revenues from the prior year

R&D intensity - ratio of R&D expenditures to total revenues

Low Efficiency Indicator – An indicator variable with 1 if the observation is in the lowest efficiency quintile and zero otherwise

Number of Analysts - number of analysts following the firm

Book-to-Market - Most recent quarterly stock holders' equity (CEQQ) prior to May 31 of year t scaled Market Value of Equity on that day.

Operating Margin - Sales minus operating expenses (Cost of Goods sold, SG&A, and R&D) scaled by Total Revenues (Sale)

Market Value of Equity - Market value of equity at the end of May

Return on Equity - Income before Extraordinary Items (IB) scaled by Stockholders Equity (CEQ)

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Appendix B
Identification of Efficiency Efforts in Earnings Conference Calls

Efficiency efforts in earnings conference calls (supplied by S&P) were extracted using Natural Language Processing (NLP) software developed by ProntoNLP (Home | Pronto NLP). It is based on the identification of ten specific areas of efficiency efforts described and illustrated below.

1. **Cost/Expense Reduction**
   We used phrases that contained any word on the list (reduction, rationalization, optimization, containment) with either cost or expense.

   On 2018-06-06, CNR made the following remark: "Second, we are making strides with our continuous improvement initiative where we are taking advantage of the great work that has been done in manufacturing to deliver cost reductions with Lean and Six Sigma initiatives across our entire business."

   On 2018-06-20, BGRP commented "As mentioned earlier, gross margin was up 160 basis points primarily due to pricing and cost optimization efforts, lower product returns and lower inventory obsolescence".

   On 2018-06-21, BKS said "Sales declines were offset by continued cost rationalization."

2. **Consolidation**

   The word consolidation is associated with any word from the following list ((facility, plant, site, capacity, manufacturing, yard, production, manufacturing, equipment, and personnel).

   On 2018-07-25, TEL claimed "2019 actually is quite a big year operationally for our Industrial segment as some of these announced restructuring programs and the site consolidations are being worked real time".

   On 2018-07-11, ANGO stated "Additionally, gross margins were positively impacted by the ongoing operational improvements, the recently completed facility consolidation and the expiration of a royalty arrangement in the second quarter of fiscal 2018."

3. **Efficiency Improvement**
   Any of the words in the list (efficiency | productivity | optimization | simplification | reengineer | rationalization | realignment) with any of the words in the list (gain | improve | enhance | bolster | maximize).

   On 2018-07-31, TMX stated "So, these productivity gains allow us to reinvest in critical aspects of the business with a relentless focus on continuing to improve our organic growth rates."

   On 2018-07-31, KNL claimed "The margins on our newer platforms expanded year-over-year as our manufacturing efficiencies improved, as volumes climbed."

4. **Focus on Core Business**

   List (focus | refocus | intensely_focused | concentrate) with list (core | core_competency).

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On 2018-07-26, HSY said "We remain committed to this important market and are optimizing our footprint to focus on core SKUs, provinces and channels."

5. **Margin Improvement**

   Any word from the list (effort | initiative | action | program | strategy) to any word from the list (improve | enhance | bolster | grow | expand) margin.

   On 2021-02-03, SITM said "In addition, our initiatives to expand gross margins should continue to pay off."

   On 2019-11-12, EBIX stated "We are presently trying to draw a balance between our effort to grow our EbixCash margins and our attempt to be a leader in the market."

6. **Program to Optimize Performance**

   Any word from (performance | operational | production) with (optimization | optimize | optimal) and (effort | program | approach | plan).

   On 2012-11-01, SBOW maintained "This reduced pace of drilling has allowed our asset team to spend more time evaluating existing wells and developing production optimization programs based on historical production data."

7. **Personnel Reduction**
   Any word from the list (headcount | head_count | personnel | staff | manpower | workforce | fte | employee | payroll) in conjunction with any word from the list (reduction | reduce | decrease | lower | rightsize | downsize | shrink).

   On 2019-04-30, GLT explained "This was achieved through a combination of head count rightsizing initiatives and tight control on spending including professional services."

   On 2007-01-30, UPS reported "The 1,200 personnel reduction is going to help drive $100 million in cost savings."

8. **Productivity Enhancement**
   Productivity with any word in the list (improvement | improve | increase | rise | grow | enhance).

   On 2008-06-19, CWST claimed "Gains were achieved through flexing our labor cost consistent with volumes, productivity enhancements and improved risk management."

   On 2012-08-02, ELNK stated "During the second quarter, retail monthly productivity grew from $2,200 to $2,300 per rep."

9. **Streamlining Operations**
   Any word from the list (streamline | simplify | simplify_streamline | reengineer | optimize | realign | eliminate_redundancy) with operations.

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On 2008-03-06, FLTWQ reported "During the last three years, we have successfully decentralized our corporate structure, streamlined our operations, refocused our Housing and RV operations, and significantly trimmed our cost."

On 2009-11-05, OMG said "We, therefore, determined that now is the time to reduce our capacity, realign our operations and get more cost out."

10. **Streamlining Products**
Any word from the list (rationalize | streamline | realign | simplify_streamline | better_align | optimize | refocus | reorganize | sharpen) with the product line

On 2008-01-31, MCK announced "As a result of the new organization, during the quarter we took several actions to streamline our staffing and product lines to improve efficiencies and deliver better customer solutions in the coming years."

On 2008-03-06, STAA declared "We also are beginning a process which will generate manufacturing efficiencies by rationalizing product lines."

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Table 1: Descriptive Statistics

Panel A: Efficiency Score by Industry

Industry	Mean	Q1	Median	Q3
Financials	0.431	0.229	0.371	0.578
Health Care	0.629	0.459	0.641	0.821
Information Technology	0.664	0.522	0.638	0.800
Energy	0.714	0.545	0.725	0.933
Materials	0.734	0.580	0.761	0.914
Consumer Discretionary	0.750	0.645	0.762	0.880
Communication Services	0.799	0.665	0.824	1.000
Consumer Staples	0.825	0.714	0.814	0.987
Real Estate	0.826	0.675	0.944	1.000
Industrials	0.827	0.756	0.837	0.921
Utilities	0.873	0.798	0.882	0.982
Overall	0.683	0.520	0.717	0.879

Panel B: Descriptive Statistics of Main Variables

	Mean	Std Dev	Q1	Median	Q3
Market Value of Equity	4739	21555	104	440	1969
Book-to-Market	0.784	1.331	0.280	0.510	0.840
Return on Equity	0.003	0.151	-0.003	0.025	0.068
Operating Margin	-0.023	0.402	-0.004	0.048	0.111
Asset Turnover	3.471	5.844	0.895	1.774	3.414

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Panel C: Mean (Median) of Main Variables by Efficiency Quintiles

Efficiency Rank	Efficiency	Market Value of Equity	Book-to-Market	Return on Equity	Margin	Asset Turnover
Low Efficiency	0.305 (0.315)	1034.032 (242.703)	0.814 (0.617)	-0.067 (0.007)	-0.206 (0.053)	2.968 (1.515)
2	0.561 (0.564)	1888.877 (280.303)	0.725 (0.53)	-0.024 (0.011)	-0.03 (0.031)	2.239 (1.399)
3	0.715 (0.716)	3087.725 (432.405)	0.759 (0.509)	0.017 (0.033)	0.024 (0.042)	2.688 (1.776)
4	0.846 (0.843)	4660.054 (812.364)	0.743 (0.476)	0.042 (0.047)	0.045 (0.049)	3.425 (2.151)
High Efficiency	0.987 (1)	13030.7 (1035.149)	0.878 (0.423)	0.046 (0.052)	0.054 (0.066)	6.035 (2.306)

This table reports the descriptive statistics of the selected variables. See Appendix A for variable definitions.

Source: Compustat, CRSP and authors' analysis.

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Table 2 - Monthly returns by efficiency portfolio

Panel A: Equal and Value Weighted Returns by Efficiency Portfolio

Efficiency Rank	Equal Weighted	Value Weighted
Low Efficiency	0.006 (0.009)	0.006 (0.008)
2	0.008 (0.01)	0.007 (0.011)
3	0.009 (0.012)	0.008 (0.011)
4	0.011 (0.014)	0.01 (0.014)
High Efficiency	0.009 (0.011)	0.008 (0.011)
High-Low: Mean	0.0031	0.0028
High-Low: Median	0.0024	0.0033

Panel B: Equal Weighted Returns by Quintiles of Efficiency and Size

	Size Quintile				
	1	2	3	4	5
Low Efficiency	0.004	0.008	0.008	0.008	0.002
2	0.009	0.009	0.008	0.009	0.008
3	0.008	0.009	0.009	0.01	0.009
4	0.01	0.011	0.012	0.012	0.011
High Efficiency	0.008	0.009	0.009	0.01	0.011
High-Low	0.004***	0.001	0.001	0.002*	0.009***

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Panel C: Equal Weighted Returns by Quintiles of Efficiency and Book-to-Market

	Book-to-Market Quintile				
	1	2	3	4	5
Low Efficiency	0.005	0.007	0.009	0.008	0.005
2	0.006	0.009	0.009	0.01	0.009
3	0.008	0.008	0.009	0.011	0.01
4	0.011	0.01	0.01	0.011	0.013
High Efficiency	0.008	0.009	0.009	0.011	0.011
High-Low	0.003***	0.002	0	0.003***	0.006***

At the beginning of June in year t, all stocks are independently sorted into quintiles based on their efficiency scores, size, and book-to-market ratio. Equally weighted and value-weighted abnormal returns on a portfolio are calculated based on the monthly returns from June of year t to May of year t + 1. The table shows the mean and median (in parentheses) monthly returns for the efficiency quintiles (Panel A) and for the 25 portfolios formed based on the intersection of independently formed quintiles of efficiency and quintiles of size (Panel B), and the intersection of independently formed quintiles of efficiency and quintiles of book-to-market (Panel C).

Source: Compustat, CRSP and authors' analysis.

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Table 3 - Excess Returns on Fama-French (1993) Factors

Panel A: Jensen's Alpha using Fama-French (1993) Factors

	Equal Weighted						Value Weighted					
Efficiency Rank	alpha	RMRF	SMB	HML	CMA	MOM	alpha	RMRF	SMB	HML	CMA	MOM
Low Efficiency	-0.344***	0.949***	0.658***	0.155***	0.082	-0.174***	-0.303***	0.979***	0.626***	0.127***	0.032	-0.188***
	(0.106)	(0.026)	(0.033)	(0.042)	(0.067)	(0.023)	(0.107)	(0.026)	(0.033)	(0.043)	(0.068)	(0.023)
2	-0.197*	1.049***	0.811***	-0.032	-0.045	-0.191***	-0.165*	1.079***	0.759***	-0.051	-0.085	-0.198***
	(0.102)	(0.025)	(0.031)	(0.041)	(0.065)	(0.022)	(0.094)	(0.023)	(0.029)	(0.038)	(0.06)	(0.021)
3	-0.116	1.024***	0.723***	0.146***	-0.042	-0.184***	-0.073	1.046***	0.661***	0.123***	-0.05	-0.187***
	(0.087)	(0.021)	(0.027)	(0.035)	(0.055)	(0.019)	(0.078)	(0.019)	(0.024)	(0.031)	(0.05)	(0.017)
4	0.112	0.985***	0.590***	0.251***	-0.004	-0.145***	0.143*	0.994***	0.522***	0.244***	-0.012	-0.149***
	(0.081)	(0.02)	(0.025)	(0.032)	(0.052)	(0.018)	(0.078)	(0.019)	(0.024)	(0.031)	(0.049)	(0.017)
High Efficiency	-0.025	0.947***	0.458***	0.137***	-0.048	-0.138***	0.043	0.965***	0.348***	0.140***	-0.04	-0.137***
	(0.078)	(0.019)	(0.024)	(0.031)	(0.05)	(0.017)	(0.073)	(0.018)	(0.023)	(0.029)	(0.047)	(0.016)
High-Low	0.319***	-0.001	-0.200***	-0.018	-0.130*	0.036	0.346***	-0.014	-0.279***	0.013	-0.072	0.052*
	(0.12)	(0.03)	(0.037)	(0.048)	(0.077)	(0.026)	(0.13)	(0.032)	(0.04)	(0.052)	(0.083)	(0.028)

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Panel B - Equal Weighted Returns on Fama-French (1993) Factors and Efficiency Factor

Efficiency Rank	alpha	RMRF	SMB	HML	CMA	MOM	EFF
Low Efficiency	-0.170**	0.945***	0.524***	0.152***	-0.006	-0.148***	-0.646***
	(-0.068)	(-0.017)	(-0.022)	(-0.027)	(-0.043)	(-0.015)	(-0.033)
2	-0.193*	1.049***	0.808***	-0.032	-0.047	-0.190***	-0.014
	(-0.103)	(-0.025)	(-0.033)	(-0.041)	(-0.065)	(-0.022)	(-0.05)
3	-0.172**	1.025***	0.766***	0.147***	-0.014	-0.193***	0.207***
	(-0.084)	(-0.02)	(-0.027)	(-0.033)	(-0.053)	(-0.018)	(-0.04)
4	0.026	0.987***	0.656***	0.252***	0.039	-0.158***	0.319***
	(-0.071)	(-0.017)	(-0.023)	(-0.028)	(-0.045)	(-0.015)	(-0.034)
High Efficiency	-0.107	0.949***	0.521***	0.139***	-0.007	-0.151***	0.304***
	(-0.068)	(-0.017)	(-0.022)	(-0.027)	(-0.043)	(-0.015)	(-0.033)
High-Low	0.063***	0.004	-0.002	-0.013**	0	-0.003	0.950***
	(-0.014)	(-0.003)	(-0.004)	(-0.005)	(-0.009)	(-0.003)	(-0.007)

Table 3 presents Jensen's alphas and factor-loading estimates from the following regression model: ER = a + a1(RMRF) + a2(SMB) + a3(HML) + a4(CMA) + a5(MOM)+ e, where ER is the portfolio return less the risk-free rate, RMRF is the market risk premium, SMB is the size premium, HML is the value premium, CMA is the investment factor, and MOM is the momentum factor. The RMRF is calculated by subtracting the risk-free rate from the CRSP index return. SMB is the difference between the returns of the small- and large-cap portfolios. HML is the difference between the returns of high and low book-to-market portfolios. CMA is the difference between the returns on conservative and aggressive investment portfolios. The MOM is the difference between the returns of the high and low prior return portfolios. Low-high is a zero-cost portfolio that takes a long position in the lowest-efficiency portfolio and a short position in the most efficient portfolio. Panel B replicates the analysis in Panel A, which includes the efficiency factor (EFF). The efficiency factor is computed as the difference between the returns to the most and least efficient portfolios. Standard errors are shown in parentheses. *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively

Source: Compustat, CRSP, Professor French data library and authors' analysis.

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Table 4: Abnormal Monthly Returns and Efficiency

Panel A: Abnormal Equal and Value Weighted Mean (Median) Returns by Efficiency Portfolio

Efficiency Rank	Equal Weighted	Value Weighted
Low Efficiency	-0.003 (-0.004)	-0.004 (-0.005)
2	-0.002 (-0.001)	-0.002 (-0.002)
3	-0.001 (0)	-0.001 (0)
4	0.001 (0.002)	0.001 (0.002)
High Efficiency	0 (0)	-0.001 (0)
High-Low: Mean	0.0031***	0.003***
High-Low: Median	0.0047***	0.0046***

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Panel B - Abnormal Returns on Fama-French (1993) Factors

	Equal Weighted						Value Weighted					
Efficiency Rank	alpha	RMRF	SMB	HML	CMA	MOM	alpha	RMRF	SMB	HML	CMA	MOM
Low Efficiency	-0.004*** (0.001)	0 (0)	0.002*** (0)	0 (0)	0 (0.001)	0 (0)	-0.004*** (0.001)	0 (0)	0.002*** (0)	0 (0)	0 (0.001)	0 (0)
2	-0.002*** (0.001)	0.001*** (0)	0.003*** (0)	0 (0)	0 (0)	0 (0)	-0.002*** (0.001)	0.001*** (0)	0.003*** (0)	-0.001** (0)	-0.001* (0)	0 (0)
3	-0.002*** (0.001)	0.000*** (0)	0.002*** (0)	0.001*** (0)	-0.001 (0)	0 (0)	-0.002*** (0.001)	0.000*** (0)	0.003*** (0)	0.001** (0)	-0.001 (0)	0 (0)
4	0 (0.001)	0 (0)	0.002*** (0)	0.001*** (0)	0 (0)	0 (0)	0.001 (0.001)	0 (0)	0.002*** (0)	0.001*** (0)	0 (0)	0 (0)
High Efficiency	-0.001 (0)	-0.000** (0)	0.001*** (0)	0.000** (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.001*** (0)	0 (0)	0 (0)	0 (0)
High-Low	0.003*** (0.001)	0 (0)	0 (0)	0 (0)	-0.001 (0.001)	0 (0)	0.003*** (0.001)	0 (0)	-0.001 (0)	0 (0)	0 (0.001)	0 (0)

Table 4 reports results of abnormal returns analysis. We compute abnormal returns as buy and hold monthly return on a stock minus buy and hold monthly return on a portfolio of similar stocks in terms of size, B/M and momentum. Panel A presents the mean abnormal returns which are calculated as the time-series average of the efficiency portfolio abnormal returns. Panel B presents the Jensen's alpha from the following regression model: BR = a + a1(RMRF) + a2(SMB) + a3(HML) + a4(CMA) + a5(MOM)+ e. High-Low is a zero-cost portfolio that takes a long position in the highest efficient portfolio and a short position in the lowest efficient portfolio. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.
Source: Compustat, CRSP, Professor French data library, and author analysis. As of July 1, 2022.

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Table 5: Efficiency: Persistence and Effect on Earnings

Panel A: Transition probability matrix (year t in rows, year t+1 in columns).

Efficiency Rank	1	2	3	4	5
1	78.07	16.9	2.83	1.05	1.16
2	16.01	56.34	21.35	4.17	2.12
3	3.32	20.64	51.85	20.34	3.85
4	1.25	4.79	20.08	59.25	14.63
5	1.47	2.97	5.11	15.72	74.74

Panel B: Persistence of Efficiency

	Dependent Variable			
	$Efficiency_t$	Rank $Efficiency_t$	$Efficiency_t$	Rank $Efficiency_t$
Constant	-0.001	0.399***	0.189***	1.130***
	(0.004)	(0.024)	(0.006)	(0.037)
$Efficiency_{t-1}$	0.779***		0.501***	
	(0.003)		(0.006)	
Rank $Efficiency_{t-1}$		0.734***		0.440***
		(0.003)		(0.005)
Size	0.008***	0.054***	0.015***	0.095***
	(0.000)	(0.002)	(0.001)	(0.005)
Book-to-Market	0.001***	0.010***	-0.000	0.001
	(0.000)	(0.001)	(0.000)	(0.001)
Fixed Effects:				
Firm	N	N	Y	Y
Year	Y	Y	Y	Y
Industry	Y	Y	N	N
Observations	99,394	99,394	99,394	99,394
R-squared	0.768	0.706	0.294	0.223

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Panel C: Efficiency and Profitability

	(1)	(2)	(3)	(4)	(5)
Constant	-0.220***	-0.131***	-0.220***	-0.123***	-0.210***
	(0.006)	(0.004)	(0.006)	(0.004)	(0.006)
$Efficiency_t$	0.072***	0.055***	0.061***		
	(0.004)	(0.004)	(0.004)		
$Efficiency_{t-1}$		0.009***	0.017***		
		(0.003)	(0.003)		
Efficiency $Rank_t$				0.010***	0.011***
				(0.001)	(0.001)
Efficiency $Rank_{t-1}$				0.003***	0.004***
				(0.000)	(0.000)
Operating Margin	0.187***	0.179***	0.191***	0.180***	0.193***
	(0.004)	(0.003)	(0.005)	(0.003)	(0.005)
Size	0.031***	0.011***	0.030***	0.010***	0.029***
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Book-to-Market	0.009***	0.001	0.008***	0.000	0.008***
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Sales Growth Rate	0.014***	0.014***	0.015***	0.014***	0.015***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Fixed Effects:					
Firm	N	N	Y	N	Y
Year	Y	Y	Y	Y	Y
Industry	Y	Y	N	Y	N
Observations	102,700	99,394	99,394	99,394	99,394
R-squared	0.332	0.426	0.332	0.430	0.336

Table 5, Panel A present the transition matrix of efficiency rank. Panel B reports results of the persistence of efficiency. The dependent variable is the level of efficiency or the efficiency quintile in year t. The independent variables include the corresponding variables as of year t-1 and control variables. Panel C presents the results of the effect of contemporaneous and lagged efficiency on the Return on Assets (ROA). Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.
Source: Compustat, CRSP and authors' analysis. As of July 1, 2022.

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Table 6: Conference Calls and Efficiency

Panel A: Descriptive Statistics

	All Sample			Efficiency Discussed at least Once	
Efficiency Rank	Analysts	Management	Efficiency Discussed Indicator	Analysts	Management
1	0.185	1.086	0.363	0.510	2.997
2	0.294	1.715	0.498	0.590	3.440
3	0.321	2.048	0.546	0.588	3.753
4	0.381	2.193	0.569	0.670	3.853
5	0.292	1.498	0.441	0.662	3.394
Total	0.294	1.707	0.483	0.609	3.533
All But Quintile 1	0.322	1.863	0.514	0.627	3.628
Quintile 1-All Other	-0.137***	-0.777***	-0.151***	-0.117***	-0.631***

Panel B: Regressions

		Number of Efficiency Discussions	
	Efficiency Discussed Indicator	Management	Analysts
Constant	-5.125***	-13.738***	-8.777***
	(0.224)	(0.421)	(0.378)
Low Efficiency Indicator	-0.202***	-0.401***	-0.324***
	(0.034)	(0.075)	(0.055)
Number of Analysts	0.005***	0.009***	0.010***
	(0.001)	(0.001)	(0.001)
Book-to-Market Ratio	0.124***	0.555***	0.232***
	(0.018)	(0.041)	(0.028)
Size	-1.573***	-4.920***	-2.607***
	(0.107)	(0.226)	(0.168)
Return on Assets	0.104***	0.070**	0.168***
	(0.011)	(0.029)	(0.018)
Sales Growth Rate	-0.001	-0.007*	-0.003
	(0.002)	(0.004)	(0.003)
R&D Intensity	-0.943***	-2.938***	-1.607***
	(0.086)	(0.189)	(0.144)
Fixed Effects:			
Firm	Y	Y	Y
Year	Y	Y	Y
Observations	36,893	36,893	36,893

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Table 6 analyzes the relationship between the level of efficiency and the extent to which it is discussed during conference calls. Panel A shows the number of times efficiency is discussed by analysts and managers and the proportion of conference calls where efficiency is discussed at least once. The regression in which the dependent variable is the efficiency discussed indicator (number of efficiency discussions) is estimated using probit (Tobit) with firm (random) effects controlling for year fixed effects. Standard errors are shown in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively. Source: Compustat, CRSP, S&P earnings conference call transcripts, and authors' analysis. As of July 1, 2022.

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Table 7: Earnings Forecasts and Implied Rate of Return

Panel A: Descriptive Statistics

Efficiency Rank	Forecast Revision	Proportion of Negative Earnings Surprise	Implied Return	Target Price Ratio	Number of Analysts
Low Efficiency	-0.022	0.392	2.011	3.271	14.549
2	-0.020	0.347	1.855	2.806	17.813
3	-0.023	0.344	1.655	2.318	20.243
4	-0.006	0.314	1.492	1.994	22.558
High Efficiency	0.006	0.302	1.603	2.353	26.532
Overall	-0.013	0.340	1.716	2.532	20.445
All but Quintile 1	-0.011	0.327	1.647	2.358	21.830
Quintile1 - All other	-0.012***	0.065***	0.363***	0.913***	-7.281***

Panel B: Regressions

	Forecast Revisions	Proportion of Negative Earnings Surprise	Implied Return	Target Price Ratio
Constant	0.079***	0.215***	0.222*	1.476***
	(0.024)	(0.040)	(0.127)	(0.397)
Low Efficiency Indicator	-0.017**	0.036**	0.074**	0.041
	(0.007)	(0.015)	(0.031)	(0.103)
Number of Analysts	0.000***	-0.002	0.002***	0.008***
	(0.000)	(0.002)	(0.000)	(0.001)
Book-to-Market Ratio	-0.016***	0.050***	0.052***	0.113***
	(0.002)	(0.006)	(0.007)	(0.028)
Size	-0.010***	-0.263***	0.205***	0.108*
	(0.003)	(0.049)	(0.020)	(0.062)
Return on Assets	-0.208***	-0.101***	-0.740***	-1.503***
	(0.021)	(0.005)	(0.108)	(0.335)
Sales Growth Rate	-0.022***	0.062***	0.063***	0.151**
	(0.004)	(0.011)	(0.017)	(0.063)
R&D Intensity	0.007	-0.032	0.535***	1.538***
	(0.020)	(0.033)	(0.154)	(0.448)
Fixed Effects:				
Firm	Y	Y	Y	Y
Year	Y	Y	Y	Y
Observations	69,723	78,361	70,523	70,523
R-squared	0.081		0.046	0.024

Table 7 analyzes the relationship between efficiency and each earnings forecast and target price. Forecast revisions are the ratio of up-down revisions to the sum of up + down + zero revisions. Earnings surprise is the IBES actual minus the mean quarterly forecast made in the 90-day period before the earnings announcement. Implied returns are the target price divided by the price the previous day. This represents the average of all implied returns in the year after portfolio formation. The target price ratio is the average target price in the subsequent year, divided by the price

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on the portfolio formation date. Standard errors are shown in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.
Source: Compustat, CRSP, IBES, and authors' analysis. As of July 1, 2022.

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Table 8: Cumulative Abnormal Returns Around Subsequent Earnings Announcements

Panel A: Mean CAR around Subsequent Quarterly Earnings Announcements

Efficiency Rank	Q1	Q2	Q3	Q4	All EA	Annual
Low Efficiency	0.1%	0.2%	0.0%	0.1%	0.7%	-2.2%
2	0.6%	0.3%	0.1%	0.4%	1.1%	0.2%
3	0.9%	0.8%	0.5%	0.8%	4.0%	0.9%
4	0.9%	0.6%	0.4%	0.8%	3.5%	1.6%
High Efficiency	0.9%	0.6%	0.3%	0.7%	4.0%	2.1%
High-Low	0.8%***	0.3%***	0.3%***	0.5%***	3.4%***	4.3%***

Panel B: Total CAR around Subsequent Quarterly Earnings Announcements by Year

Year	All EA High	All EA Low	Hedge
1997	0.068	0.005	0.063
1998	0.044	0.022	0.022
1999	0.061	0.039	0.022
2000	0.060	0.016	0.044
2001	0.039	0.018	0.021
2002	0.038	0.035	0.003
2003	0.040	0.006	0.034
2004	0.032	0.024	0.008
2005	0.043	0.025	0.018
2006	0.034	-0.008	0.042
2007	0.043	-0.002	0.045
2008	0.037	-0.020	0.057
2009	0.061	0.005	0.057
2010	0.034	-0.002	0.035
2011	0.025	-0.001	0.026
2012	0.024	-0.003	0.027
2013	0.026	-0.004	0.030
2014	0.032	-0.002	0.034
2015	0.026	-0.016	0.042
2016	0.033	-0.007	0.039
2017	0.032	0.019	0.013
2018	0.034	0.007	0.027
2019	0.069	0.021	0.048

Table 8 shows Cumulative Abnormal Return (CAR) around quarterly earnings announcements (Q1-Q4) in the year from June of year t to May of year t + 1. All EA is the sum of the CARs around the four quarters. Annual is the buy and hold abnormal returns during the year from June of year t to May of year t + 1. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.
Source, Compustat, CRSP and authors' analysis. As of July 1, 2022.

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Table 9: Earnings Forecasts and Delayed Market Reaction Subsequent to Efficiency Discussion in Conference Calls

Panel A: Forecast Revisions and Negative Earnings Surprise

	Forecast Revisions	Proportion of Negative Earnings Surprise
Constant	-0.051	0.086**
	(0.178)	(0.038)
Low Efficiency Indicator	0.026	0.034*
	(0.071)	(0.019)
Number of Analysts	-0.007	0.000***
	(0.005)	(0.000)
Book-to-Market Ratio	0.134***	-0.023***
	(0.034)	(0.006)
Size	-0.556***	0.010***
	(0.210)	(0.004)
Return on Assets	-0.124***	-0.032
	(0.018)	(0.052)
Sales Growth Rate	0.056	-0.091***
	(0.095)	(0.023)
R&D Intensity	-1.419***	0.224**
	(0.356)	(0.095)
Fixed Effects:		
Firm	Y	Y
Year	Y	Y
Observations	5,541	5,548

Panel B: Mean CAR around Subsequent Quarterly Earnings Announcements

Efficiency Rank	Q1	Q2	Q3	Q4	All EA	Annual
Low Efficiency	0.1%	0.8%	0.2%	0.4%	3.6%	3.1%
2	0.0%	0.0%	0.4%	0.6%	-1.0%	2.0%
3	-0.1%	0.2%	0.3%	0.8%	2.0%	-2.0%
4	0.1%	0.1%	0.1%	0.4%	0.1%	-0.8%
High Efficiency	0.3%	0.0%	0.1%	-0.2%	0.4%	-0.7%
High-Low	0.2%	-0.8%	-0.1%	-0.5%	-3.2%*	-3.8%

Variable definitions are the same as in Tables 7 and 8.
Source: Compustat, CRSP, IBES and authors' analysis. As of July 1, 2022.

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