

**Measuring Managerial Ability:
A Retrospective and Review of the Literature**

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Abstract

In this paper, we discuss the managerial ability score (MA Score) developed in Demerjian, Lev, and McVay (2012). In the first section, we provide an overview of the development of the score, including the conceptual definition of managerial ability; the implementation of the score using DEA and regression analysis; and some limitations of the score. In the next section, we review research that has used the MA Score as a primary variable. The review, organized by topic, includes papers on firm performance, financial reporting, tax reporting, firm information environment, investment, debt contracting, and executive hiring and compensation contracting. In the final section we recommend directions for future work. This includes extending the original model presented in Demerjian et al., and ways that the growing literature on managerial ability can link to other streams of research.

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1 Introduction

In this paper, we describe the development of the managerial ability score (MA Score) from Demerjian, Lev, and McVay (DLM: 2012) and review the literature that has emerged applying this score. DLM developed the MA Score to be a general purpose, broadly available, and, most importantly, quantitative measure of managerial ability. Focusing a set of widely available accounting variables, and using data envelopment analysis and Tobit regressions, the MA Score has proven to be a versatile measure of managerial ability: evidence has shown the MA Score to be associated with a wide range of decisions and outcomes.

In the first part of the paper, we describe the motivation for developing the score, and some of the choices made when implementing it. Prior to development of the MA Scores, analysis of managerial ability was constrained in a variety of ways. In some cases, researchers had to rely on “best company” lists, e.g., from Fortune magazine, that are inherently subjective and often lack methodological transparency. Or, studies followed the fixed effects methodology pioneered in Bertrand and Schoar (2003). This method, however, required CEOs (or other executives under study) to switch firms; this led to small, idiosyncratic samples. The development of an easily measured, broadly available measure—the MA Score is available for approximately 200,000 firm years between 1980 and 2016—allowed for a broad range of empirical studies that had not previously been possible.

In the second part of the paper, we review the empirical literature that has emerged applying the MA Score. We focus our attention on studies where the MA Score is the key variable (or one of the key variables) of interest. In organizing the review, we group studies into the following categories: firm performance, financial reporting, tax reporting, firm information environment, investment, debt contracting, and executive hiring and compensation contracting. The groupings

are meant to capture commonality in research question or research objective, although there exists the potential for variation or overlaps between topics.

The main conclusions from the research is that managerial ability is reflected in a wide range of decisions and outcomes of the firms; managerial ability has a strong positive association with financial reporting quality, disclosure quality, firm performance, and investment. Studies also show that various stakeholders in the firm understand the effects of managerial ability and incorporate it into their decisions. For examples, managerial ability is associated with executive compensation contracts, and the borrowing firm's managerial ability affects both debt contract terms and credit ratings. In the final section, we recommend avenues for future research, particularly for expanding and extending the measurement of managerial ability.

2 Development of the MA score using DEA

2.1 Research objective

In the neo-classical model of the firm, the manager has no role other than to implement the objectives of the firm owners. That is, the manager does not have opinions of her own, but rather makes decisions that efficiently maximize the wealth of investors. Although it has long been established that managers are heterogeneous in their preferences, beliefs, and styles, the literature was largely silent on how differences in managers manifested in various firm policies and outcomes. Bertrand and Schoar (2003) initiated a line of literature on the role of individual managers. In their study, they identify a set of managers who switch firms at some point during their sample period. This "switching" sample allows Bertrand and Schoar to identify the effects of managers incremental to firm effects. Their evidence shows that manager fixed effects provide incremental explanatory power for a variety of corporate policies, such as investment and dividend

policies. Bertrand and Schoar also identify various regularities in managerial characteristics, linking features such as age and educational background to aggressiveness in firm policies.

Following Bertrand and Schoar (2003), several studies examine the impact of managerial style using a fixed effects framework. Bamber, Jiang, and Wang (2010) show that individual managers are associated with features of firms' voluntary disclosure policies. Ge, Matsumoto, and Zhang (2011) examine the association of CFO fixed effects and various accounting outcomes, such as earnings aggressiveness and income smoothing. Dyreng, Hanlon, and Maydew (2010) show an association between individual executives and tax avoidance. These studies, among others, established within the literature a clear association between individual managers, including their backgrounds and preferences, and a wide range of firm outcomes.

Although the fixed effects methodology of Bertrand and Schoar (2003) has proven influential, it is not without limitations. For one, its identification relies on a relatively small, and possibly idiosyncratic, set of managers who switch jobs. It is not clear that these results can generalize beyond the managers in these studies' samples. Additionally, the tests of effects are relatively coarse; the joint effects of individual managers are assessed using F-tests and incremental adjusted R^2 s. Although this provides evidence of an aggregate or collective effect, it is impossible to determine the direction of the effect or the role of individual managers.

Our initial objective in seeking to measure managerial ability was to expand on the post-neoclassical model initiated by Bertrand and Schoar (2003). We sought to develop a measure that could be measured for a broad cross-section of firms (i.e., not just for the subsample that switches firms) and would provide a directional measure of a manager's influence. We originally conceived of using the measure in a test of earnings quality; our prior belief was that individual managers

should affect the measured quality of earnings, and that *better* managers should have *higher* quality earnings.

2.2 *Conceptual background*

We approached measuring managerial ability from the following pair of primitive questions. First, what are the most important things that managers do? Second, given these actions, how would we assess how well the manager is doing? The manager's decision set is almost unlimited, and there is a large number of outcomes for which the manager's performance could be evaluated. In developing our model of managerial ability, we wanted to focus on an output that was of first-order importance to a broad range of stakeholders of the firm and a set of inputs that are both under the manager's control and directly affect our chosen output. After significant consideration, we decided to focus on a single output, revenue, against a set of inputs representing various capital investments the manager selects.

We ground our conceptual modeling of the role of the manager, and how to measure the manager's ability, in the fundamental decisions that the manager makes for the firm. Given some amount of capital, the manager is charged with producing the largest amount of revenue.¹ Revenue, in this sense, is the key objective of the manager in making investing decisions for the firm. This view is consistent with that of Dichev and Tang (2008), who note the firm is "...an entity that continually advances expenses hoping to reap revenues and earnings." We consider alternatives to this revenue-optimization view in Section 4.

Once we decided to base our optimization on the maximization of revenue, we needed to determine those capital investments that would be under the manager's control and would plausibly lead to revenue in the future. As we perceived it, the manager's decision set includes

¹ Alternatively, the manager may be expected to produce a certain level of revenue with the objective of minimizing the required capital base.

making new investments for the firm and deciding whether to retain or divest previous investments of the firm. As such, the capital base of the firm at any point in time represented the manager's target mix of capital investments (with possible adjustment errors). The main constraint we faced in incorporating capital investments into our DEA calculation was measurement: some investments of potential economic value are not included in the financial statements of firms due to the potential for measurement error. We tried to incorporate these decisions using other data when possible, although in some cases relevant capital investments were likely omitted from our model. We provide specific details on implementation of our model in Section 2.3.

Using revenue as the output and capital investments as the input, we use DEA to measure the relative efficiency of firms within industry groups. Our goal, however, was more nuanced than just measuring efficiency. Given that our DEA metric captures firm efficiency, our objective was to identify and quantify the manager's specific contribution to the firm's efficiency. There are reasons to believe that certain firm features would lead to higher or lower relative efficiency. For example, large firms are likely to enjoy economies of scale and scope, and have access to more options to finance investments. This suggests that these firms would be naturally more efficient, holding the ability of management equal. We identified a series of firm-level features that plausibly affect firm efficiency.

In order to isolate the effect of managers, we developed a second stage of analysis. In this stage, we use firm efficiency as the dependent variable and the firm-level features as independent variables in a multiple regression model. The fitted values from this model capture the portion of firm efficiency explained by firm variables. We interpret the residuals from the regression—that is, the portion of efficiency not explained by firm-level explanatory variables—as the manager's contribution to efficiency. This residual is the DLM MA Score.

2.3 *Model implementation*

Our first-stage DEA analysis uses variables measured with Compustat annual data. Our single output is total sales revenue (*Sales*). We use seven different measures of capital investment. The firm's investment in tangible assets is measured as *PPE*, the net value of the firm's property, plant, and equipment. We also measure the assets acquired under operating leases (*OpsLease*). These are assets that are acquired and used by the firm, but by the nature of the financing arrangement are not reported as assets on the firm's balance sheet. We calculate a capitalized value for assets acquired under operating leases; following the method of Ge (2006), this is the discounted present value of the next five years of lease payments.

Research and development investments (*R&D*) are similarly not afforded recognition as assets. We follow the technique in Lev and Sougiannis (1996) and measure *Net R&D* as the sum of five years of research and development expenditures. To capture the declining value of these expenditures over time, we subtract 20 percent of the value for each year since the firm made the expenditure; for example, we use 60 percent of the value of the expenditure from two years earlier. We use two intangibles which have values reported on the balance sheet: goodwill (*Goodwill*) and acquired intangible assets (*OtherIntan*). Goodwill represents the excess of purchase price over the estimated value in an acquisition. Acquired intangibles include any intangible assets, for example patents and copyrights, that the firm has purchased.

The two final input variables we measure from the income statement. The cost of goods sold (*CoGS*) is the cost of the inventory that was sold during the year. We include this value, rather than the value of inventory on the balance sheet, because we believe this would more accurately reflect the cost of generating revenue. We also use selling, general, and administrative costs

(SG&A) to capture other investing and operating decisions not reflected in our other input accounts.

We collect our output (*Sales*) and our set of seven inputs (*PPE*, *OpsLease*, *R&D*, *Goodwill*, *OtherIntan*, *CoGS*, and *SG&A*) for each firm-year in our sample period. We restrict our sample to:

- Observations where *Sales* is non-missing and greater than zero.
- Observations where each input is non-missing and at least one is strictly non-negative.²

To run DEA, we use an output-oriented, variable returns to scale (VRS) model. We sort firm-years into peer groups based on industry, using the definitions in Fama and French (1997). Due to their fundamentally different revenue-generating structure, we exclude financial firms (banks, insurance companies, real estate firms, and finance companies). We also exclude utilities, as their revenue is often not determined by competitive forces (to which efficiency contributes) but rather by regulation.

After various sample restrictions, the study sample consists of 177,134 firm-year observations from 1980 through 2009, drawn from 43 different industries. The mean (median) efficiency is 0.569 (0.588). Industries range in size from 268 firm-year observations (Smoking) to 21,884 (Business Services). There is also considerable variation in reported efficiency at the industry level, with scores ranging from 0.271 (Drugs) to 0.942 (Ships). The mean (median) of the industry totals is 0.672 (0.674).

In the second stage, we use six firm-level variable to control for items that we believe make firms more or less efficient regardless of the manager's contribution. *Total Assets* and *Market Share*, capturing firm size and market power, both are predicted to lead to higher efficiency; larger

² We code missing values of R&D expense, operating lease expense, goodwill, other intangibles, and SG&A to zero, as many firms will not report values for these variables or the values are consolidated into other variables. We hand-checked a random sample of observations to confirm the appropriateness of this treatment of missing value.

firms and those with more market power should enjoy economies of scale and scope, and have access to financing to investment in favorable opportunities. Similarly, *Firm Age* captures the lifecycle of the firm. Older, more established firms are likely to be more efficient. We also expect that firms with more *Free Cash Flows* will be more efficient, as they are less reliant on external finance; we measure this with an indicator for non-negative free cash flows. In contrast, we expect that firms with higher *Business Segment Concentration* are operationally more complex, which we predict to hinder efficiency. Along the same lines, firm with *Foreign Currency* transactions are likely to be more complex multi-nationals, leading to lower efficiency.

For our second stage analysis, we run 43 industry-level regressions, using firm efficiency as the dependent variable and the six firm features as the independent variables. We also include year fixed effects to control for time-varying changes in efficiency not captured by these other variables. We use a Tobit specification because firm efficiency is censored below zero and above one. We calculate a residual by taking the fitted value from the regression and subtracting the actual value of firm efficiency. This essentially gives us an unexplained portion, which we attribute to the manager as firm efficiency.

In the second stage analysis, the average adjusted R^2 from the regressions is 0.374. The independent variables behave, for the most part, as predicted; in most regressions each has the predicted sign, and at least 65 percent have significant coefficients in the predicted direction for five of the six independent variables. The mean (median) value of Managerial Ability is -0.004 (-0.013), and the standard deviation is 0.149.³ Based on the summary statistics, the distribution is fairly symmetric, with a slight right skew.

2.4 *Limitations*

³ Because we use Tobit regression, rather than OLS, our calculated “residuals” from the regressions do not have an average value of zero.

The DLM Managerial Ability score represented a first attempt to quantify the skill of management using financial accounting data. The advantages of the DLM method—availability for a large number of firms and years, intuition of calculation, and broad applicability—have made the measure popular, as reflected by the frequent citations of DLM.⁴ This being said, there are a number of issues with the original DLM formulation that limits its usefulness. We describe these limitations here, and how addressing them may improve measurement of managerial ability.

A potential significant issue with the DLM method, particularly in the first stage, is measurement error.⁵ There are two sources of measurement error. First, some accounting variables are measured with error relative to their economic values. For example, the capitalization of operating leases requires estimates and assumptions by the researcher, so is unlikely to capture true economic values.⁶ Second, some valuable economic resources are not reported in the financial accounting system and are excluded from the DLM model. For example, the value of human capital of a firm is not recognized as an asset, and estimating its value would likely entail significant measurement error. Correcting these sources of measurement error should improve the precision with which the score captures managerial ability.

In the DLM model, firm-years were pooled by industry but across years in both stages of the analysis. This means that past efficiency was used to calculate future efficiency. For example, when calculating General Electric's efficiency for 1981, DLM would use all industry peer observations from 1980 through 2009...meaning GE's past efficiency is being evaluated against its peers' (and its own) *future* revenue and capital amounts. In some contexts, this is not an issue,

⁴ The count of citations on Google Scholar as of December 17, 2019 is 614.

⁵ DLM acknowledge and discuss this issue on pg. 1235.

⁶ New lease accounting standards under ASC 842 (effective December 15, 2018) requires all leases to be reported on the balance sheet.

but in other contexts, for example if managerial ability is being used for prediction, it introduces look-ahead bias.

There are various alternatives to address this potential bias. First, we could group observations by industry and year, which would eliminate the look-ahead problem. We considered this in developing the original DLM model. The problem is that many industry-year groups had very few observations. The “small calculation group size” problem, as described in Demerjian (2018), leads to many firms on the frontier and subsequently little variation in measured efficiency. A second alternative is to group observations just by year. This formulation, also explored in Demerjian (2018), avoids the problem of look-ahead and generates distribution of managerial ability similar to the original DLM model. Exploring different methods of group observations to calculate DEA presents an opportunity to improve on the DLM model.

The DLM model explicitly attributes their score to the entire management team. This is because their method cannot discriminate the contributions of individual managers—the variables used are all firm-level. Since research questions often involve the incentives and actions of individual executive (e.g., the CEO and CFO) as opposed to the management team as a whole, there are certain questions that are challenging to address use the DLM managerial ability score.⁷ A natural extension of the DLM model is stratify the score between different executives. This, however, is challenging proposition. One method would be to sort inputs based on the presumed decision-maker and identify outputs linked exclusively to the inputs. Given the relative coarseness of accounting data, it is unlikely such partitioning would be successful without developing new data sources. Alternatively, the management team score could be allocated to different executives

⁷ DLM and a variety of subsequent studies examine the association between managerial ability measured at the management team level and CEO features such as compensation (e.g., Chang et al. 2015). The assumption is that the CEO ultimately has control over the firm, including the hiring of other executives, so the actions of the management team ultimately reflect the incentives of the CEO.

based on their contribution. This would require a “management mobility” method, such as used by Bertrand and Schoar (2003). The drawback of this method is that it is data intensive and requires management changes for identification. At this point, measuring true executive-level ability scores remains elusive.

Finally, the DLM model fails to take into account the endogeneity of hiring. While the second stage of the model does try to control for firm-level features, it does not necessarily control for those factors that caused the firm to hire the manager in the first place. Recent work (Pan 2015) has started to explore this decision explicitly, using the assortative matching model of Fox (2010). This method presents significant promise to allow us to understand the model the determinants of firm-manager matches, and integrate this into the calculation of managerial ability.

3 Review of managerial ability papers

Since the publication of DLM, a literature has emerged using their score to examine the impact of managerial ability on a number of decisions and actions. In this section, we provide a review of this literature. We focus on published papers, although we also discuss several more recent working papers. We try to identify prominent examples from each area where managerial ability research is common. As such, this review is not meant to be exhaustive, but rather a means to introduce interested readers to the scope of papers currently being produced by researchers applying the MA Score.

We group studies into seven categories. These are: firm performance, financial reporting, tax reporting, firm information environment, investment, debt contracting, and executive hiring and compensation contracting. In each section, we discuss how the authors predict managerial ability will affect the phenomenon under study, and describe their results.

3.1 *Firm performance*

There is likely to be a direct, positive association between managerial ability and firm performance. On the surface, the features of a high ability manager—better foresight and understanding of the business, and superior investment decisions—should lead to better firm performance. In contrast, it is possible that managers with superior ability use their skill opportunistically; that is, they make investments that benefit themselves at the expense of maximizing firm value. The risk of opportunism makes the relation between managerial ability and firm performance ambiguous.

A number of papers examine this relation from different perspectives. Cheung, Naidu, Navissi, and Ranjeeni (2017) examine the question directly, focusing on the role of managerial discretion. In their study, they argue that managerial ability is most useful when accompanied by discretion; that is, high ability managers need significant latitude to take actions that will increase firm value.⁸ Cheung et al. find that managerial ability has a positive effect on firm performance in all cases, but that the effect is enhanced when the manager has greater discretion. They further examine the downside of excessive managerial discretion, and find the positive interaction between managerial ability and discretion requires better monitoring quality, measured with various institutional investor and board variables.

Andreou, Ehrlich, and Louca (2013) examines the relation between managerial ability and firm performance, using the 2008 Global Financial Crisis as their setting. Although they argue that high ability should improve firm performance, their paper is silent on what aspects of ability are particularly useful in a crisis setting. Additionally, they test the association between ability and firm performance for the period 2008 through 2011, which comprises the crisis period. It would

⁸ Cheung et al. (2017) divide firms into “prospecter” and “defender” categories based on Miles and Snow (1978); prospectors are associated with more discretion, and defenders with less.

be informative for the authors to examine how this relation changes from the period before the crisis, through the crisis, and then into the subsequent recovery period. This would allow readers to understand if managerial ability is *incrementally* more important during crises.

Yuan, Tian, Yi, and Yu (2019) examine a different aspect of firm performance: corporate social responsibility (CSR) performance. They measure CSR performance using the MSCI STATS index, which evaluates CSR on a number of dimensions, including corporate governance, employee relations, the environment, and human rights. To the extent that CSR investments reduce the firm's financial return—for example, from diverting investment dollars away from projects that provide purely monetary return but no social benefits—CSR investment can be risky for managers. Yuan et al. argue that high ability managers have fewer career concerns, for example, they have strong reputations, that allow them to invest in CSR despite the potential decline in firm performance. Their results support this contention, showing a positive relation between managerial ability and CSR performance.

3.2 *Financial reporting*

DLM captures the manager's ability to efficiently select investments and make them profitable; that is, ability is related to both investment and operating ability. A requirement for successful investment and operating outcomes is foresight; more skilled managers should make superior projections, for example, of demand for their products and services and related costs. The concept of superior foresight and prediction ability provides the link between managerial ability and financial reporting.

Demerjian, Lev, Lewis, and McVay (2013) is one of the earliest studies to apply the MA Score. They examine whether abler managers have higher quality earnings. They argue that high ability managers, by virtue of their superior knowledge and operating acumen, will make more

accurate estimates, leading to higher quality earnings. They find evidence of this on a number of dimensions, including a lower frequency of restatements, more persistent earnings, and higher quality accruals. These findings are consistent with superior ability leading to better estimates, leading to better accruals and higher quality financial reporting.

Moving from earnings quality to earnings management, Demerjian, Lewis-Western, and McVay (2019) examine the association between managerial ability and income smoothing. Unlike the predicted positive relation between ability and reporting quality, the hypothesis in this case is less clear. On the one hand, managers may use their superior ability to smooth away transitory aspects of earnings, leading to a more informative income stream. On the other hand, high ability managers may use their ability nefariously to effect transfers to benefit themselves or other shareholders. Demerjian et al. (2019) find evidence of the former: while higher ability is associated with greater smoothing, a test of proxies for motive in smoothing suggest that managers use discretionary smoothing to make earnings more informative. Among other studies that examine ability and earnings management, Wang, Che, Chin, and Zheng (2017) find a lower incidence of reporting fraud, examining firms in China, when managerial ability is high.

There is, to this point, relatively little evidence looking at association between managerial ability and reporting quality of individual accounts. One exception is Sun (2016), which examines managerial ability and goodwill impairment. Sun provides evidence that high ability managers recognize goodwill impairments less frequently, and when they do recognize them, the impairments are smaller. It is unclear from the results, however, the exact channel by which managerial ability affects this outcome. The author argues that the high ability manager will "...better manage their firms to maximize shareholders' benefits..." (pg. 44), suggesting these higher ability managers will somehow be better equipped to use discretion to forestall impairment.

We would argue a more likely explanation is that high ability managers make better acquisitions, leading to either less goodwill (i.e., they are less likely to overpay for an asset) or fewer economically-motivated impairments (i.e., they manage the acquisition more effectively, leading to less value loss). Understanding the role of ability in affecting investment quality as well as operating acumen is a promising direction for future research.

The prior studies relate managerial ability to various aspects of financial reporting quality, including earnings management. In recent years, a related literature has emerged, following Roychowdhury (2006), which examines whether firms make investment and operating decisions to affect reported financial outcomes. A study by Huang and Sun (2017) examines the association between managerial ability and real activities earnings management (REM). The authors argue that the value-destroying effects of REM will be alleviated by high ability managers selecting the least costly methods. They predict and find that high ability managers are less likely manage earnings through real activities, and when they do the effect on future performance is less severe. These results are consistent with high ability managers deploying their superior foresight and predictive ability to increase firm value.

3.3 *Tax reporting*

A large literature exists examining incentives for firms to delay or avoid taxation. The idea underlying these studies is that taxation reduces cash flows of the firm, so actions undertaken to avoid the present value of all future tax payments are beneficial for the firm. Following a similar logic as studies examining ability and financial reporting features, high ability managers should be able to use their ability—superior foresight and ability to make accurate predictions—to manage their firms' taxation more effectively.

Koester, Shevlin, and Wangerin (2017) argue that managerial ability is associated with tax planning in three ways. First, similar to the argument for financial reporting, understanding of the firms operating environment should lead to more efficient tax planning. Second, a skilled manager can hire a staff that is focused on cutting costs, including the minimization of taxes. Third, high ability managers will more efficiently allocate resources from tax saving to productive use, leading to greater incentives to avoid taxes. Their evidence shows that managers at the 75th percentile of ability enjoy a tax rate more than three percent lower than managers in the 25th percentile.

Park, Ko, Jung, and Lee (2015) examine the relation between taxes, firm value, and managerial ability, focusing on firms in Korea. Their evidence shows a negative association between firm value and tax avoidance, meaning more valuable firms pay *higher* taxes. They find, however, that this relation is mitigated by high managerial ability, consistent with Koester et al. (2017). Guan, Li, and Ma (2018) examine a different aspect of taxes, the sensitivity of dividends to the tax effects of dividends. Some evidence shows that the tax on dividends reduces the frequency and amount of dividends, although the evidence is mixed. This study proposes that high ability managers, through their greater skill in identifying future changes in the operating environment (and particularly, its implications for dividend taxes) should mitigate this effect. They find that a one standard deviation increase in ability is associated with an almost 40 percent increase in shareholder tax sensitivity to dividends.

3.4 Firm Information Environment

Managerial ability is also conjectured to have a positive influence on the overall information environment of the firm. The rationale is similar to that for arguments for superior reporting quality: the high ability manager's greater understanding of the firm, including operating and investment policy, should lead to the manager producing superior information about the firm.

Studies that focus on the firm's information environment either explicitly or implicitly take this perspective.

Baik, Farber, and Lee (2011) examine the association between managerial ability and management forecasts. They argue that high ability managers are more likely to issue forecasts, as this can serve as a costly signal of their latent ability. Their evidence is consistent with this both likelihood and frequency of issuing forecasts, consistent with a signaling motive. They further find that high ability managers issue more accurate forecasts, and that the equity market responds more to the forecast of high ability managers. Their evidence is, collectively, consistent with ability being associated with the amount and quality of management forecasts.

Baik, Brockman, Farber, and Lee (2018) examine the association between managerial ability and firm information environment more broadly. Their stated objective is to examine a broad, diverse set of information variables. In their study, they focus on four: analyst following, analyst forecast accuracy, bid-ask spread, and trading volume. They aggregate these into a summary measure, which they argue addresses various measurement issues associated with use of individual metrics. Their evidence shows that managerial ability has a positive association with their information environment composite. This evidence is interesting as there is no direct channel through which managerial ability affects the components of their composite. For example, management forecasts are provided directly by the manager, so a direct link should exist between these forecasts and ability. Analyst forecasts, in contrast, are prepared by a party external to the firm; thus the link between ability and the outcome in this case is less direct.

Krishnan and Wang (2015) examine a different aspect of the firm's information environment, related to the mandated external audit of financial statements. The study examines the association between managerial ability and two aspects of audit engagement, audit pricing and

going concern opinions. They argue that managerial ability affects the audit in two different ways. First, higher ability managers should have lower firm risk, in an investment or operational sense. Second, high ability managers also produce higher quality earnings. The former should lead to a lower likelihood of a going concern opinion, while the latter should lower engagement risk due to the firm's higher quality information, leading to lower audit fees. The evidence in Krishnan and Wang supports these predictions. Like the evidence discussed above, this study illustrates how external parties understand and interpret managerial ability.

3.5 *Investment*

By designing the MA score using sales revenue as the single measure of firm output, there is a clear link to the manager's operational ability; the manager's ability to manage the assets of the firm efficiently leads directly to higher revenue, holding other things equal. A different, but perhaps equally important, aspect of performance, is the selection of investment projects. A number of studies have examined how managerial ability affects the firm's selection of investments, and focuses both on the performance that results from those investments and their risk.

Chen, Podolski, and Veeraraghavan (2015) examine how managerial ability affects innovative output. Chen et al. argue that investments in innovation have an ambiguous relation to managerial ability. On the one hand, innovative investments, such as research and development, have very uncertain outcomes, in a sense featuring lottery payouts rather than traditionally distributed investment returns. For this reason, no amount of managerial ability can change the outcome probabilities, and higher ability managers are better off employing their skill elsewhere. On the other, high ability managers face fewer financing frictions and hire the most promising research staff, leading to the greatest chance of innovation success (and potentially large payoffs).

Examining a large sample of firms, they find that managerial ability is positively associated with both the number of patents and patent citations, consistent with the latter argument. Yung and Chen (2018) present similar findings, presenting evidence that high ability managers make riskier investments (including research and development) than lower ability managers.

Papers by Habib and Hasan (2017) and Andreou, Karasamani, Louca, and Ehrlich (2017) examine the association between managerial ability and investment policy as it relates to extreme performance. Habib and Hasan find that high ability managers overinvest relative to less able managers, leading to a positive association between managerial ability and crash risk. Andreou et al. argue, in contrast, that high ability managers made better investments during crisis periods, which they attribute to superior financing options for firms with better managers. Since crisis periods and periods of financial stress likely create greater demand for the skills of high ability managers, future work should attempt to reconcile these apparently conflicting results.

Finally, Andreou, Philip, and Robejsek (2016) adapt the MA Score for banks. Using their ability score, which is calculated using a large set of banking specific variables, they examine how ability is associated with both bank liquidity and bank risk-taking. Their results show that managerial ability has a positive association with liquidity creation, but that this effect is concentrated in small and medium banks. Examining a number of measures of bank risk metrics, including Tier 1 capital ratio and Z-Score, they find a positive association between managerial ability and risk, particularly for medium and large banks. Although this research does not examine investment in the sense typically employed for industrial firms, it opens an interesting new area of research, for understanding how managerial ability affects choices and outcomes at financial firms.

3.6 Debt Contracting

The managerial ability of the borrower is likely to serve as an input to debt contract terms in two ways, through a direct channel and through an indirect channel. The direct channel pertains to the link between managerial ability and the investing and operating decisions of the borrower. To the extent high ability manager make superior decisions, this should lead to a lower risk of default and a higher expected return to creditors in the event of default. This, in turn, should lead to less stringent loan contract terms, including lower interest rates, fewer covenants, and larger, longer loans. The role of management providing information to the creditor yields the indirect channel. If high ability managers provide higher quality information for contracting, information asymmetry between the borrower and creditor should be reduced, leading to more favorable contract terms holding other things equal.

De Franco, Hope, and Lu (2017) examine how managerial ability correlates with bank loan pricing, the interest spread of the loan. They find that loans to borrowers with higher ability managers receive lower interest spreads, consistent with managerial ability mitigating borrower risk. They examine the direct and indirect channels described above and find evidence of both. Specifically, they find that the effect of managerial ability is stronger for firms with weak underlying economics (consistent with the direct channel) and when information risk is high (consistent with the indirect channel). Bui, Chen, Hasan, and Lin (2018) also examine the association between managerial ability and loan pricing. In their study, they sort borrowers into those with persistent high ability and those with temporary increases in ability. Attributing he increases of the latter group to luck, they find the benefits to higher ability are concentrated in those cases where the high MA is not due to luck, but rather more persistent features.

Several studies also examine whether managerial ability is reflected in borrower credit rating. Bonsall, Holzman, and Miller (2017) examine this link directly, finding that firms with high

ability managers have higher credit ratings, holding other things equal. They confirm this result with a sample of CEO changes, illustrating that ability appears to have a causal (rather than just associational) link to credit ratings. Cornaggia, Krishnan, and Wang (2017) also find evidence that high borrower managerial ability leads to higher credit ratings. In cross-sectional tests, they find their results are particularly strong for borrowers facing financial constraints and high levels of competition. These results collectively suggest that various stakeholders in debt contracting, including lenders and rating agencies, incorporate information about managerial ability into their assessments and decisions.

3.7 Executive Hiring and Compensation Contracting

The final broad area of research where researchers have directly applied managerial ability is compensation contracting. On the surface level, there are clear links between managerial ability and various aspects of executive hiring and compensation. For example, holding other things equal, firms will want to hire higher ability managers, should pay them more, and will be less likely to terminate them. Examining these relations empirically, however, is complicated by the joint endogeneity of these decisions. A number of studies have, despite this issue, examined links between ability and various of these executive contracting outcomes.

Evans, Luo, and Nagarajan (2014) examines firms in financial distress. In a setting where they examine changes in executive compensation contracting over time, they find that managerial ability is not associated with turnover decisions occurring in the 1980s, but subsequently has a positive association with management retention in the 1990s. This is consistent with management ability taking on a more important role over time, at least for distressed firms. Chang, Hayes, and Hillegeist (2016) examines the association between financial distress risk and executive compensation. In theory, executives should demand higher pay when firm distress risk is high, a

result that their evidence confirms. Their results further show that managerial ability does not change this relation; that is, the pay premium is not due to higher ability, but rather extra compensation for financial distress risk.

Acharya, Gabarro, and Volpin (2012) examine the CEO hiring decision, with a focus on corporate governance. They argue and find that a low supply of high ability managers leads to a reduction in firms' investment in corporate governance. Among other tests, they find that corporate governance at a firm will weaken when a low ability CEO is replaced by a higher ability one. This could mean either that high ability CEOs are less likely to take opportunistic actions, thus obviating the need for strong corporate governance; or that high ability CEOs have a bargaining advantage (relatively to lower ability managers) and can demand less restrictions on their actions.

Finally, Pan (2017) examines how executives and firms match. This paper uses an assortative matching model based on Fox (2010), where matches are determined based on maximum score estimation (Manski 1975). The paper describes a competitive matching equilibrium where firms bid up the price of skills and abilities of executives, with the final hiring decisions reflecting the revealed preference how firms value different executive features. Pan shows that large firms tend to hire higher ability managers, largely due to their ability to pay more for the executive's skill.

4 Conclusion and Future Work

As this retrospective and review suggest, the development of a quantitative measure of managerial ability has been broadly accepted and applied within the accounting and related literatures. From initial work focused on the link between managerial ability and information quality, the MA Score developed in DLM has been applied to a wide range of settings, including

investment policy, compensation, and debt contracting. We expect researchers will continue to find innovative research questions and settings in which to apply the MA Score.

We also take this opportunity, in evaluating the literature on managerial ability, to consider some expansions and extensions of the score. First, we believe there is considerable space to expand the set of outputs considered in the first stage efficiency calculations. In designing the MA Score, we sought to develop a “general purpose” metric; that is, a score that was capable of proxying for decision-making ability across a wide range of decision contexts. The selection of revenue as the sole output in the first stage is consistent with this broad objective. This being said, we expect there are a variety of additional outputs that managers consider and could thus be interesting and useful to as outputs. For example, managers of publicly traded firms have incentives to produce value for shareholders, so an additional output could be the market value of the firm’s common equity in addition to or incremental to the effects of revenue. Managers may also work to optimize value not related to equity value; examples include providing employment or CSR activities. To the extent these variables can be measured, they would make reasonable outputs.

Second, there are also inputs that could plausibly be added to the original DLM model. The inputs in the first stage are readily measurable and widely available for a large set of firm years. While our objective was to create as exhaustive a set of variables as possible, we acknowledge that we were not able to include some relevant inputs to the firm’s value-creation process. For example, our inputs do not measure the human capital of firm employees, or the value of various contractual relationships of the firm. With improved data sources and computational resources, including additional inputs are another promising direction to expand the original work in DLM.

Third, there are likely insights to be gained by developing MA Scores focused on specific industries and even specific decisions. While the DLM MA Score emphasizes breadth, there are likely ways that the method can be applied to smaller settings. Researchers could develop scores incorporating the distinct feature of firms in specific industries, such as insurance or banking. Other extensions have examined new settings and decisions; for example, recent work by Schwab, Stomberg, and Williams (2019) examines the efficiency of tax planning. These studies illustrate the potential to expand the set of decision contexts, and to develop more precise measures.

We also believe the literature developing around managerial ability could benefit from linking up with other established literatures. One area that managerial ability fits particularly well with is the literature on managerial overconfidence. Malmendier and Tate (2005) provide evidence that the level of overconfidence affects managerial decision-making related to investments. A vast literature has emerged examining how overconfidence manifests in a variety of decision contexts. Understanding how ability and overconfidence interact, and their possible joint causes, seems a particularly fruitful direction for future research.

Another literature that managerial ability may inform is a recent extension of managerial features research that focuses on managerial practices. Bloom and Van Reenen (2007; 2010) define managerial practices as the various structures and institutional features that facilitate the actions of management. Examples of managerial practice include activities such as performance evaluation, goal-setting, and incentive compensation. Understanding how managerial ability interacts with managerial practices is likely to shed light on how both relate to firm performance.

Finally, another recent line of literature examines organization capital. As described in Lev, Radhakrishnan, and Zhang (2009), organization capital is a valuable intangible asset comprising “unique structural and organizational designs and business processes generating sustainable

competitive advantages.” (pg. 276) It is likely that managers benefit from strong organization capital (i.e., it is easier to manifest high ability when organization capital is high), and that managers also *affect* organization capital (i.e., high ability managers may help generate long-lasting competitive advantages for their firms through their superior investments and decision-making). Given the fundamental manager of managerial skill and the features of the organization, understanding the links between managerial ability and organization capital is another potential direction for future research.

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