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Evaluation of Managerial Ability in the Japanese Setting*

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ABSTRACT

Following Demerjian, Lev, and McVay (2012), we quantify managerial ability using a sample of Japanese listed firms for the period 2005-2015. Consistent with their findings, we find that the estimated managerial ability is strongly correlated with manager-fixed effects. Further, we find that the managerial ability is economically and significantly associated with the stock price reactions to CEO turnovers and changes in future return on assets following CEO turnovers. Our results are robust to alternative specifications of DEA models and inputs used in the estimation of firm efficiency. We contribute to the literature by generalizing the validity of the managerial ability introduced by Demerjian, Lev, and McVay (2012) to a non-US setting.

JEL Classification: M10, M41
Keywords: Managerial ability, Japan, Stock returns, ROA, and CEO turnovers.

1. Introduction

Demerjian, Lev, and McVay (2012, hereafter DLM) introduce a new measure on managerial ability (MA) that quantifies managers' economic efficiency in transforming corporate resources into revenues based on publicly disclosed accounting data. The uniqueness of MA and its validity as a CEO-specific measurement of ability have been attracting much attention in various fields. Recent studies use MA in the context of management forecasts (Baik et al. 2011; Ishida et al.

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2018), earnings quality (Demerjian et al. 2013; Demerjian et al. 2017), audit fee (Krishnan and Wang 2015), mergers and acquisitions (Leverty and Qian 2010), corporate investments (Andreou et al. 2017; Habib and Hasan 2017), tax avoidance (Koester et al. 2017), innovative activities (Chen et al. 2015; Cho et al. 2016), and credit ratings/bank loans (Bonsall et al. 2016; De Franco et al. 2017).

Although these prior studies generally accept the *legitimacy* of managerial ability, it remains an open question as to whether its generalizability holds in countries outside the United States. Given that US firms are typically characterized by market-orientation, shareholder-governance, and liquid CEO markets (Aoki et al. 1994; Kaplan and Minton 1994; Ball et al. 2000), MA may be specific to the US economic environment in which managers are more likely to be exposed to strong external pressures for efficient business operations. On the other hand, in the spirit of DLM (2012), some recent studies have begun to quantify managerial ability using non-US firms (Park and Jung 2017; Wang et al. 2017; Garcia-Meca and Garcia-Sanchez 2018).[1] However, these studies mainly focus on estimating MA scores rather than validating them.[2] As a result, the literature still leaves the generalizability of MA outside the US in question.

We extend DLM's study by testing the validity of managerial ability using Japanese data. Unlike the U.S., Japan has a very different institutional environment that is characterized by bank-orientation, strong stakeholder-governance, and illiquid CEO markets (Aoki et al. 1994; Shuto and Iwasaki 2015). Specifically, it has been argued that Japanese firms are unusual in terms of appointing outsiders to CEO positions and board of directors (Kaplan and Minton 1994; Kang and Shivdasani 1995), non-performing firms that rarely go bankrupt with intensive support from their main banks (Peek and Rosengren 2005), and pressures from activists that are more likely to fail (Becht et al. 2017). These remarkable differences with the US economy cast doubt on the usefulness of MA in Japan to the extent that economic institutions are less effective in shaping managers' incentives for efficient business operations that MA conceptually relies on. On the other hand, if DLM's methodology and metric are truly universal, we expect that MA holds its generalizability even in a different economy, in measuring relative managerial ability among Japanese firms.

Using a sample of 28,853 Japanese firm-year observations for the period 2005–2015, we estimate the MA score and evaluate its validity, following DLM (2012). We find that the estimated MA score is strongly associated with manager-fixed effects. Further, we find that the MA score is economically and significantly associated with the stock price reactions to CEO turnover and changes in future return on assets (ROA) following CEO turnover. Our results are robust to alternative model specifications of DEA models. Taken together, consistent with DLM (2012), we conclude that MA provides a clean depiction of managers' ability for Japanese firms.

We contribute to the literature in the following important ways. First, we extend DLM's (2012) framework to the Japanese setting. In line with the findings in DLM (2012), we document that the proposed MA measure is more likely to capture manager-specific ability than alternative measures used in prior studies, supporting the generalizability and validity of MA in a non-US

[1] Park and Jung (2017) and Wang et al. (2017) apply MA in the context of Chinese and Korean listed firms, respectively. García-Meca and García-Sanchez (2018) use MA for banks from nine Western countries.

[2] Although Wang et al. (2017) examine the validity of MA in China, they provide limited information for their estimation process and conduct less comprehensive validation tests compared to DLM (2012), which makes it difficult to compare and confirm the validity of MA outside the U.S.

economy. Second, while our estimation procedures and testing variables differ slightly from those in DLM (2012) due to differences in the information publicly disclosed between the U.S. and Japanese firms, we consistently find that the MA measure is a clean measurement for managerial ability in Japanese companies. Third, we provide further evidence that the MA measure is robust to alternative specifications of DEA models, which DLM (2012) do not consider.

The remainder of this paper is organized as follows. Section 2 describes DLM's (2012) framework in estimating the MA score and discusses the advantage of the MA score relative to alternative proxies for managerial ability. Section 3 explains the detailed procedures for estimating MA scores and compares our estimated MA scores with those in DLM (2012). Section 4 reports our empirical results on the validity of MA scores as a manager-specific measurement of ability. Section 5 concludes with a summary.

2. Framework of DLM

To measure managerial ability, prior studies largely rely on measures such as stock prices (Hayes and Schaefer 1999; Fee and Hadlock 2003), return on assets (Rajgopal et al. 2006; Carter et al. 2010), CEO tenure and compensation (Milbourn 2003; Carter et al. 2010), and media mentions (Milbourn 2003; Francis et al. 2008). However, most of these measures are subject to strong assumptions and firm-specific factors that are outside of management's control. For example, stock returns are affected by various factors and depend on the assumption that market participants have good *ex-ante* knowledge of managers' ability. Similarly, media mentions are more prevalent for larger firms, subject to media coverage and its accuracy.

In contrast, DLM (2012) introduce a new metric based on managers' efficiency in transforming corporate resources into revenues. They calculate firm efficiency, relative to industry peers, using data envelopment analysis (DEA) and then estimate MA score as the unexplained portion of firm efficiency by Tobit regressions. The underlying notion is that more able managers are expected to generate higher revenue for a given level of resources or, conversely, to minimize the resources used for a given level of revenue (DLM 2012, p. 1229). DLM's "managerial ability" is based on a concept of economic efficiency in which economic persons should pursue "more outputs with fewer inputs." Compared to other measures on managers' ability, this is more intuitively consistent with the overarching goal of profit-maximizing firms.

DLM's estimation process consists of two stages. The first stage involves the use of DEA to estimate firm efficiency within an industry by comparing outputs (Sales) generated over expense and capital inputs (Cost of Goods Sold, Selling and Administrative Expenses, Net PP&E, Net Operating Leases, Net Research and Development Capitals, Purchased Goodwill, and Other Intangible Assets). Running DEA by-industry results in a relative firm efficiency score that takes one for firms that are among the most efficient in the industry and less than one for those relatively inefficient firms. The difference from one indicates the shortage of outputs for a given input or excess of inputs for a given level of outputs in each inefficient firm. The second stage is the employment of Tobit regressions to remove effects of firm-specific factors on the firm efficiency score. Since the firm efficiency score obtained from the first stage is affected by both firm-specific factors and management characteristics, DLM (2012) consider the effects of firm size, market share, positive free cash flow, and firm age (all aiding management), as well as complex multi-segment and international operations (challenges to management) in their Tobit regressions. They then attribute the residuals from regressions, an unexplained portion of firm efficiency, to the measurement of managerial ability.

The comparative advantages of DLM's (2012) approach can be summarized as follows. First, their approach is relatively free from data constraints and thus sample selection biases. DLM (2012) use only accounting variables that are publicly reported in firms' annual reports. Unlike media mentions, the managerial ability measure does not require such specific information resources as newspaper/article databases. Similarly, while manager-fixed effects can be a good proxy for managerial ability (Bertrand and Schoar 2003), they can be applied only to a relatively small sample of firms and do not offer a stand-alone measure.[3] Hence, as long as companies disclose accounting information, DLM's approach can be used to calculate these companies' managerial ability. Second, stock returns and media mentions are inherent results from investors' and media's reputations, which inevitably assume that those stakeholders can correctly evaluate managers' ability. In contrast, DLM's (2012) managerial ability measure is relatively less dependent on stakeholders' reputation. Third, the DEA efficiency measure has two advantages over conventional measures of efficiency. One is that DEA provides an ordinal ranking of relative efficiency to the efficient frontier: the best performance that can be practically achieved. Parametric methods, such as regressions and basic ratio comparisons, consider efficiency relative to *average*, that is lowered disproportionately by inefficient industry peers. The other one is that DEA does not necessarily impose explicit weights on inputs and outputs. Efficiency measures, like return on assets, implicitly assume that all assets and profits are equally valuable across firms. That is, they do not consider differences in resource mixes for generating economic outcomes. In the DEA procedure, if two firms produce the same level of output with different mixtures of inputs, both can be considered efficient.

3. Estimation of MA Score for Japanese Firms

3.1. Estimation Process of the MA Score

We adopt the estimation process of DLM (2012) using Japanese firms. For the first stage, we use DEA to calculate firm efficiency by solving the following optimization problem:

$$\max_v \theta = \frac{(Sales)}{(v_1 CoGS + v_2 SG\&A + v_3 PPE + v_4 OpsLease + v_5 R\&D + v_6 Goodwill + v_7 OtherIntan)} \quad (1)$$

where *Sales* is net revenues earned by the firm; *CoGS* is costs of goods sold; *SG&A* is selling, general, and administrative expenses; *PPE* is net plant, property, and equipment; *OpsLease* is net operating lease assets; *R&D* is net research and development capital assets (Lev and Sougiannis 1996); *Goodwill* is acquired intangible assets; and *OtherIntan* is other intangible assets. DLM (2012) set a single output, *Sales*, and consider that seven inputs contribute to the generation of revenues. For each firm-year observation, each input is assigned a weight as an expressed vector (v) in calculating the efficiency score. The maximization process determines each weight to maximize Equation (1) for each firm-year relative to its peers within an industry (i.e., varying weights). Using these weights, we then calculate the firm-year efficiency score within the industry and scale it by the effi ciency score of the most efficient firm observations, yielding a relative

[3] DLM (2012, p. 1231) argue that fixed effects are difficult to implement as a measure of managerial ability. First, the firm must experience at least one manager turnover during the period of examination to differentiate manager fixed effects from firm fixed effects. Second, fixed effects do not immediately offer a generalizable ordinal ranking of quality.

efficiency score of between zero and one. Observations with an efficiency score of one are considered efficient and form the efficiency frontier for the industry. Observations enveloped by the frontier (i.e., below the frontier) are classified as inefficient in terms of generating outputs over the set of possible input combinations. The degree of inefficiency is calculated as its distance from the frontier, indicating how much the firm-year should either increase revenues or decrease capital and expenses for the given levels of inputs and outputs, respectively. Following DLM (2012, footnote 11), we estimate the efficiency frontier using the variable returns-to-scale model (VRS model, Banker et al. 1984), in which the frontier takes the form of piecewise linear connecting the most efficient firm-year observations in the industry. Since firms typically have less control on outputs than on inputs, we use an input-oriented VRS model of DEA to calculate the efficiency score.

Our DEA procedure differs from DLM (2012) in the following two respects. First, although DLM (2012) use Fama and French's (1997) industry classification, we use the Tokyo Stock Exchange industry classification (33 industries). This is because we do not have the equivalent for Japanese firms. Similarly, compared to other industry classifications, such as the Nikkei industry classification, the Tokyo Stock Exchange industry classification yields a relatively well-balanced distribution of firms in each industry.[4] Second, while DLM (2012) estimate net operating leases as the discounted present value of required operating lease payments which is available in footnotes to the financial statements in the U.S. firms, Japanese firms do not disclose the same information. Alternatively, Japanese firms disclose the total amounts of future operating lease payments and amounts due within a year. Under this condition, we follow Kusano et al. (2015) and calculate the present value of net operating lease assets (see Appendix for variable definitions).[5]

In the second stage, we specify the Tobit regression to remove the effects of firm-specific factors. Specifically, we follow DLM (2012) and estimate the following equation by industry:

$$\begin{aligned} \textit{Firm Efficiecy}_i = {} & \alpha + \beta_1 \ln(\textit{Total Assets})_i + \beta_2 \textit{Market Share}_i + \beta_3 \textit{FCF\_D}_i + \beta_4 \ln(\textit{Age})_i \\ & + \beta_5 \textit{Business Segment Concentration}_i + \beta_6 \textit{Foreign Currency\_D}_i + \textit{Year}_i + \varepsilon_i \end{aligned} \quad (2)$$

where *Firm Efficiency* is measured using DEA in the first stage; *Total Assets* is total assets at the end of year *t*; *Market Share* is the percentage of revenues earned by the firm within its industry (Tokyo Stock Exchange industry classification) in year *t*; *FCF_D* is a dummy variable that takes one if the firm has non-negative free cash flow in year *t* and zero otherwise; *Age* is the number of years that the firm has been established;[6] *Business Segment Concentration* is the sum of the squares

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[4] The sample size for each industry is important in DEA. When there are too few firms in the industry, a large percentage of these firms will be on the frontier (DLM 2012), resulting in a higher score of firm efficiency. To avoid this sample-size effect, we adopt the Tokyo Stock Exchange industry classification.

[5] The estimation process of *OpsLease* requires certain assumptions for future payments. Hence, the variable may contain measurement errors. As noted in DLM (2012, footnote 7), we will be back to this issue and test whether our results change if we exclude *OpsLease* from the DEA estimation.

[6] Our variable of *Age* is slightly different from DLM (2012) as they use the number of years the firm has been listed on Compustat. Because we use the Japanese database called *Nikkei NEEDS FinacialQUEST*, we cannot obtain the same data as DLM (2012). Thus, we calculate the firm age based on the year the firm was established since our database discloses the date of establishment for each firm. For the robustness check, we also use the listing date recorded in a database called *Nikkei Cges* to calculate firm age. Our results remain unchanged.

of sales from each business segment as a percentage of total sales in year *t* (Bushman et al. 2004); *Foreign Currency_D* is a dummy variable that takes one if the firm reports nonzero value for foreign currency adjustments in year *t* and zero otherwise; and *Year* denotes a set of year dummies. DLM (2012) consider these six factors as firm-specific and thus less relevant to managers-specific ability. *Total Assets* and *Market Share* are included to control for the effect of bargaining power over suppliers and customers. *FCF_D* controls for firms' investment capacity to pursue positive net present value projects. *Age* is for the life cycle of the firm. Younger firms are less efficient due to the required start-up costs of investments. Both *Business Segment Concentration* and *Foreign Currency_D* represent the diversification and business complexity of the firm. The greater the diversification, the more challenging it is for the management team to allocate capitals efficiently. Finally, *Year* controls year-fixed effects as the *Firm Efficiency* is estimated by industry in DEA. The residual from the estimation of Equation (2) is DLM's (2012) measure of managerial ability.

3.2. Data

We obtain data from the *Nikkei NEEDS FinancialQUEST* database. Our sample period spans from 2005 to 2015 and includes all firm-year observations. We start from 2005 because the variable of *R&D* requires data on research and development expenses over the past five years and the data began to be disclosed after 2000 in Japan. Table 1 shows our sample selection process. Compared to DLM (2012), we add the criterion that our sample firms are mandated to prepare their financial statements in accordance with Japanese accounting standards. Because Japanese firms can choose either Japanese GAAP or the U.S. GAAP as of 2002 and International Accounting Standards (IAS) / International Financial Reporting Standards (IFRS) as of 2010 for consolidated financial statements, it is necessary to set an identical condition for measuring the basis of inputs and outputs.[7] Following DLM (2012), we require that each industry group must have at least 100 firm-year observations for DEA. These criteria yield a final sample of 28,853 firm-year observations.

3.3. Descriptive Statistics of Inputs, Output, and Efficiency Scores

Table 2 Panel A presents the descriptive statistics for the inputs and output of DEA. Panel B reports the descriptive statistics for the estimated firm efficiency for the full sample and by industry. We estimate 26 industry groups excluding the following seven industries: "Fishery, Agriculture, and Forestry," "Mining," "Air Transportation" for their sample size, "Banks," "Securities and Commodities Futures," "Insurance," and "Other Financing Business" because of the uniqueness of their asset structure and earnings generating process (DLM 2012).[8] The DEA efficiency measure takes a value between zero and one. We observe from Table 2 Panel B that the mean (median) efficiency is 0.847 (0.898), which is much higher than that of 0.569 (0.588) reported in DLM (2012). However, the standard deviation of 0.163 is lower than that of 0.273 in DLM (2012). Given fundamental differences between Japanese firms and the U.S. firms, we conjecture that these

[7] On the other hand, this requirement excludes certain Japanese leading companies using the U.S. GAAP or IAS/IFRS (e.g., Toyota Motor Corporation). This omission might influence our estimation of firm efficiency, relative to its peers. However, our results do not change when we include these firms in our analyses.

[8] DLM (2012) also excludes firms in utilities sectors because of regulation on the output price. However, we include utilities such as sector of "Electric Power and Gas" because the estimation process are by-industry and inclusion of these firm do not alter our results significantly.

TABLE 1. SAMPLE SELECTION

	Sample	
Firm-year observations listed on Japanese stock markets		36,882
− Firm-year observations with fiscal years that do not have 12 months	(1,226)	35,656
− Firm-year observations in the bank, insurance, and security sectors	(4,766)	30,890
− Firm-year observations do not prepare financial statements by Japanese accounting standards	(485)	30,405
− Firm-year observations without data for Equation (1)	(1,224)	29,181
− Industry group contains less than 100 firm-year observations	(233)	28,948
− Firm-year observations without data for Equation (2)	(95)	28,853
Final Sample Size		28,853

differences largely stem from the difference in sample size. While we use 28,948 firm-year observations of Japanese firms, DLM's (2012) sample consists of 177,512 firm-year observations, which is approximately six times larger than ours. When there are fewer firms in a group, more firms are likely to be on the efficiency frontier and assigned the value of one in the VRS model, *a priori*. As a result, the values of third quartile for industries such as "Pulp and Paper," "Pharmaceutical," and "Oil and Coal Products," take the value of one; the percentage of firm-years that is on the frontier ("% of one" in Table 2 Panel B) is particularly higher than other industries.[9] To illustrate this tendency, we check the correlation coefficient between the number of firms in each industry and the means of firm efficiency score and find that the value is −0.546, indicating that the firm efficiency score is negatively correlated with the number of firms used in DEA.[10]

On the other hand, firm efficiency substantially varies across industries with similar sample size. For example, while the mean of "Machinery" is 0.847 for a sample of 2,251 firm-years, that of "Information & Communication" is 0.678 for 2,282 firm-years, indicating that the latter industry includes more inefficient firms than the former one. Finally, we further examine whether firm efficiency varies across years since the measure is estimated by industries. The untabulated results indicate that the largest average value is 0.862 (2015), and the smallest is 0.824 (2009), suggesting that o ur measure of firm efficiency does not change much over time.

[9] The same tendency is also observed in Leverty and Qian's (2010) study, which conducted a similar DEA by industry-year group. They estimate the firm efficiency score using relatively fewer firms for each group, consequently resulting in a higher average score than DLM (2012) (i.e., the mean is 0.745 for the full sample).

[10] Another possible explanation for higher efficiency score in Japan is attributable to the lower dispersion of firms' profitability. Acharya et al. (2011) and Nakano and Aoki (2016) compare the time-series and cross-sectional volatility of return on assets using an international dataset and find that Japanese firms exhibit the lowest dispersion. This finding seems to be consistent with the notion that the industries with high competition might have a high firm efficiency score.

TABLE 2. DESCRIPTIVE STATISTICS OF INPUTS, OUTPUT, AND FIRM EFFICIENCY SCORE

Panel A: Full Sample

	Mean	Std.Dev.	Min	25%	Median	75%	Max	N
Sales	152,413	486,552	26	9,867	29,528	95,182	12,400,000	28,948
CoGS	119,397	402,783	1	6,946	21,892	72,577	11,600,000	28,948
SG&A	25,356	83,742	92	1,804	4,797	15,212	2,384,778	28,948
PPE	55,163	243,400	1	2,235	7,168	24,830	6,025,838	28,948
OpsLease	919	5,879	0	0	46	354	382,131	28,948
R&D	7,317	43,082	0	0	127	1,686	1,360,475	28,948
Goodwill	1,930	22,211	0	0	0	51	2,106,887	28,948
OtherIntan	2,383	13,524	0	43	167	758	652,520	28,948

Panel B: Firm Efficiency Score

	Mean	Std.Dev	25%	Median	75%	N	% of one
Full Sample	0.847	0.163	0.783	0.898	0.970	28,948	14.7%
Demerjian, Lev, and McVay (2012)	0.569	0.273	0.347	0.588	0.802	177,512	4.5%
By Industry							
Construction	0.925	0.055	0.891	0.929	0.968	1,919	11.2%
Foods	0.928	0.064	0.884	0.936	0.992	1,301	19.5%
Textiles and Apparels	0.926	0.074	0.881	0.946	0.995	706	22.7%
Pulp and Paper	0.981	0.029	0.969	1.000	1.000	267	52.4%
Chemicals	0.925	0.058	0.879	0.924	0.982	2,021	17.3%
Pharmaceutical	0.857	0.172	0.791	0.913	1.000	437	27.5%
Oil and Coal Products	0.986	0.026	0.978	1.000	1.000	121	62.0%
Rubber Products	0.970	0.034	0.941	0.980	1.000	193	40.9%
Glass and Ceramics Products	0.920	0.068	0.868	0.923	0.994	651	22.7%
Iron and Steel	0.886	0.103	0.804	0.903	0.997	565	24.4%
Nonferrous Metals	0.937	0.073	0.900	0.961	1.000	368	26.9%
Metal Products	0.885	0.106	0.814	0.912	0.981	899	19.0%
Machinery	0.847	0.105	0.783	0.844	0.927	2,251	12.0%
Electric Appliances	0.765	0.125	0.673	0.753	0.849	2,430	6.5%
Transportation Equipment	0.939	0.055	0.900	0.947	0.994	967	21.9%
Precision Instruments	0.926	0.095	0.871	0.971	1.000	406	39.4%
Other Products	0.893	0.082	0.824	0.891	0.977	966	18.7%
Electric Power and Gas	0.982	0.033	0.976	1.000	1.000	161	54.0%
Land Transportation	0.978	0.024	0.964	0.984	1.000	612	29.6%
Marine Transportation	0.888	0.110	0.805	0.915	1.000	184	28.3%
Warehousing and Harbor Transportation	0.963	0.033	0.940	0.965	0.997	426	23.0%
Information & Communication	0.678	0.154	0.570	0.657	0.762	2,282	5.1%
Wholesale Trade	0.933	0.058	0.903	0.943	0.974	2,972	7.9%
Retail Trade	0.894	0.076	0.842	0.897	0.956	2,543	11.5%
Real Estate	0.841	0.134	0.748	0.844	0.969	906	19.1%
Services	0.511	0.171	0.391	0.480	0.577	2,394	4.0%

Notes: This table reports the descriptive statistics for variables used in Equation (1). *Sales* are net sales for year *t*; *CoGS* is costs of goods sold for year *t*; *SG&A* is selling, general, and administrative expenses for year *t*; *PPE* is net plant, property, and equipment at the beginning of year *t*; *OpsLease* is net operating lease assets at the beginning of year *t*; *R&D* is net research and development capital assets at the beginning of year *t; Goodwill* is goodwill at the beginning of year *t*; *OtherIntan* is other intangible assets at the beginning of year *t*; $Firm\ Efficiency_{i,t}$ is a firm-year metric of firm efficiency that takes a value between zero and one, obtained from DEA.

TABLE 3. DESCRIPTIVE STATISTICS FOR VARIABLES USED IN TOBIT REGRESSIONS

	Mean	Std.Dev.	Min	25%	Median	75%	Max	N
Firm Efficiency$_{i,t}$	0.847	0.162	0.320	0.784	0.899	0.970	1.000	28,853
ln(Total Assets)$_{i,t}$	10.384	1.640	5.889	9.227	10.244	11.412	16.139	28,853
Market Share$_{i,t}$	0.009	0.029	0.000	0.001	0.002	0.005	0.618	28,853
FCF_D$_{i,t}$	0.731	0.443	0.000	0.000	1.000	1.000	1.000	28,853
ln(Age)$_{i,t}$	3.796	0.677	1.099	3.555	4.043	4.220	4.868	28,853
Business Segment Concentration$_{i,t}$	0.746	0.259	0.168	0.508	0.813	1.000	1.000	28,853
Foreign Currency_D$_{i,t}$	0.516	0.500	0.000	0.000	1.000	1.000	1.000	28,853

Notes: This table reports the descriptive statistics for variables used in Equation (2). *Firm Efficiency$_{i,t}$* is a firm-year metric of firm efficiency that takes a value between zero and one, obtained from DEA; *ln(Total Assets)$_{i,t}$* is the natural log of total assets; *Market Share$_{i,t}$* is the percentage of sales earned by the firm within its industry in year *t*; *FCF_$_{i,t}$* is an indicator variable that takes one if the firm has a non-negative value of free cash flow in year *t*, and zero otherwise; *ln(Age)$_{i,t}$* is the natural log of the number of years the firm has been established; *Business Segment Concentration$_{i,t}$* is the sum of the squares of sales from each business segment as a percentage of total sales in year *t*; and *Foreign Currency_D$_{i,t}$* is an indicator variable that takes one if the firm reports nonzero value for foreign currency adjustments at the end of year *t*, and zero otherwise. All variables except indicator variables are winsorized at the bottom 1% and top 99% levels.

3.4. Estimation and Descriptive Statistics of Managerial Ability Score

The firm efficiency score itself can be used as a performance indicator. However, as discussed above, the measure can be subject to the effects of both firm-specific and manager-specific factors. To rule out the effects of firm-specific factors, we estimate Equation (2) by the Tobit regression for each industry and extract the residual as a measure of managerial ability. Table 3 shows the descriptive statistics for variables used for regressions. To minimize the impact of outliers, we winsorize each variable at the bottom 1% and top 99% levels by year except indicator variables.

Following DLM (2012), we summarize our results from estimations in Table 4. We report the arithmetic average coefficient across 26 industry estimations and note the significant percentage and the percentage with a predicted sign. For example, the coefficient on firm size (the natural log of total assets) has a one-tailed *p*-value of less than 0.05 in 80.8% of the industry estimations, and 57.7% of coefficients (i.e., 15 out of 26 industry estimations) are a positive value. We also note the results of DLM (2012) on the right side of Table 3.

Regarding the proportion of significance, *Market Share* and *Business Segment Concentration* are more likely to be significant in the Japanese setting than the U.S. (92.3% vs. 65.1% for *Market Share*; and 73.1% vs. 41.9% for *Business Segment Concentration*). Given that other independent variables show a similar percentage as DLM (2012), the results suggest that the estimation model fits well with the Japanese data. On the other hand, for the proportion with a predicted sign, we find several differences. For example, the firm size (*ln(Total Assets)*) effects in both positive and negative ways depending on the industry. The proportion of 57.7% with a predicted sign implies that the firm size positively affects firm efficiency in approximately half of the Japanese industries while this negatively influences in the other half of the industries. Although we do not examine the reason in this paper, our results show that the effect of firm size is not monotonic across

TABLE 4. SUMMARY OF ESTIMATIONS FOR MANAGERIAL ABILITY

Dependent Variable = *Firm Efficiency*$_{i,t}$

		Japanese Sample			Demerjian, Lev, and McVay (2012)		
	Predicted sign	Average coefficient	Proportion significant (%)	Proportion with predicted sign (%)	Average coefficient	Proportion significant (%)	Proportion with predicted sign (%)
ln(Total Assets)$_{i,t}$	+	0.004	80.8	57.7	0.037	90.7	100.0
Market Share$_{i,t}$	+	2.043	92.3	96.2	1.599	65.1	76.7
FCF_D$_{i,t}$	+	0.024	84.6	96.2	0.075	93.0	100.0
ln(Age)$_{i,t}$	+	−0.022	69.2	15.4	0.021	67.4	86.1
Business Segment Concentration$_{i,t}$	+	0.030	73.1	88.5	0.029	41.9	67.4
Foreign Currency_D$_{i,t}$	−	−0.009	65.4	73.1	−0.014	67.4	72.1
Intercept		0.910			0.567		
Year-fixed effects		Included			Included		
Industry estimations		26			43		

Notes: This table reports the averages from the Tobit estimation of Equation (2). For illustrative purposes, we present the arithmetic average of the coefficients obtained from 26 by-industry estimations. The proportion of significant indicates the percentage of coefficients that are statistically significant at the 5% level among 26 estimations. The proportion with predicted signs denotes the percentage of 26 coefficients with predicted signs. For comparative purposes, we cite the results in DLM (2012). Variables are defined as follows: *Firm Efficiency*$_{i,t}$ is a firm-year metric of firm efficiency that takes a value between zero and one, obtained from DEA; *ln(Total Assets)*$_{i,t}$ is the natural log of total assets; *Market Share*$_{i,t}$ is the percentage of sales earned by the firm within its industry in year *t*; *FCF_D*$_{i,t}$ is an indicator variable that takes one if the firm has a non-negative value of free cash flow in year *t*, and zero otherwise; *ln(Age)*$_{i,t}$ is the natural log of the number of years the firm has been established; *Business Segment Concentration*$_{i,t}$ is the sum of the squares of sales from each business segment as a percentage of total sales in year *t*; and *Foreign Currency_D*$_{i,t}$ is an indicator variable that takes one if the firm reports nonzero value for foreign currency adjustments at the end of year *t*, and zero otherwise. All variables except indicator variables are winsorized at the bottom 1% and top 99% levels.

industries. Moreover, in contrast to the prediction, the coefficients of *ln(Age)* are more likely to be negative, suggesting that older firms are more inefficient in many industries. This can stem from Japanese-specific economic circumstances in which firms rarely go bankrupt due to support from their main banks (Peek and Rosengren 2005). As such, non-performing firms are more likely to survive in a Japanese setting.

The residual from these by-industry estimations is the measure of managerial ability. Table 5 reports the descriptive statistics. For comparative purposes, we cite the results of DLM (2012) again. The mean value of *Managerial Ability* is −0.009, and the median is −0.008. Unlike OLS residuals, which must sum to zero by definition, residuals from Tobit regressions need not (DLM 2012, notes 16). Compared to DLM (2012), our *Managerial Ability* measure has a narrower range and smaller standard deviation. However, we cannot simply compare the results with DLM

TABLE 5. DESCRIPTIVE STATISTICS OF MANAGERIAL ABILITY

	Mean	Std.Dev	Min	25%	Median	75%	Max	N
Firm Efficiency$_{i,t}$	0.847	0.162	0.320	0.784	0.899	0.970	1.000	28,853
Managerial Ability$_{i,t}$	−0.009	0.082	−0.231	−0.056	−0.008	0.037	0.278	28,853
Ref. Managerial Ability (DLM)	−0.004	0.149	−0.415	−0.094	−0.013	0.075	0.557	177,134
Fitted Value of Ability$_{i,t}$	0.000	0.071	−0.184	−0.041	0.001	0.039	0.227	25,079
Alternative Measures of Ability								
Historical Return$_{i,t}$	0.083	1.012	−4.113	−0.364	−0.059	0.297	9.418	25,232
Historical ROA$_{i,t}$	−0.092	0.229	−1.276	−0.208	−0.093	0.023	0.666	25,030
ln(President Tenure)$_{i,t}$	1.595	0.965	0.000	0.693	1.609	2.303	3.689	24,169

Notes: This table reports descriptive statistics of measures on managerial ability. Variables are defined as follows: *Firm Efficiency$_{i,t}$* is a firm-year metric of firm efficiency that takes a value between zero and one, obtained from DEA; *Managerial Ability$_{i,t}$* is the residual-based measure of managerial ability that is estimated in Table 4; *Fitted Value of Ability$_{i,t}$* is the fitted value obtained from regressing firm efficiency on manager-fixed effects; *Historical Return$_{i,t}$* is the five-year historical value-weighted industry-adjusted return (from year *t–5* to year *t–1*); *Historical ROA$_{i,t}$* is the five-year industry-adjusted return on assets (cumulative income before extraordinary items and taxes scaled by average total assets from year *t–5* to year *t–1*); and *ln (President Tenure)$_{i,t}$* is the natural log of the number of years an executive has been listed on the top of the board members.

(2012) because our sample is much smaller, which results in a smaller standard deviation of *Firm Efficiency* as shown in Table 2 Panel B.

4. Results of Validation Tests

To evaluate the validity of the measurement for managerial ability, DLM (2012) conduct three tests using a subset of CEOs who switched employers within their sample period: test on manager fixed effects; price reactions to turnovers; and its relation to future performances. By examining CEOs who were present in at least two firms during the sample period, they rigorously investigate whether managerial ability differs across individual CEOs. While this results in the much smaller size of the testing sample, DLM (2012) conclude that their proposed measurement on managerial ability is a good proxy of CEOs' ability.

However, in this current study, we do not follow their validation tests for several reasons. First, it is rare in Japan that a CEO switches employer and moves to another position of CEO in a different firm.[11] Traditionally, Japanese CEOs are chosen from insiders and firms hardly employ CEOs from different firms (Kang and Shivdasani 1995). Hence, we cannot perform the same tests as DLM (2012), w ho utilize data from the US where CEO markets are more liquid.

[11] We find 43 CEOs that have switched their employers and moved to another position of CEO in a different firm. However, the proportion of CEOs switching employers is 1.36%; 43 CEOs out of 3,163 CEOs during the testing period.

Second, we do not have a Japanese database on CEO turnover dates, which makes it difficult to conduct an event study based on the announcement date.

Instead, we conduct three different validation tests. First, we correlate our MA measure with four alternative measures of managerial ability used in prior research and DLM's (2012) study. Second, as an alternative to event study, we relate the change in ability measure to stock returns in the same period. If our measure captures the CEO ability and capital markets are efficient regarding assessing the quality of CEOs, we expect that firms hiring better (worse) managers experience higher (lower) stock returns followed by CEO turnovers. Finally, following DLM (2012), we test whether appointing a relatively more or less able manager is systematically related to changes in subsequent long-term firm performance.

4.1. Correlation Tests

Following DLM (2012), we create an alternative measure of managerial ability, based on CEO fixed effects, for a sample of 25,079 firm-year observations with available CEO identifiers. Specifically, we regress *Firm Efficiency* on CEO fixed effects and obtain the predicted value (*Fitted Value of Ability*). The fitted value of the CEO fixed effects can be the lower bound of the manager-specific component of firm efficiency (DLM 2012). Thus, to the extent that the residual-based managerial ability captures the CEO-specific components of firm efficiency, we predict that *Managerial Ability* positively correlates with the predicted value.

We also use three alternative measures of managerial ability: historical industry-adjusted stock returns, historical industry-adjusted ROA, and CEO tenure. In addition to these, DLM (2012) use two variables: CEO compensation and media mentions. However, we do not apply these two measurements due to the data constraints in a Japanese setting. The mandatory disclosure on CEO-specific compensation began in March 2010 but this is required only for CEOs whose compensation is larger than 100 million yen (Cabinet Office Ordinance on the Disclosure of Corporate Affairs, Financial Services Agency in Japan). Hence, no comprehensive data on CEO-specific compensation is available. For the media mentions, we exclude this from our analyses because we do not have the equivalently approved database to search for publications. Furthermore, media mentions are more prevalent for large firms, which could limit our sample. As a result, we consider that challenges for constructing both two measurements can result in serious sample biases.

Table 6 shows the correlations between various measurements of managerial ability. First, we observe strong positive correlation coefficients between *Managerial Ability* and *Fitted Value of Ability* (0.874 and 0.868). This highlights that our computed MA measure is CEO-specific and supports the notion that the residual from Equation (2) is largely attributable to the manager. Further, the measurement positively relates to *Historical Return* (0.090 and 0.108) and *Historical ROA* (0.106 and 0.132), indicating that our measure is also consistent with ability measures used in prior studies. On the other hand, *ln(President Tenure)* is not likely to relate to other ability measures. This result suggests that CEO tenure is not a clean measure of manager ability because tenure indicates the existence of entrenchment (Lee et al. 2012) as well as manager ability, which may offset each other. Overall, we conclude that the computed measure, *Managerial Ability*, is CEO-specific.

TABLE 6. CORRELATION ANALYSIS

	(1)	(2)	(3)	(4)	(5)	(6)
(1) *Firm Efficiency$_{i,t}$*		**0.532**	**0.461**	**0.138**	**0.226**	**–0.072**
(2) *Managerial Ability$_{i,t}$*	**0.477**		**0.868**	**0.108**	**0.132**	–0.001
(3) *Fitted Value of Ability$_{i,t}$*	**0.410**	**0.874**		**0.090**	**0.169**	0.003
(4) *Historical Return$_{i,t}$*	**0.089**	**0.090**	**0.073**		**0.151**	–0.006
(5) *Historical ROA$_{i,t}$*	**0.171**	**0.106**	**0.152**	**0.094**		**0.030**
(6) *ln(President Tenure)$_{i,t}$*	**–0.073**	–0.001	0.006	**–0.027**	**0.046**	

Notes: This table reports Pearson correlation coefficients below the diagonal and Spearman correlation coefficients above the diagonal. Correlations are presented in bold when they are statistically significant at the 5% level using a two-tailed test. Variables are defined as follows: *Firm Efficiency$_{i,t}$* is a firm-year metric of firm efficiency that takes a value between zero and one, obtained from DEA; *Managerial Ability$_{i,t}$* is the residual-based measure of managerial ability that is estimated in Table 4; *Fitted Value of Ability$_{i,t}$* is the fitted value obtained from regressing firm efficiency on manager-fixed effects; *Historical Return$_{i,t}$* is the five-year historical value-weighted industry-adjusted return (from year *t–5* to year *t–1*); *Historical ROA$_{i,t}$* is the five-year industry-adjusted return on assets (cumulative income before extraordinary items and taxes scaled by average total assets from year *t–5* to year *t–1*); and *ln(President Tenure)$_{i,t}$* is the natural log of the number of years an executive has been listed on the top of the board members.

4.2. Changes in Ability Measure and Stock Returns

To further investigate whether our measure of managerial ability is valid in assessing CEO ability, we use a subset of firms which experience "forced" CEO turnover during our sample period. Here, we define CEO as a person in a position of president (Kaplan 1994; Kaplan and Minton 2012), who has been listed as top of the board members in the *Yuka Shouken Houkokusho* (the Japanese equivalent of the U.S. 10-K filings). Because there has been a convention of Japanese firms that the successful CEO remains as an adviser or a chairman of the board of directors after their CEO tenure, we focus on "forced" turnover where the CEO left the board of directors after retirement (Kang and Shivdasani 1995). This enables us to examine the net effect of CEO turnover.

Using the subset of CEO turnovers, we test whether this relates to current stock returns. If our measure reflects managerial ability and the capital markets are, on average, efficient regarding assessing the ability of both old (leaving) and new (incoming) CEOs, we expect that the change in ability measures are positively associated with stock returns. Thus, we predict that firms appointing better (worse) new CEOs experience higher (lower) stock returns in the period of CEO turnover.

We form ten groups based on deciles of changes in each ability measure and test the correlation between the average stock return and the group rank. Table 7 shows the results. Focusing on *Managerial Ability*, stock returns are increasing along with the difference in ability. The lowest four groups exhibit relatively large negative stock returns, on average, while the highest three groups present positive abnormal returns. As a result, we find a statistically significant positive correlation coefficient (0.788, p-value<0.05). On the other hand, we find no

TABLE 7. MANAGERIAL ABILITY, STOCK RETURNS, AND CEO TURNOVERS

	Market Adjusted Stock Return$_{i,t}$			
Difference in Ability$_{i,t}$	*Managerial Ability$_{i,t}$*	*Historical Return$_{i,t}$*	*Historical ROA$_{i,t}$*	*ln(President Tenure)$_{i,t}$*
Lowest	−0.064	−0.056	0.031	−0.031
2	−0.074	0.019	0.049	−0.026
3	−0.041	0.014	0.041	0.029
4	−0.047	−0.072	−0.046	0.046
5	−0.012	0.015	−0.099	−0.029
6	0.014	0.065	0.004	0.053
7	−0.018	0.110	−0.013	−0.045
8	0.001	0.030	0.069	−0.024
9	0.126	−0.049	−0.012	0.019
Highest	0.017	−0.136	−0.060	−0.148
Correlation Coefficient	**0.788**	−0.132	−0.311	−0.372
N	1,433	1,249	1,236	1,185

Notes: This table presents the comparison of stock returns among firm groups. We use firms which experienced CEO turnover in year *t* and in which the CEO left the board of directors. We form ten groups based on deciles of changes in each ability measurement. Each cell shows the average stock returns of firms assigned to each group. Correlations are presented in bold when they are statistically significant at the 5% level. Variables are defined as follows: *Market Adjusted Stock Return$_{i,t}$* is firm's stock return minus market return based on TOPIX; *Managerial Ability$_{i,t}$* is the residual-based measure of managerial ability that is estimated in Table 4; *Historical Return$_{i,t}$* is the five-year historical value-weighted industry-adjusted return (from year *t−5* to year *t−1*); *Historical ROA$_{i,t}$* is the five-year industry-adjusted return on assets (cumulative income before extraordinary items and taxes scaled by average total assets from year *t−5* to year *t−1*); and *ln(President Tenure)$_{i,t}$* is the natural log of the number of years an executive has been listed on the top of the board members. For the proxies of managerial ability, we use the changes from year *t−1* to year *t*.

evidence of a positive relation for alternative measures. These results are similar to those of DLM (2012), indicating that our ability measure reflects CEO quality that is valued by the market and outperforms other ability proxies.

4.3. Changes in Future Performance Following CEO Turnovers

As a final validity test, we use the subset mentioned above of CEO turnovers and investigate whether changes in managerial ability relate to the subsequent performance. Again, we expect that firms hiring better (worse) managers experience improvements (declines) in future performance. We follow the research design employed by DLM (2012) with a difference in testing sample. DLM (2012) use 78 CEOs who were employed by more than one firm in their sample period and calculated the difference in ability by subtracting the outgoing managers' ability from the incoming managers' ability as measured in their prior firm. As argued above, however, it is difficult to follow the same sampling in a Japanese setting due to the lack of CEO observations which had been employed by multiple firms. Instead, we calculate the change in ability followed by CEO turnover as a simple difference between incoming and outgoing managers' ability measured in the same firm (i.e., the difference from year *t–1* to year *t* where CEO turnover occurs in year *t*). This is the same metric we used in the previous section.

Table 8 reports the results. We regress subsequent changes in performance on the change in managerial ability. Following DLM (2012), we use industry-adjusted ROA and industry-adjusted stock returns from year *t–1 to t*+3. In panel A, changes in *Managerial Ability* are associated with changes in industry-adjusted ROA, suggesting that appointing a higher-ability CEO leads to improved performance in the following three years. For their economic significance, the interquartile increases in the relative ability of CEO are associated with a 1.9% higher ROA over the next three years. Among the alternative measures, *Historical Return* and *ln(President Tenure)* are also related with improved ROA yet their interquartile changes are associated with relatively lower ROA (0.7% and 1.3%, respectively). We find a negative coefficient on *Historical ROA*, indicating the existence of regression to the mean in accounting income (Fama and French 2000; Healy et al. 2014). Panel B presents the result using industry-adjusted stock returns. We find no evidence that changes in ability measures are positively associated with future stock returns. As to our measure of managerial ability, this is not surprising because capital markets may have already evaluated and incorporated the new CEOs ability at the time of turnover in year *t* (Table 7), which consequently makes it difficult to detect the incremental effect of changes in CEO ability on subsequent performance.[12]

Collectively, our results confirm the generalizability of the MA measure proposed by DLM (2012) in Japanese firms and conclude that the MA measure provides a clean depiction of managers' ability. It is significantly related to manager fixed effects and is associated with both the price reactions to the CEO turnover and changes in firm performance following a CEO turnover.

4.4. Alternative Measurement Process of Managerial Ability

Our estimation process for MA is slightly different from DLM (2012) with regards to operating lease assets. While DLM (2012) calculate the operating lease assets at the discounted present value of the required operating lease payments for the next five years, Japanese firms are required to disclose only their total future minimum lease payments and the payments within one year, which makes it difficult to follow the same procedure.

To evaluate whether changes in orientation and inputs in DEA affect our results, we re-calculate the managerial ability measurement with efficiency scores estimated from: (1) output-oriented VRS model and (2) input-oriented VRS model without operating lease assets (i.e., six inputs). Table 9 presents the correlation matrix among alternatives and proxies for managerial ability. We find that *Managerial Ability* is positively and highly correlated with both managerial ability measures based on the output-oriented VRS model (*Managerial Ability = 0.964 in Output-Oriented DEA*) and based on the six inputs (*Managerial Ability = 0.953 in 6 inputs specification*), respectively. Moreover, untabulated results present evidence that both alternatives do not significantly differ regarding the stock price reactions to CEO turnovers and its association

[12] As a sensitivity test, we use a subsample of 43 CEOs that have switched employers and moved to another position of CEO in different firms. The analysis shows the same results as those in Table 8.

TABLE 8. PERFORMANCE CHANGES FOLLOWING MANAGEMENT CHANGES

Panel A: Dependent Variable = Change in Industry-Adjusted $ROA_{i,t+3}$

		Ability Measure							
	Predict Sign	*Managerial Ability* Coeff.	*t*-value	*Historical Return* Coeff.	*t*-value	*Historical ROA* Coeff.	*t*-value	*ln(President Tenure)* Coeff.	*t*-value
Difference in Ability$_{i,t}$	+	0.242	[4.469]***	0.007	[1.957]*	−0.354	[−7.066]***	0.009	[2.580**]
Change in Stock Return$_{i,t+3}$	+	0.009	[2.137]**	0.013	[2.532]**	0.005	[1.034]	0.008	[1.610]
Change in Book-to-Market$_{i,t+3}$	?	0.015	[4.365]***	0.012	[3.398]***	0.014	[4.335]***	0.018	[4.934***]
Change in ln(Market Value of Equity)$_{i,t+3}$	?	0.058	[9.217]***	0.056	[8.815]***	0.054	[8.729]***	0.064	[9.331***]
Constant		−0.025	[−2.307]**	0.036	[3.514]***	0.038	[4.327]***	0.047	[3.658***]
Year fixed effect		Included		Included		Included		Included	
Industry fixed effect		Included		Included		Included		Included	
Adjusted R^2		0.244		0.210		0.334		0.218	
N		990		868		863		826	

Panel B: Dependent Variable = Change in Industry-Adjusted Stock $Return_{i,t+3}$

		Ability Measure							
	Predict Sign	*Managerial Ability* Coeff.	*t*-value	*Historical Return* Coeff.	*t*-value	*Historical ROA* Coeff.	*t*-value	*ln(President Tenure)* Coeff.	*t*-value
Difference in Ability$_{i,t}$	+	−0.385	[−0.885]	−0.240	[−8.663]***	−0.614	[−1.279]	−0.045	[−1.608]
Change in ROA$_{i,t+3}$	+	0.785	[2.281]**	0.891	[2.511]**	0.444	[0.956]	0.757	[2.202]**
Change in Book-to-Market$_{i,t+3}$	?	−0.094	[−2.735]***	−0.071	[−2.093]**	−0.069	[−1.804]*	−0.096	[−2.687]***
Change in ln(Market Value of Equity)$_{i,t+3}$	?	0.180	[3.334]***	0.182	[3.207]***	0.212	[3.491]***	0.231	[3.769]***
Constant		−0.326	[−3.885]***	0.286	[3.600]***	0.329	[3.755]***	0.305	[2.936]***
Year fixed effect		Included		Included		Included		Included	
Industry fixed effect		Included		Included		Included		Included	
Adjusted R^2		0.127		0.235		0.128		0.140	
N		990		868		863		826	

Notes: This table presents OLS regression results using a subsample of firms that experienced CEO turnover, and the CEO left the board of directors in year *t*. The dependent variables are *Change in Industry-Adjusted ROA* and *Change in Industry-Adjusted Stock Return*, where changes are measured as the value in year *t+3* less the value in year *t−1*. The difference in the four ability measures is measured as the value in year *t* less the value in year *t−1*. *Managerial Ability*$_{i,t}$ is the residual-based measure of managerial ability that is estimated in Table 4; *Historical Return*$_{i,t}$ is the five-year historical value-weighted industry-adjusted return (from year *t−5* to year *t−1*); *Historical ROA*$_{i,t}$ is the five-year industry-adjusted return on assets (cumulative income before extraordinary items and taxes scaled by average total assets from year *t−5* to year *t−1*); and *ln(President Tenure)*$_{i,t}$ is the natural log of the number of years an executive has been listed on the top of the board members. Changes in control variables are measured as year *t+3* less year *t−1*. *ROA* is income before extraordinary items and taxes scaled by average total assets; *Book-to-Market* is the book value of equity divided by *Market Value of Equity*, and *Market Value of Equity* is the equity capitalization at the end of year *t−1*. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 9. CORRELATION MATRIX AMONG ALTERNATIVE MANAGERIAL ABILITY

	(1)	(2)	(3)	(4)	(5)	(6)
(1) *Managerial Ability$_{i,t}$*		**0.968**	**0.950**	**0.108**	**0.132**	−0.001
(2) *Managerial Ability (Output-Oriented)$_{i,t}$*	**0.964**		**0.916**	**0.112**	**0.140**	−0.001
(3) *Managerial Ability (6 inputs)$_{i,t}$*	**0.953**	**0.915**		**0.123**	**0.144**	−0.006
(4) *Historical Return$_{i,t}$*	**0.090**	**0.092**	**0.107**		**0.151**	−0.006
(5) *Historical ROA$_{i,t}$*	**0.106**	**0.119**	**0.117**	**0.094**		**0.030**
(6) *ln(President Tenure)$_{i,t}$*	−0.001	0.002	−0.004	**−0.027**	**0.046**	

Notes: This table reports Pearson correlation coefficients below the diagonal and Spearman correlation coefficients above the diagonal. Correlations are presented in bold when they are statistically significant at the 5% level using a two-tailed test. Variables are defined as follows: *Managerial Ability$_{i,t}$* is the residual-based measure of managerial ability that is estimated in Table 4; *Managerial Ability (Output-Oriented)$_{i,t}$* is the residual-based measure of managerial ability that is estimated using the output-oriented VRS model; *Managerial Ability (6 inputs)$_{i,t}$* is the residual-based measure of managerial ability that is estimated using six inputs other than operating lease assets in DEA; *Historical Return$_{i,t}$* is the five-year historical value-weighted industry-adjusted return (from year *t−5* to year *t−1*); *Historical ROA$_{i,t}$* is the five-year industry-adjusted return on assets (cumulative income before extraordinary items and taxes scaled by average total assets from year *t−5* to year *t−1*); and *ln(President Tenure)$_{i,t}$* is the natural log of the number of years an executive has been listed on the top of the board members.

with future performance as shown in Tables 7 and 8, respectively.[13] Therefore, we conclude that (1) although the underlying idea is different between input- and output-oriented VRS models, the proposed DEA procedures produce a consistent metric for managerial ability, and that (2) removing the operating lease assets does not significantly alter our results.

5. Conclusion

In this study, we estimate the managerial ability (MA) score following Demerjian, Lev, and McVay (2012) and evaluate the generalizability of the MA measure using Japanese data. Although some recent studies generally accept the legitimacy of their measure, it is still questionable as to whether their measurement is generalizable to countries outside the United States.

Using a sample of 28,853 Japanese firm-year observations for the period 2005–2015, we estimate the MA score and evaluate its validity, following the proposed procedures in DLM (2012). We find that the calculated MA score is strongly correlated with manager fixed effects.

[13] For the stock price reactions to CEO turnover, we again form ten groups based on deciles of changes in the ability measure and test the correlation between the average stock return and the group rank. We obtain the correlation coefficients of 0.680 and 0.848 when we form ten groups based on *Managerial Ability (Output-Oriented)* and *Managerial Ability (6 inputs)*, respectively, where both coefficients are significant at the 5% levels. We also find that changes in these ability measures followed by CEO turnover are positively associated with future performance as measured by ROA (*t*-values are 7.838 and 4.739, respectively).

Further, we find that the MA score is economically and significantly associated with the price reactions to CEO turnovers and changes in future return on assets (ROA) following CEO turnovers. Our results are robust to alternative specifications of DEA models as well as different inputs used. Taken together, consistent with DLM (2012), we conclude that the MA score provides a clean depiction of managers' ability for Japanese firms.

We consider MA score to be generalizable even in a different institutional setting for at least two reasons. First, the DEA adopted by DLM (2012), by its nature, estimates a firm's efficiency relative to its peers in the same industry under a specific institutional environment. Second, DLM (2012) include an appropriate set of firm-specific factors in Equation (2) to control for potential impacts of firm-specific factors on the measurement of manager-specific managerial ability. As a result, MA scores for Japanese firms derived from DLM framework retain their validity even under bank-oriented, stakeholder-governance, and illiquid CEO markets such as Japan.

The arguments and findings herein provide useful insights and a pragmatic metric for future research. For example, given that Japanese firms are internationally unique with regards to its cash-holdings (Pinkowitz et al. 2006), dividend policies (Denis and Osobov 2008), and management earnings forecasts (Kato et al. 2009), it would be interesting to examine how managerial ability relates to these corporate behaviors in Japan (Skinner 2011). Also, it is worth investigating how Japanese-specific factors, such as the banking system and the lifetime employment, systematically affect the firm's efficiency, which consequently leads us to a better model specification for the MA score in a Japanese setting.

Our study has three major limitations. First, we were not able to use the same sampling method as DLM (2012). While DLM (2012) use a subset of CEOs who switched employers, we use CEO turnovers as a testing sample because it is rare that a CEO in Japan switches employer and moves to another position of CEO in a different firm. Second, due to the absence of commercial databases for Japan, we do not consider alternative measures for managerial ability such as news and media publications and CEOs' cash compensation. Future research can develop these alternative variables and compare with our estimated MA scores. Finally, our estimated firm efficiency and MA score are specific to Japanese firms/industries, which consequently makes it difficult to compare with those in DLM (2012). Thus, one cannot conclude that Japanese firms are more efficient than the US counterparts, or *vice versa*, based on our reported results. To document additional evidence, future research can estimate both firm efficiency and managerial ability using more samples from various countries around the world. This can help us better understand manager's specific ability and its relation with country-specific factors.

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APPENDIX: VARIABLE DEFINITIONS

	Variables	Definitions
DEA for Firm Efficiency	*Sales*	Net sales for year *t*.
	CoGS	Costs of goods sold for year *t*.
	SG&A	Selling, general, and administrative expenses for year *t*.
	PPE	Net plant, property, and equipment at the beginning of year *t*.
	OpsLease	Net operating lease assets at the beginning of year *t* (Kusano et al. 2015).
	R&D	Net research and development capital assets at the beginning of year *t* (Lev and Sougiannis 1996).
	Goodwill	Goodwill (B/S item) at the beginning of year *t*.
	OtherIntan	Other intangible assets (intangible assets minus goodwill) at the beginning of year *t*.
Tobit Regressions for MA Score	*Firm Efficiency*	Firm Efficiency Score obtained from DEA.
	ln(*Total Assets*)	Natural log of total assets at the end of year *t*.
	Market Share	The percentage of sales earned by the firm within its industry in year *t*.
	FCF_D	A dummy variable that takes one if the firm has a non-negative value of free cash flow in year *t*, and zero otherwise. Free cash flow is defined as earnings before depreciation and amortization minus the change in working capital (account receivables and inventories and the other current assets minus account payables and other current liabilities) and capital expenditures.
	ln(*Age*)	Natural log of the number of years the firm has been established.
	Business Segment Concentration	The sum of the squares of sales from each business segment as a percentage of total sales in year *t*. If the firm does not report segment information, it is assigned a concentration of one (DLM 2012).
	Foreign Currency_D	A dummy variable that takes one if the firm reports a nonzero value for foreign currency adjustments at the end of year *t*, and zero otherwise.
Validation Tests	*Managerial Ability*	The residual-based measure of managerial ability that is estimated from Tobit regressions.
	Fitted Value of Ability	The fitted value obtained from regressing *FirmEfficiency* on manager fixed effects.
	Historical Return	The five-year historical value-weighted industry-adjusted return (from year *t–5* to year *t–1*).
	Historical ROA	The five-year industry-adjusted return on assets (cumulative income before extraordinary items and taxes scaled by average total assets from year *t–5* to year *t–1*).
	ln(*President Tenure*)	Natural log of the number of years an executive has been listed on the top of board members.
	Market Adjusted Stock Return	The firm's annual stock return minus market return based on TOPIX.
	Change in Industry-Adjusted ROA	Changes in industry-adjusted ROA measured as the value in year *t+3* less the value in year *t–1*.
	Change in Industry-Adjusted Stock Return	Changes in industry-adjusted stock return is measured as the value in year *t+3* less the value in year *t–1*.
	ROA	Income before extraordinary items and taxes scaled by average total assets.
	Book-to-Market	The book value of equity divided by *Market Value of Equity*.
	ln(*Market Value of Equity*)	Natural log of equity capitalization at the end of the year.