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ORIGINAL RESEARCH

Managerial ability and firm risk-taking behavior

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Abstract In this study, we show that managerial heterogeneity plays an important role in firm decisions. Our view is that in addition to the effects of previously examined determinants, firm decisions are affected not just by the managers' explicit mandate to maximize firm value, but also by the ability of the manager in managing the firm. We find that high-ability managers and low-ability managers have opposite effects on firm behavior and firm value. High-ability managers are receptive to risk-taking whereas low-ability managers refrain from risk-taking. High-ability managers cut capital expenditures but spend significantly more on research and development projects; low-ability managers reduce both capital expenditures and research and development expenses significantly. High-ability managers are associated with higher levels of firm focus than low-ability managers. Managerial ability is negatively associated with firm leverage. In addition, our results show that high-ability managers are associated with increases in firm value whereas low-ability managers are associated with decreases in firm value.

Keywords Managerial ability · Managerial attributes · Risk-taking · Firm value · Managerial incentives · Corporate governance

JEL Classification G31 · G32 · G34

1 Introduction

Traditional models assume firm managers behave rationally and follow the mandate of firm value maximization; managerial heterogeneity is accordingly considered unlikely to

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have a significant role in firm decisions (Berk and Stanton 2007; Bamber et al. 2010). Yet, recent advances of the research of behavioral finance have amassed evidence that managerial attributes are important determinants of firm behavior (Graham et al. 2012; Kaplan et al. 2012). Among these studies, it has been shown that managerial ability has significant impact on corporate earnings quality (Demerjian et al. 2013; Choi et al. 2015); firm innovative activity (Chen et al. 2015); bank liquidity creation (Andreou et al. 2016); and strategic entry in a new market (Goldfarb and Xiao 2011).

The literature on managerial ability is relatively new and infrequent. In this study, we extend the literature by investigating the effect of managerial ability on firm risk-taking behavior. Corporate risk-taking is fundamental to firm survival. Researchers have long argued that managers' willingness to take risks in the pursuit of profitable opportunities is a fundamental driving force of firm performance and growth (Bromiley 1991; John et al. 2008). There is also evidence that many managers believe that risk-taking is an essential element of the managerial role (March and Shapira 1987). Surveys of business executives conducted by earlier investigations found that managerial risk-taking propensities vary across individuals, and the variation across managers appeared to be related to personality traits and experience (Maccrimmon and Wehrung 1986; Shapira 1986). Based on the findings of Nuthall (2001, 2009) that personality traits, early life experience, education and intelligence are determinants of managerial ability; one can posit that managerial risk-taking propensity is related to managerial ability. Koijen (2014) finds that there is substantial heterogeneity in the ability of the managers in the investment industry. Laboratory experiments also suggest that there is significant heterogeneity in the ability of decision makers (Camerer 2003; Camerer et al. 2004; Costa-Gomes and Crawford 2006). Managerial ability is likely a valuable input to the firm. Consistent with this view, Murphy and Zabojnik (2007) and Custódio et al. (2013) find that managerial ability is a sought after asset as firms frequently offer lucrative packages to lure capable CEOs from other companies.

Chen et al. (2015) find that managerial ability is positively related to firm innovative activity. Admittedly, firm innovation is an important form of corporate risk-taking; but with firm innovation measured by the number of patent grants or citations, it is likely that firm innovation tends to concentrate in a few industries only. In fact, Fang et al. (2014) report that firm-year observations with zero patents represent 77% of their sample. Similarly, Tian and Wang (2014) report that 73% of their sample observations have zero patents. According to the distribution statistics reported by Fang et al. (2014), innovation is concentrated in a few industries such as manufacturing, healthcare, chemicals, and business equipment. The literature has not yet examined the effect of managerial ability on low-risk investment decisions such as capital expenditures (Bhagat and Welch 1995). Similar, not much is known regarding the effect of managerial ability on research and development that do not result in patent grants. The investigation of Chen et al. (2015) therefore is a limited study of the effect of managerial ability on firm risk-taking activity. In this study, we expand the literature by examining firm risk-taking behavior in general. We measure firm risk-taking by a number of proxies other than innovation and investigate the effect of managerial ability on these general risk-taking activities. Despite the findings of Nuthall (2001, 2009) suggest that managerial ability is positively related to education background and intelligence, some behavioral studies have provided evidence that educated persons and individuals of higher levels of intelligence are more risk cautious in making decisions (Sjöberg and Drottz-Sjöberg 1991; Boholm 1998; Culver et al. 2001). In addition, Wang et al. (2013) find a significant negative relation between the education background of business executives and corporate risk-taking in China. Thus, the effect of managerial ability on firm risk-taking is less than straightforward.

In this study, we measure firm risk-taking behavior by the standard deviation of return on assets (σ_{ROA}), the standard deviation of return on equity (σ_{ROE}), capital expenditures to total assets (CAPEX_TA), research and development expenses to total assets (R&D_TA), acquisitions value to total assets (ACQ_TA), sales-based Herfindahl index, and book leverage, respectively. We obtain several important results in this study. First, our results show that managerial ability is associated with higher levels of risk-taking activity except firm leverage. Second, the effect of managerial ability on firm risk-taking is non-linear. We find that managers of high-ability are in general receptive to risk-taking whereas managers of low-ability are unwilling to take risks. Third, our results show that high-ability managers shift resources from low risk capital expenditures to high risk research and development projects whereas low-ability managers significantly reduce capital expenditures and research and development expenses. Fourth, managers of high-ability are associated with higher levels of firm focus whereas managers of low-ability are associated with lower levels of firm focus. Fifth, firms with high-ability managers have lower leverage ratios whereas firms with low-ability managers have higher leverage ratios. Sixth, we find that high-ability managers are associated with higher levels of Tobin's Q and low-ability managers are associated with lower levels of Tobin's Q. The economic impact of managerial ability on firm value is significant.

We implement additional tests to ensure our results are robust. First, we address the effect of managerial incentives as it has been argued that CEO compensation can be structured to influence the risk-taking behavior of managers (Coles et al. 2006). Second, we further control for the effect of corporate governance given the fact that firm risk-taking behavior is significantly related to governance practices (John et al. 2008). The additional tests show that our results remain robust.

This study is related to a growing literature on the role of managers in firm performance (Baker and Wurgler 2012). This literature has examined how corporate achievements relate to management practices and characteristics (Bloom and Van Reenen 2009), interpersonal skills (Kaplan et al. 2012), overconfidence (Malmendier and Tate 2005, 2008), and manager education and experience (Bertrand and Schoar 2003). However, the focus on managerial attributes overlooks the effect of managerial ability in decision making. In this study, we make three contributions to the nascent literature on managerial ability. First, our results on the effects of managerial ability on capital expenditures, R&D expenses, firm acquisitions, firm focus, and leverage are new additions to the literature. Existing studies have only examined the effects of managerial ability on firm innovation and bank liquidity creation. Second, in contrast to earlier studies that show that high-ability managers increase risk-taking more whereas low-ability managers increase risk-taking less, our results show that high-ability managers and low-ability managers have opposite effects on firm risk-taking and firm value. We document that low-ability managers are in fact associated with decreases in firm risk-taking activity and firm value. Third, our finding of a negative association between high-ability managers and firm leverage adds to the literature that managerial attributes have important impacts on financing decisions (Chemmanur et al. 2009; Bhagat et al. 2012). Chemmanur et al. (2009) argue that managers of higher reputation can overcome problems of asymmetric information more effectively and thus prefer to use less debt because they have better access to equity markets. Our results, however, suggest that the lower firm leverage associated with high-ability managers is consistent with the suggestion of behavioral researchers that capable individuals dislike third party monitoring. We examine the relationship between managerial ability and the risk choices in corporate investment in this study. Our view is that in addition to the effects of previously examined

determinants, the risk choices are affected not just by the managers' explicit mandate to maximize firm value, but also by the ability of the manager in managing the firm.

The reminder of the paper is structured as follows. We review the related literature and present our empirical hypotheses in Sect. 2. Section 3 describes key variable construction and our sample. Section 4 presents our main results and provides some interpretation. Section 5 implements some robustness tests and examines the effect of managerial ability on firm value. Section 6 provides a summary.

2 Related literature and hypothesis development

The importance of managers for the outcomes achieved by the firm is emphasized by researchers of organization behavior. For example, the upper echelons theory argues that the complexity of actual decision-making situations demands an idiosyncratic importance of the top managers (Hambrick and Mason 1984; Hambrick 2007). Bertrand and Schoar (2003) report that managers influence their organization's behavior over and above time- and firm-specific characteristics. Complementing the findings reported in the literature of organization behavior, recent studies conducted by financial economists find evidence that managerial characteristics have significant impact on firm behavior. For example, Bolton et al. find that CEOs with strong managerial resoluteness perform better in situations requiring greater coordination. Malmendier and Tate (2005, 2008) find that overconfident CEOs are more likely to engage in value-destroying mergers and acquisitions. Yim (2013) finds that CEO age has a negative effect on firm investment activity. Bargeron et al. (2010) suggest that CEO risk preference causes significant declines in firm investment activity after the implementation of the Sarbanes–Oxley Act of 2002. Chemmanur et al. (2009) find that managerial quality and CEO reputation significantly impacts the firm investment.

The significance of managerial ability in decision making has been documented in behavioral studies. Numerous laboratory experiments show that some people are better than others in decision making as they have the ability to execute better strategies; this heterogeneity does not appear to be random (Camerer 2003; Camerer et al. 2004; Costa-Gomes and Crawford 2006). Financial economists attest to the importance of managerial ability in some recent studies. It has been shown that managerial ability has significant impact on corporate earnings quality (Demerjian et al. 2013; Choi et al. 2015); firm innovative activity (Chen et al. 2015); bank liquidity creation (Andreou et al. 2016); and strategic entry in a new market (Goldfarb and Xiao 2011).

Existing studies justify a positive association between managerial ability and corporate risk-taking. For example, it has been shown that skillful investment managers are also active managers who can make superior risky investment decisions in the investment industry (Cremers and Petajisto 2009). Chemmanur et al. (2009) find that managers with better reputation and managers of higher quality are capable of selecting better projects; the authors further argue that firms with better managers are likely to have a larger equilibrium scale of investment. Accordingly, it is likely that capable managers are more willing to assume risks in corporate decisions. Consistent with this view, Chen et al. (2015) and Andreou et al. (2016) find that capable managers are more inclined to pursue corporate risk-taking activity.

The literature also offers justifications for a negative association between managerial ability and risk-taking. Nuthall (2001, 2009) suggests that managerial ability is positively associated with education background and the level of intelligence; however, some

behavioral studies suggest that individuals with significant education and/or high levels of intelligence are more risk cautious and conservative in assuming risk (Sjöberg and Drottz-Sjöberg 1991; Boholm 1998; Culver et al. 2001). Thus, capable managers, likely educated and intelligent, may be less inclined to take risks in firm decisions. Consistent with this view, Wang et al. (2013) find a significant negative relation between the education background of business executives and corporate risk-taking in China. Mishra (2014) argues that when a manager's skills are highly firm-specific, concerns regarding the protection of his human capital may cause the manager to resist risk-taking. A similar opinion is made by Amihud and Lev (1981). In addition, it has been found that some managers may avoid risk-taking because they prefer a quiet-life (Bertrand and Mullainathan 2003) or want to play it safe (Gormley and Matsa 2016).

The mixed theoretical possibilities regarding the relation between managerial ability and firm risk-taking motivate our empirical investigation. As managerial ability is likely an important determinant of corporate decisions, its effect on firm value cannot be ignored. Thus, we also investigate the relation between managerial ability and firm value.

Earlier studies report a positive relation between management quality and firm performance (Chemmanur et al. 2009). In addition, Demerjian et al. (2013) show that managerial ability enhances firm operating performance. Thus, existing results imply that managerial ability has a positive impact on firm value. On the other hand, Mishra (2014) argues that capable managers, given their greater mobility in the job market, are relatively less concerned about firm-specific risk and are more likely to engage in value-destroying activity because the personal objectives of these managers may be different from the interests of shareholders. Accordingly, the argument of Mishra (2014) implies that managerial ability could have a negative effect on firm value. Moreover, if educated and intelligent individuals are more risk cautious as suggested by some behavioral studies (Halek and Eisenhauer 2001; Culver et al. 2001), the educated and intelligent capable managers may be less inclined to pursue value-enhancing risk-taking activity. In sum, opposite views can be found in the literature regarding the relation between managerial ability and firm value.

Based on the discussion presented above, we develop the following hypotheses:

Hypothesis 1 High-ability (low-ability) managers are associated with increases (decreases) in firm risk-taking activity.

Hypothesis 2 High-ability (low-ability) managers are associated with increases (decreases) in firm value.

3 Key variables and the sample

3.1 Measuring managerial ability

To infer managerial ability, prior studies rely on proxies such as firm size, past abnormal performance, compensation, tenure, media coverage, education, or manager fixed effects. These measures, however, are noisy in general. For example, media coverage is more common for large firms; abnormal stock returns can be attributed to market factors other than managerial ability. Although manager fixed effects are more directly attributable to management, they can be applied only to a relatively small sample of firms and do not offer a stand-alone measure of ability (Demerjian et al. 2012). We follow the two-step

methodology of Demerjian et al. (2012, 2013) in measuring managerial ability. The first step is to use data envelopment analysis (DEA) to create an initial measure of the relative efficiency of the firm within its industry (Charnes et al. 1978). DEA is a linear programming methodology that measures the relative efficiency of decision-making units (firms) by evaluating inputs (labor, capital, etc.) relative to outputs (revenue, income, etc.). Efficient firms are those that generate more revenues from a given set of inputs. The following optimization is applied to estimate firm efficiency:

$$max_V \theta = \frac{\text{Sales}}{\text{v}_1\text{CoGS} + \text{v}_2\text{SG\&A} + \text{v}_3\text{PPE} + \text{v}_4\text{OpsLease} + \text{v}_5\text{R\&D} + \text{v}_6\text{Goodwill} + \text{v}_7\text{OtherIntan}}$$

where CoGS is cost of goods sold; SG&A is selling and administrative expenses; PPE is net PP&E; OpsLease is net operating leases; R&D is net research and development; Goodwill is purchased goodwill; and OtherIntan is other intangible assets. The firm efficiency measure, however, is affected by both firm-specific factors and management characteristics. The second step is to remove firm-specific characteristics from the DEA generated firm efficiency measure. This is done by removing the effects of firm size, market share, free cash flow, firm age, multi-segment and international operations challenges by performing the following regression:

$$\begin{aligned} \textit{Firm Efficiency}_i = {} & \alpha_0 + \alpha_1 \textit{Ln(Total Assets)}_i + \alpha_2 \textit{Market Share}_i \\ & + \alpha_3 \textit{Free Cash Flow Indicator}_i \\ & + \alpha_4 \textit{Ln(Firm Age)}_i + \alpha_5 \textit{Business Segment Concentration}_i \\ & + \alpha_6 \textit{Foreign Currency Indicator}_i + \alpha_7 \textit{Year Indicator}_i + \varepsilon_i \end{aligned} \tag{1}$$

According to Demerjian et al. (2012), the error term of the regression measures managerial ability.

3.2 Measuring firm risk-taking behavior

To measure corporate risk-taking behavior, we rely on seven widely used measures in the literature: standard deviation of return on assets (σ_{ROA}), standard deviation of return on equity (σ_{ROE}), capital expenditures to total assets (CAPEX_TA), research and development expenses to total assets (R&D_TA), acquisitions value to total assets (ACQ_TA), sales-based Herfindahl Index, and book leverage. σ_{ROA} (σ_{ROE}) is computed over a 5-year rolling window. σ_{ROE} has been used in previous studies as an indicator of firm riskiness (Faccio et al. 2011); it reflects both the riskiness of a firm's projects and the additional risk associated with the use of leverage in the capital structure. While CAPEX_TA is commonly used in the literature as a proxy for risk-taking, Bhagat and Welch (1995) suggest that capital expenditures represent low-risk activity. Following Berger and Ofek (1995), we compute sales-based Herfindahl Index based on the Fama–French 48 industrial classifications, 2-digit SIC code, and 4-digit SIC code, respectively. Herfindahl Index is an indication of industry concentration. A high Herfindahl Index implies a high level of firm focus and fewer business segments (Berger and Ofek 1995). Firms that are focused are likely to be affected significantly by external shocks due to non-diversified cash flows. ACQ_TA (Acquisition expenditures to total assets) is a risk-taking measure because acquisitions frequently involve significant amounts of resources and have a high rate of failure (Porter 1987).

3.3 Sample, data, and descriptive statistics

Our sample consists of all the firms on Compustat between 1980 and 2014. We exclude depository receipts and firms in utility and financial industries. Following Bates et al. (2009), research and development expenses (R&D) is assigned a value of zero if the number is missing. We also exclude observations that have negative total assets or stockholders' equity.

We select our control variables following previous literature. Specifically, we use firm level controls, CEO characteristics controls, and corporate governance controls. For firm level control variables, we use return on assets (ROA), sales growth, firm size, firm age, market-to-book ratio, surplus cash ratio and dividend cut. To calculate the market value of a firm, we use the sum of market value of equity and book value of labilities. In robustness checks, we control for managerial incentives. Specifically, we take into consideration the influence of the CEO delta and CEO vega. CEO delta and vega are used to capture CEOs' risk attitudes. As in previous literature, CEO delta is defined as the change in dollar value of CEOs' wealth for one percentage point change in stock price; CEO vega is the change in the dollar value of CEOs' wealth for 0.01 change in the annualized stock volatility. We calculate CEO delta and CEO vega following Guay (1999) and Core and Guay (2002). The logarithmic values of CEO delta and CEO vega are used in our regression analysis. For controlling the impact of corporate governance, we use board size as our proxy. We count the number of board directors per year in ExecuComp as the board size.

Values of dependent and independent variables are collected from several sources. Specifically, we collect firm-specific and industry segment data from Compustat. CEO compensation, characteristics of the CEO, and the number of board members are collected from ExecuComp. Because the data of ExecuComp start after 1992, the number of observations may be smaller in some regressions. We use stock return data from the Center for Research in Security Prices (CRSP) to estimate expected stock return volatility and then use the Black–Scholes option pricing model to calculate CEO delta and CEO vega. We winsorize the variables at the 1st and 99th percentiles. Our final sample has 130,317 firm-year observations. In Table 1, we provide a list of the variables used in this study and their definitions.

Table 2 presents descriptive statistics of the sample. Included are the mean, median, standard deviation, and 25th and 75th percentiles. The mean(median) managerial ability score is 0.00 (− 0.01). Demerjian et al. (2012) report a mean (median) managerial ability score of − 0.004 (− 0.013) for US firms between 1992 and 2009. In Table 2, the mean (median) CEO cash compensation is 1.04 (0.80) million, the mean (median) CEO age is 55.4 (55) years old, and the mean(median) CEO tenure is 7.94 (5.67) years. These numbers are comparable to those reported in Demerjian et al. (2012). Regarding the measures of firm risk-taking, the mean (median) σ_{ROA} is 0.07 (0.05), the mean (median) σ_{ROE} is 0.18 (0.10) and the mean (median) Acquisition Ratio is 0.02 (0.00). CAPEX_TA has a mean of 0.04 and a median of 0.02; R&D_TA has a mean of 0.04 and a median of 0.00; Herfindahl Index has a mean of 0.89 and a median of 1.00; Book leverage has a mean of 0.22 and a median of 0.20. The statistics are consistent with prior studies (Coles et al. 2006).

Table 1 Variables definition

Variable	Definition
$\sigma(ROA)$	Standard deviation of returns on assets over time-period (t, t + 4)
$\sigma(ROE)$	Standard deviation of returns on equity over time-period (t, t + 4)
CAPEX_TA	Capital expenditures to total assets
R&D_TA	Research and development expenses to total assets
Acquisition_TA	Acquisitions to total assets
Herfindahl index-2Digital SIC	Herfindahl Index = (Sum of squared segment sales)/(squared firm sales): (The segment is based on 2 digital SIC code)
Herfindahl index-4 Digital SIC	Herfindahl Index = (Sum of squared segment sales)/(squared firm sales): (The segment is based on 4 digital SIC code)
Herfindahl index-ff48	Herfindahl Index = (Sum of squared segment sales)/(squared firm sales): (The segment is based on Fama–French 48 Industries category)
Book Leverage	(Long-Term Debt + Debt in Current Liabilities)/Total Assets
Managerial Ability	Managerial ability score (Demerjian et al. 2012, 2013)
CEO Cash Compensation	CEO total current compensation (salary + bonus)
CEO Delta	The CEO Delta is defined as the change in dollar value of CEOs' wealth for one percentage point change in stock price
CEO Vega	The CEO Vega is the change in the dollar value of CEOs' wealth for 0.01 change in the annualized stock volatility.
CEO Equity Holding	*Value of CEOs' Equity Holding: CEO Total Stock Value + CEO Total Option Value*
CEO tenure	Dummy variable that equals one if the CEO was replaced, and zero otherwise
ROA	Returns on assets: income before extraordinary items/total assets
ROE	Returns on equity: income before extraordinary items/total stockholders' equity
Firm Size	Logarithmic value of total sales
Firm Age	Logarithmic value of (1 + number of years since public)
Market-to-book	(Fiscal Annual Closed Price * Common Shares Outstanding + Total Assets - Total Common Equity)/Total Assets
Surplus Cash/Total Assets	(Operating Activities Net Cash Flow − Depreciation and Amortization + R&D Expense)/Total Assets
Sales Growth	$\ln \frac{Sales_t}{Sales_{t-1}}$
Stock return	Stock's annual return
Net fixed assets	Net property, plant, and equipment scaled by total assets (Net PPE/TA)
Board Size	The number of board directors reported in ExecuComp
Dividend Cut	Dummy variable that equals one if there is a reduction in annual dividend, and zero otherwise
Z-Score	(1.2*(Total Current Assets − Total Current Liabilities) + 1.4* Retained Earnings + 3.3*(Net Income (Loss) + Total Interest and Related Expense + Total Income Taxes) + Sale)/Total Assets +0.6* Fiscal Annual Closed Price * Common Shares Outstanding/Total Liabilities
EBIT_TA	Earnings before interest and taxes to total assets

4 Main results

4.1 Managerial ability and firm risk-taking behavior

To analyze the impact of managerial ability on firm risk-taking behavior, we augment standard firm risk-taking regression models by adding managerial ability as the

Table 2 Descriptive statistics of the sample

Variables	N	Mean	SD	25th	50th	75th
$\sigma(ROA)$	74,054	0.07	0.07	0.02	0.05	0.10
$\sigma(ROE)$	74,047	0.18	0.20	0.05	0.10	0.22
CAPEX_TA	131,037	0.04	0.06	0.00	0.02	0.06
R&D_TA	131,037	0.04	0.08	0.00	0.00	0.04
Acquisition_TA	125,999	0.02	0.06	0.00	0.00	0.00
Herfindahl index-2Digital SIC	125,054	0.91	0.18	1.00	1.00	1.00
Herfindahl index-4 Digital SIC	125,054	0.84	0.24	0.65	1.00	1.00
Herfindahl index-ff48	125,054	0.91	0.18	1.00	1.00	1.00
Book Leverage	130,835	0.22	0.20	0.04	0.20	0.35
Managerial Ability$(t-1)$	131,037	0.00	0.10	− 0.06	− 0.01	0.04
CEO Cash Compensation	28,498	1044.00	872.30	521.36	802.00	1210.54
CEO Delta$(t-1)$	27,986	634.68	1483.28	65.80	183.45	527.77
CEO Vega$(t-1)$	27,986	111.19	202.69	7.11	35.90	114.82
CEO Equity Holding	28,498	54,037.11	146,101.47	3933.80	12,623.71	37,679.80
CEO Age	28,313	55.37	7.66	50.00	55.00	60.00
CEO tenure	27,965	7.94	7.61	2.67	5.67	10.67
ROA	131,037	− 0.02	0.21	− 0.03	0.03	0.07
ROE	131,037	− 0.14	0.81	− 0.08	0.07	0.15
Ln(*Sale*)	131,037	4.88	2.21	3.26	4.83	6.43
Firm Age	131,037	15.09	10.77	6.00	12.00	21.00
Market Value/Book Value	131,037	1.78	1.47	0.98	1.31	1.98
Surplus Cash/Total Assets	103,039	0.03	0.16	− 0.02	0.04	0.11
Sales Growth	131,024	0.10	0.33	− 0.03	0.08	0.21
Stock returns	114,052	− 0.01	0.57	− 0.29	0.04	0.32
Board Size	11,452	8.00	2.45	6.00	8.00	10.00

independent variable of interest. Specifically, our model has the following specification:

$$\begin{aligned} Risk-taking\ activity_{it} = {} & \beta_{0i} + \beta_{1i}\text{Managerial Ability}_{it-1} + \beta_{2i}X_{it} \\ & + Industry\ dummies + Year\ dummies + \varepsilon_{it} \end{aligned} \tag{2}$$

where risk-taking activity is measured by the standard deviation of ROA(σ_{ROA}), the standard deviation of ROE(σ_{ROE}), capital expenditures divided by total assets (CAPEX_TA), research and development expenses divided by total assets(R&D_TA), acquisition values to total assets (ACQ_TA), Herfindahl Index, and book leverage, respectively.

Following existing studies, the control variables, X_{it}, include (1) firm age, measured by Ln(1 + firm age); (2) stock return, measured by the prior year buy-and-hold stock return; (3) firm performance, measured by return on assets; (4) investment opportunities, measured by Ln(M/B ratio); (5) book leverage; (6) firm size, a proxy for economies of scale, is measured by log(sales); (7) sales growth; (8) surplus cash, defined as the amount of cash available to finance new projects, scaled by total assets (see Coles et al. 2006); and (9) dividend cut, a (0, 1) dummy variable that has a value of one if there was a decrease in the annual dividend, and zero otherwise. The lagged value of managerial ability is used in the estimation to control for potential endogeneity problems (Coles et al. 2006). We also control for industry fixed effects and year fixed effects in the model.

In Table 3, regression results using Eq. (2) are reported. In columns (1) to (6) where the dependent variable in each column is a measure of investment behavior, the coefficient on managerial ability is positive and significant at the one percent level. In column (7) where the dependent variable is book leverage, the coefficient on managerial ability is negative and significant at the one percent level. In short, managerial ability is positively associated with firm risk-taking behavior but negatively associated with firm leverage. The results in Table 3 suggest that the economic impact of managerial ability on firm risk-taking is considerable. For example, in column (1), the coefficient on managerial ability is 0.0268 with a t-value of 9.25. Evaluating σ_{ROA} at it mean, a one standard deviation increase in managerial ability is associated with a 3.83% increase in σ_{ROA}. Similarly, evaluating σ_{ROE} at it mean, a one standard deviation increase in managerial ability is associated with a 4.29% increase in σ_{ROE}. The positive relation between managerial ability and the two risk measures (σ_{ROA} and σ_{ROE}) is consistent with the finding of Andreou et al. (2016) that managerial ability increases the risk-taking activity of financial institutions. In addition, columns (3) and (4) show that a one standard deviation increase in managerial ability is associated with a small increase of 1.83% in CAPEX_TA but a large increase of 11.63% in R&D_TA. Bhagat and Welch (1995) argue that capital expenditures represent low risk investment activity. The results in columns (3) and (4) show that managerial ability is more associated with high risk research and development than low risk capital expenditures. Consistent with our results, Chen et al. (2015) find that firms with capable managers are associated with higher levels of innovation, which are in general associated with research and development expenses. Our observation of a positive association between managerial ability and firm investment activity does not support the implications of some behavioral studies that managers, because of their higher levels of education and intelligence, may be more risk cautious. In column (5), the regression result shows that a one standard deviation increase in managerial ability is positively associated with a 4.4% increase in firm acquisitions. Some researchers have documented that managerial characteristics are related to firm acquisition activity (Bertrand and Schoar 2003; Malmendier and Tate 2005; Jenter and Lewellen 2015). Our results add to this line of research by showing that managerial ability has a positive effect on firm acquisitions. In column (6), the dependent variable is Herfindhal Index. An increase in the value of Herfindhal Index implies a larger market share and a higher market power; it happens when a firm increases its focus in fewer market segments. In column (6), the coefficient on managerial ability is positive and significant at the one percent level. The result suggests that managers with high-ability are associated with firms that have revenues from fewer market segments; that is, managerial ability increases firm focus. Earlier studies on firm efficiency in general conclude that improved firm focus has positive effects on firm performance and firm value (Comment and Jarrell 1995). The literature, however, has not examined the relation between managerial characteristics and firm focus. To the best of our knowledge, our result in column (6) is likely the first to report a relation between managerial ability and firm focus. In sum, the results in Tables 3 and 4 suggest that firms with managerial ability is positively associated with higher levels of risk-taking activity in general. It is interesting to note that in column (7), the result shows that a one standard deviation increase in managerial ability is associated with a 4.59% decrease in book leverage. Consistent with our finding, Bhagat et al. (2012) develop a theoretical construct of managerial ability and predict that managerial ability is associated with a decline in firm leverage. According to Bhagat et al. (2012), capable managers prefer less debt because firm leverage increases the expected bankruptcy costs for the firm and personal bankruptcy costs for the manager, which negatively affect his continuation value. Some behavioral studies suggest that capable individuals are less receptive of interferences

Table 3 Regressions of managerial ability effect on firm risk-taking behavior

	(*1*) σ(ROA)	(*2*) σ(ROE)	(*3*) CAPEX_TA	(*4*) R&D_TA	(*5*) Acquisition_TA	(*6*) Herfindahl index-ff48	(*7*) Book Leverage
Managerial Ability	0.0268***	0.0772***	0.0073***	0.0465***	0.0159***	0.0389***	− 0.1010***
	(9.25)	(9.03)	(3.52)	(21.48)	(7.80)	(7.90)	(− 20.19)
Book Leverage	− 0.0281***	0.1263***	0.0003	− 0.0358***	0.0436***	− 0.0234***	
	(− 16.76)	(21.55)	(0.26)	(− 32.57)	(32.55)	(− 7.46)	
Stock return	− 0.0075***	− 0.0180***	− 0.0070***	− 0.0003	0.0030***	− 0.0046***	
	(− 11.30)	(− 8.91)	(− 16.82)	(− 0.56)	(7.48)	(− 4.55)	
ROA	− 0.2175***	− 0.5209***	0.0007	− 0.2715***	− 0.0063***	0.0051*	− 0.0367***
	(− 72.15)	(− 61.69)	(0.49)	(− 90.46)	(− 4.39)	(1.73)	(− 9.80)
Ln(*Sale*)	− 0.0058***	− 0.0099***	− 0.0006***	− 0.0028***	0.0022***	− 0.0136***	0.0118***
	(− 35.80)	(− 19.95)	(− 5.32)	(− 24.96)	(18.64)	(− 36.42)	(42.86)
Ln (*Firm Age*)	− 0.0112***	− 0.0290***	− 0.0073***	− 0.0037***	− 0.0036***	− 0.0472***	− 0.0229***
	(− 24.57)	(− 21.02)	(− 23.03)	(− 13.13)	(− 10.41)	(− 51.70)	(− 28.42)
Market-to-book Value/Book Value	0.0047***	0.0118***	0.0034***	0.0059***	− 0.0028***	0.0030***	0.0127***
	(17.58)	(15.05)	(21.04)	(26.46)	(− 20.22)	(8.92)	(25.14)
Surplus Cash/Total Assets	0.0099***	0.0292***	0.0235***	0.2482***	0.0157***	0.0621***	
	(3.02)	(2.95)	(13.60)	(76.03)	(8.82)	(16.18)	
Sales Growth	0.0040***	0.0041	0.0188***	0.0059***	0.0359***	− 0.0074***	
	(3.38)	(1.16)	(24.56)	(6.42)	(39.98)	(− 4.59)	
Dividend Cut					0.0005	− 0.0041	
					(0.61)	(− 1.52)	
R&D_TA							− 0.4619***
							(− 55.59)
Z-Score							− 0.0129***
							(− 93.55)
Net PPE/TA							0.1554***
							(48.29)

Table 3 (continued)

	(1) σ(ROA)	(2) σ(ROE)	(3) CAPEX_TA	(4) R&D_TA	(5) Acquisition_TA	(6) Herfindahl index-ff48	(7) Book Leverage
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FF48 Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	51,835	51,923	90,497	90,497	87,165	85,560	111,681
Adj R-Square	33.75%	24.09%	12.94%	60.03%	9.33%	14.97%	30.83%

***, **, and * denote the significance levels of 1, 5, and 10%, respectively

Table 4 Compare the effects of high (top quartile) and low (both quartile) managerial ability on firm risk-taking behavior

	(*1*) σ(ROA)	(*2*) σ(ROE)	(*3*) CAPEX_TA	(*4*) R&D_TA	(*5*) Acquisition_TA	(*6*) Herfindahl index-ff48	(*7*) Book Leverage
Hi_MA	0.0065***	0.0160***	− 0.0018***	0.0140***	0.0002	0.0110***	− 0.0082***
	(9.51)	(7.78)	(− 3.87)	(28.03)	(0.36)	(8.56)	(− 7.03)
Low_MA	− 0.0006	− 0.0066***	− 0.0047***	0.0022***	− 0.0053***	0.0058***	0.0205***
	(− 0.87)	(− 3.10)	(− 9.15)	(4.71)	(− 10.53)	(4.17)	(15.89)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FF48 Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	51,835	51,923	90,497	90,497	87,165	85,560	111,681
Adj R-Square	33.77%	24.10%	13.02%	60.17%	9.40%	14.98%	30.85%

***, **, and * denote the significance levels of 1, 5, and 10%, respectively

(Bandura 1997). Accordingly, the negative relation between managerial ability and firm leverage suggests that capable managers dislike the monitoring imposed by debtholders.

Although it is not the focus of this paper, Table 3 also provides information about other conventional determinants of risk-taking activity. The regression coefficients on these determinants have signs that are largely consistent with existing studies. For example, firm age has a negative and significant coefficient as older firms are likely to have fewer growth opportunities relative to younger firms. Similarly, the coefficient on sales growth and the coefficient on market-to-book are positive and significant. The coefficient on surplus cash is positive and significant. Consistent with Coles et al. (2006), the coefficient on stock return is negative and significant.

To garner additional insights into the effect of managerial ability on firm risk-taking, we repeat the regressions using Eq. (2) to examine if the effect of managerial ability on firm risk-taking is nonlinear. Specifically, we want to examine if high managerial ability (top quartile) and low managerial ability (bottom quartile) have different impacts on firm risk-taking behavior. We revise Eq. (2) to include indicator variables for firms that are in the top and bottom quartiles of MA score.

$$\begin{aligned} Risk-taking\ activity_{it} = {} & \beta_{0i} + \beta_{1i} Hi\_MA_{it-1} \beta_{2i} Low\_MA_{it-1} + \beta_{3i} X_{it} \\ & + Industry\ dummies + Year\ dummies + \varepsilon_{it} \end{aligned} \tag{3}$$

For brevity sake, we report only the coefficients on high managerial ability (hi_MA) and low managerial ability (low_MA) in Table 4. It can be seen in Table 4 that managers of high managerial ability and managers of low managerial ability indeed affect firm risk-taking behavior differently. In column (1) where the dependent variable is σ_{ROA}, the coefficient on hi_MA is positive and significant whereas the coefficient on low_MA is negative and insignificant. The existing literature has not provided an explanation of why less capable managers do not engage firms in risk-taking activity, a plausible explanation is that less capable managers may be more content with a quiet life (Bertrand and Mullainathan 2003) or prefer a playing it safe approach (Gormley and Matsa 2016) in risk-taking. Consistent with the result in column (1), it can also be seen that in column (2) where the dependent variable is σ_{ROE}, the coefficient on hi_MA is positive and significant at the one percent level whereas the coefficient on low_MA is negative and significant at the one percent level. In columns (3) and (4), the different impacts of high managerial ability and low managerial ability on capital expenditures and R&D expenses are considerable. In column (3) where the dependent variable is CAPEX_TA, the coefficient on hi_MA is − 0.0018; in column (4) where the dependent variable is R&D_TA, the coefficient on hi_MA is 0.014 with a t-value of 28.03. The results suggest that managers with high-ability (top quartile) reduce low risk capital expenditures and shift firm resources to high risk research and development. In contrast, the coefficient on low_MA in columns (3) and (4), suggests that low-ability managers (bottom quartile) cut capital expenditures significantly more (260% of the amount cut by hi_MA managers) but shift only a nominal amount (15.7% of the amount added by hi_MA managers) of resources to R&D expenses. Recall earlier that we obtained a positive coefficient on MA in column 3 (dependent variable is CAPEX_TA) of Table 3, the result in column 3 of Table 4 implies that the positive coefficient on MA in Table 3 is primarily driven by managers of median-ability (and confirmed by untabulated results). The result in column (5) of Table 4 shows that hi_MA managers are associated with higher levels of firm acquisitions. In column (6), it is shown that firms with high-ability managers are associated with higher levels of firm focus. In sum, the results in columns (1) to (6) of Table 4 overwhelmingly suggest that hi_MA managers increase

investment related risk-taking activities whereas low_MA managers decrease investment related risk-taking activities. Interestingly, in contrast to the result in Table 3, the result in column (7) of Table 4 shows that hi_MA managers are associated with lower firm leverage whereas low_MA managers are associated with higher firm leverage. This finding suggests that low_MA managers do not seek to avoid the monitoring imposed by debtholders.

5 Additional tests

5.1 The effect of managerial incentives

It has been generally argued that CEOs prefer less risk than do more well diversified outside shareholders (Amihud and Lev 1981). In addition, some managers are averse to risk-taking because they either prefer a quiet life or want to play it safe. There is also significant evidence that managers are less willing to assume risk due to potential legal liabilities (Bargeron et al. 2010). When CEOs are risk-averse, shareholders may suffer.

Researchers have suggested that stock and option based compensation incentives could be used to encourage managerial risk-taking behavior (Guo et al. 2015). Prior research on managerial incentives suggests that the two most important measures in capturing incentives are the sensitivity of managerial wealth to stock price, that is, compensation delta, and the sensitivity of managerial wealth to stock return volatility, that is, compensation vega (Guay 1999; Core and Guay 2002).

Stock-based pay makes CEO wealth sensitive to movements in the underlying stock price. Theoretically, higher delta helps align managerial behavior with the interests of shareholders resulting in a convex payoff that encourages managers to work harder and take on value enhancing risky projects (Jensen and Meckling 1976; Haugen and Senbet 1981). However, empirical findings suggest that the effect of delta on managerial risk-taking is ambiguous. On the one hand, an increase in the sensitivity of compensation to stock price improves the alignment of interests between managers and shareholders, since both benefit from an increase in the stock price. On the other hand, high deltas expose risk-averse managers to greater risk, which prior research argues might deter managers from increasing their preference for risk-taking (Amihud and Lev 1981; Lambert et al. 1991; Brick et al. 2012).

Recent empirical studies present evidence of a positive relationship between vega and managerial risk-taking (Guay 1999; Coles et al. 2006; Low 2009). The underlying rationale is that convex payoffs (e.g., those of stock options) provide managers strong incentives to increase the return volatility of the underlying asset, which will induce managers to take more risk to maximize their expected wealth. However, whether the convexity of higher vega overcomes managerial risk aversion remains a theoretical and empirical question. For instance, the effectiveness of option compensation depends on the managerial utility function. Guay (1999) and Ross (2004) present models in which the concavity of the manager's utility function overcomes the convexity of the payoff causing managers to be more risk averse. In addition, empirical studies frequently measure vega using the market value (Black–Scholes value) of the stock option. This measure differs from the CEO's certainty equivalent value (the value of riskless cash the CEO would trade for the risky asset). So, managers unable to sell or hedge their options will value them differently than market value based on their personal risk preferences (Lambert et al. 1991; Carpenter 2000; Ross 2004). Thus, the net effect of option compensation on firm risk is unclear.

The empirical validity of the effects of vega and delta is beyond the scope of this study. Nevertheless, we examine the robustness of our results on the relation between managerial ability and risk-taking by controlling for the effect of managerial incentives. Following the literature, we also add CEO characteristics such as cash compensation, age, tenure, and turnover, to the list of control variables. The regression model has the following specification:

$$\begin{aligned} Risk-taking\ activity_{it} = {} & \beta_{0i} + \beta_{1i}\text{Managerial Ability}_{it-1} \\ & + \beta_{2i}CEO\_Delta_{it-1} + \beta_{3i}CEO\_Vega_{it-1} \\ & + \beta_{4i}X_{it} + Industry\ dummies + Year\ dummies + \varepsilon_{it} \end{aligned} \tag{4}$$

In Table 5, regression results using Eq. (4) are reported. The results are largely consistent with the findings reported in Table 3. With the exception in column (3), Table 5 shows that the coefficient on managerial ability is positive and significant at the one percent level when the dependent variable is a measure of investment related risk-taking activity. That is, managerial ability is positively associated with firm risk-taking even after controlling for the effect of managerial incentives on CEO behavior. In column (3) where the dependent variable is CAPEX_TA, the coefficient on MA is insignificant. The result, consistent with our earlier findings in Table 4, suggests that capable managers do not add resources to low risk capital expenditures; instead, as shown in column (4), capable managers prefer to engage in high risk R&D activity. In column (7) where the dependent variable is book leverage, the coefficient on managerial ability is negative and significant at the one percent level.

Consistent with the existing literature, the results in Table 5 show that the effect of managerial incentives on firm risk-taking is less than straight forward. Specifically, the sign of the coefficient on delta in Table 5 does not remain consistent. The same is true of the sign of the coefficient on vega. Nevertheless, the negative effect of delta and the positive effect of delta on CAPEX are consistent with the findings of Coles et al. (2006). Specifically, Coles et al. (2006) find that greater sensitivity of CEO wealth to stock return volatility is related to greater research and development expenditures and less capital expenditures.

We compare the effects of high managerial ability and low managerial ability and report the results in Table 6. For brevity sake, we report only the coefficients on hi_MA and low_MA in the table. As can be seen in Table 6, except for CAPEX_TA in column (3), the coefficient on hi_MA is positive and significant in the first six columns. That is, hi_MA managers are associated with increases in investment related risk-taking. In contrast, the coefficient on low_MA in Table 6 is negative and significant in general; the results in Table 6 show that low_MA managers are associated with decreases in investment related risk-taking. More importantly, after controlling for the effect of managerial incentives, the results in columns (3) and (4) show that hi_MA managers cut capital expenditures and spend more on R&D expenses; low_MA managers cut both capital expenditures and R&D expenses.

5.2 The effect of corporate governance

Agency theory predicts that the divergence of interests between shareholders and managers has significant impacts on investment decisions. Yet the effect of agency conflicts on firm risk-taking is ambiguous. On the one hand, some researchers argue that managers overinvest for their own benefits rather than the benefits of the firm's shareholders (Jensen and

Table 5 Regressions of managerial ability effect on firm risk-taking behavior while controlling for the effect of managerial incentives

	(1) σ(*ROA*)	(2) σ(*ROE*)	(3) *CAPEX_TA*	(4) *R&D_TA*	(5) *Acquisition_TA*	(6) *Herfindahl index-ff48*	(7) *Book Leverage*
Managerial Ability	0.0209***	0.0451***	0.0001	0.0389***	0.0194***	0.0501***	− 0.1021***
	(4.74)	(3.36)	(0.03)	(15.46)	(5.39)	(5.75)	(− 12.49)
Ln (*CEO Delta*)	− 0.0001	− 0.0011	0.0016***	0.0001	0.0007*	− 0.0029***	− 0.0041***
	(− 0.23)	(− 0.86)	(4.99)	(0.24)	(1.68)	(− 2.83)	(− 4.72)
Ln (*CEO Vega*)	− 0.0005	0.0001	− 0.0011***	0.0021***	− 0.0002	0.0028***	0.0027***
	(− 1.59)	(0.06)	(− 5.05)	(14.52)	(− 0.72)	(3.69)	(4.50)
Ln (*CEO Age*)	− 0.0058	− 0.0154	− 0.0150***	− 0.0142***	0.0055*	− 0.0628***	− 0.0263***
	(− 1.53)	(− 1.36)	(− 5.38)	(− 6.76)	(1.67)	(− 6.88)	(− 3.44)
Ln (*CEO Tenure*)	− 0.0011	− 0.0066***	0.0025***	− 0.0001	− 0.0045***	0.0053***	0.0091***
	(− 1.48)	(− 2.74)	(4.40)	(− 0.33)	(− 6.43)	(2.65)	(5.66)
Ln (*Cash Compensation*)	0.0052***	0.0107***	− 0.0014**	0.0007	0.0030***	− 0.0062***	− 0.0009
	(6.32)	(4.09)	(− 2.26)	(1.54)	(4.34)	(− 2.85)	(− 0.50)
Ln (*CEO Equity Holding*)	− 0.0008***	− 0.0019**	0.0006**	− 0.0005**	0.0011***	− 0.0037***	0.0002
	(− 2.66)	(− 2.12)	(2.53)	(− 2.55)	(3.59)	(− 5.02)	(0.25)
CEO turnover	− 0.0002	− 0.0003	0.0014	− 0.0024**	− 0.0086***	− 0.0012	0.0008
	(− 0.10)	(− 0.06)	(1.16)	(− 2.43)	(− 5.88)	(− 0.25)	(0.23)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FF48 Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,056	15,101	25,095	25,095	23,622	23,261	23,225
Adj R-Square	23.22%	15.78%	19.83%	63.69%	10.51%	22.61%	38.45%

***, **, and * denote the significance levels of 1, 5, and 10%, respectively

Table 6 Compare the effects of high (top quartile) and low (both quartile) managerial ability on firm risk-taking behavior while controlling for the effect of managerial incentives

	(*1*) *σ(ROA)*	(*2*) *σ(ROE)*	(*3*) *CAPEX_TA*	(*4*) *R&D_TA*	(*5*) *Acquisition_TA*	(*6*) *Herfindahl index-ff48*	(*7*) *Book Leverage*
Hi_MA	0.0054***	0.0127***	− 0.0025***	0.0104***	0.0001	0.0149***	− 0.0020
	(4.58)	(3.59)	(− 3.15)	(15.88)	(0.10)	(5.47)	(− 0.88)
Low_MA	− 0.0018	− 0.0041	− 0.0036***	− 0.0017***	− 0.0071***	0.0073**	0.0290***
	(− 1.57)	(− 1.13)	(− 4.61)	(− 3.18)	(− 7.00)	(2.43)	(12.82)
Ln (*CEO Delta*)	− 0.0001	− 0.0010	0.0016***	0.0001	0.0007*	− 0.0029***	− 0.0043***
	(− 0.21)	(− 0.85)	(4.99)	(0.33)	(1.70)	(− 2.82)	(− 4.88)
Ln (*CEO Vega*)	− 0.0005	0.0001	− 0.0010***	0.0021***	− 0.0001	0.0028***	0.0025***
	(− 1.50)	(0.11)	(− 4.94)	(14.56)	(− 0.50)	(3.67)	(4.17)
Ln (*CEO Age*)	− 0.0056	− 0.0150	− 0.0150***	− 0.0139***	0.0055*	− 0.0630***	− 0.0261***
	(− 1.48)	(− 1.32)	(− 5.40)	(− 6.63)	(1.66)	(− 6.89)	(− 3.43)
Ln (*CEO Tenure*)	− 0.0012	− 0.0067***	0.0025***	− 0.0002	− 0.0045***	0.0054***	0.0093***
	(− 1.55)	(− 2.80)	(4.39)	(− 0.52)	(− 6.49)	(2.67)	(5.82)
Ln (*CEO Cash Compensation*)	0.0052***	0.0106***	− 0.0013**	0.0007	0.0031***	− 0.0063***	− 0.0013
	(6.28)	(4.05)	(− 2.20)	(1.48)	(4.43)	(− 2.90)	(− 0.72)
Ln (*CEO Equity Holding*)	− 0.0008***	− 0.0019**	0.0006**	− 0.0005***	0.0011***	− 0.0037***	0.0003
	(− 2.69)	(− 2.13)	(2.53)	(− 2.62)	(3.58)	(− 5.04)	(0.40)
CEO turnover	− 0.0002	− 0.0004	0.0014	− 0.0024**	− 0.0087***	− 0.0011	0.0010
	(− 0.11)	(− 0.08)	(1.14)	(− 2.50)	(− 5.92)	(− 0.22)	(0.29)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FF48 Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,056	15,101	25,095	25,095	23,622	23,261	23,225
Adj R-Square	23.25%	15.81%	19.90%	63.76%	10.61%	22.61%	38.57%

***, **, and * denote the significance levels of 1, 5, and 10%, respectively

Meckling 1976; Stulz 1990; Fluck and Lynch 1999). On the other hand, a number of studies on agency conflicts suggest that managers underinvest when investment performance affects the manager's reputation (Campbell et al. 1989; Hirshleifer and Thakor 1992). Smith and Watts (1992) suggest that managers underinvest because when they face a limited payout horizon.

To mitigate agency conflicts, corporate governance mechanisms are commonly adopted by firms to align the interests between shareholders and managers. Among the various governance practices, the board of directors plays a pivotal role in the governance of widely held corporations. Monitoring, advising the top management, and ensuring that the firm is run in the shareholders' interest are the fiduciary duties of the board. There is evidence that the presence of the board of directors has positive impact on firm performance (Yermack 1996; Coles et al. 2008).

In our second robustness test, we control for the effect of corporate governance on managerial risk-taking behavior. Specifically, we add board size to the list of independent variables in our regression model:

$$\begin{aligned} Risk-taking\ activity_{it} = {} & \beta_{0i} + \beta_{1i}\text{Managerial Ability}_{it-1} + \beta_{2i} Board\ Size_{it-1} \\ & + \beta_{3i} X_{it} + Industry\ dummies + Year\ dummies + \varepsilon_{it} \end{aligned} \tag{5}$$

In Table 7, regression results using Eq. (5) are reported. The results are largely consistent with the findings reported in Table 3. With the exception in column (2), the coefficient on MA is positive and significant at the 1% level in each regression. The coefficient on Board Size is negative and significant in columns (1), (5) and (6); suggesting that the board of directors impose restraints on firm risk-taking. However, consistent with the view of Wang (2012), we find that the presence of the board of directors is associated with higher levels of R&D expenditures.

In Table 8, we compare the effects of high managerial ability and low managerial ability on firm risk-taking while controlling for managerial incentives and board size. The results show that hi_MA managers are associated with increases of σ_{ROE}, R&D expenses, and firm focus. In contrast, low_MA managers are associated with decreases of risk-taking measured by σ_{ROA}, CAPEX_TA, R&D_TA, and Acquisitions_TA. The results are largely consistent with the findings reported in earlier tables.

5.3 Managerial ability, firm value, and firm operating performance

In our next investigation, we examine the effect of managerial ability on firm value (measured by Tobin's Q). We report the regression results in Tables 9 and 10. As can be seen in Table 9, the coefficient of managerial ability is positive and significant at the one percent level in each column. The result persists in column (8) where we control for all the risk-taking measures and the other independent variables. The economic impact of managerial ability on firm value is considerable. For example, in column (1), a one standard deviation in managerial ability is associated with a 13.69% increase in firm value. In column (8), a one standard deviation in managerial ability is associated with a 10.99% increase in firm value. The high R-square of each regression suggests that the model specification is accurate and that managerial ability is an important explanatory variable of firm value. Consistent with our result, Demerjian et al. (2012) find that capable CEOs are associated with improvements in firm performance.

In Table 10, we compare the effects of high managerial ability and low managerial ability on firm value. As can be seen in the table, the coefficient on hi_MA is positive and

Table 7 Regressions of managerial ability effect on firm risk-taking behavior while controlling for the effect of corporate governance

	(*1*) *σ(ROA)*	(*2*) *σ(ROE)*	(*3*) *CAPEX_TA*	(*4*) *R&D_TA*	(*5*) *Acquisition_TA*	(*6*) *Herfindahl index-ff48*	(*7*) *Book Leverage*
Managerial ability	0.0176**	0.0179	0.0078*	0.0377***	0.0231***	0.0730***	− 0.1083***
	(1.99)	(0.68)	(1.88)	(10.53)	(4.26)	(6.14)	(− 8.86)
Board size	− 0.0008*	0.0005	− 0.0001	0.0009***	− 0.0006*	− 0.0030***	− 0.0005
	(− 1.81)	(0.36)	(− 0.45)	(5.04)	(− 1.88)	(− 3.42)	(− 0.73)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FF48 Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4959	4989	11,154	11,154	10,616	10,454	10,413
Adj R-Square	17.69%	12.71%	19.14%	60.84%	9.90%	20.92%	37.93%

***, **, and * denote the significance levels of 1, 5, and 10%, respectively

Table 8 Compare the effects of high (top quartile) and low (bottom quartile) managerial ability on firm risk-taking behavior while controlling for the effect of corporate governance

	(1) σ(*ROA*)	(2) σ(*ROE*)	(3) *CAPEX_TA*	(4) *R&D_TA*	(5) *Acquisition/AT*	(6) *Herfindahl index*	(7) *Book Leverage*
Hi_MA	0.0035	0.0148*	0.0004	0.0082***	0.0018	0.0215***	− 0.0045
	(1.29)	(1.81)	(0.36)	(7.77)	(1.08)	(5.36)	(− 1.17)
Low_MA	− 0.0049**	0.0066	− 0.0053***	− 0.0032***	− 0.0045***	0.0054	0.0244***
	(− 2.02)	(0.90)	(− 5.28)	(− 3.83)	(− 2.91)	(1.19)	(7.07)
Ln (*CEO Delta*)	− 0.00109	− 0.0024	0.0028***	− 0.0004	0.0019***	− 0.0058***	− 0.0005
	(− 1.07)	(− 0.79)	(5.87)	(− 1.05)	(2.92)	(− 3.32)	(− 0.35)
Ln (*CEO Vega*)	0.0006	0.0010	− 0.0014***	0.0022***	0.0002	0.0062***	− 0.0006
	(0.84)	(0.48)	(− 4.98)	(10.09)	(0.47)	(5.57)	(− 0.68)
Ln (*CEO Age*)	− 0.00326	− 0.0335	− 0.0023	− 0.0183***	0.0026	− 0.0531***	− 0.0378***
	(− 0.37)	(− 1.32)	(− 0.59)	(− 5.56)	(0.45)	(− 3.68)	(− 3.04)
Ln (*CEO Tenure*)	− 0.00408**	− 0.0138**	0.0007	0.0001	− 0.0064***	0.0025	0.0150***
	(− 2.12)	(− 2.37)	(0.78)	(0.11)	(− 5.18)	(0.78)	(5.37)
Ln (*CEO Cash Compensation*)	0.0000**	0.0000	0.0000	0.0000	0.0000	0.0000***	0.0000*
	(2.15)	(1.61)	(− 0.85)	(− 0.48)	(− 0.33)	(− 6.28)	(− 1.85)
Ln (*CEO Equity Holding*)	0.0000	0.0000	0.0000**	0.0000***	0.0000	0.0000**	0.0000***
	(1.00)	(− 0.08)	(− 2.23)	(4.86)	(0.41)	(− 2.40)	(− 7.91)
CEO turnover	− 0.0047	− 0.0146	− 0.0005	− 0.0022	− 0.0145***	0.0030	0.0059
	(− 1.16)	(− 1.19)	(− 0.32)	(− 1.46)	(− 6.12)	(0.43)	(1.02)
Board size	− 0.0012**	− 0.0014	0.0003	0.0007***	− 0.0008**	− 0.0040***	− 0.0009
	(− 2.47)	(− 0.97)	(1.44)	(3.59)	(− 2.51)	(− 4.32)	(− 1.24)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FF48 Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4503	4536	10,377	10,377	9868	9733	9689
Adj R-Square	18.83%	13.70%	18.62%	61.52%	10.35%	22.63%	38.70%

***, **, and * denote the significance levels of 1, 5, and 10%, respectively

significant at the one percent level in all the eight columns; the coefficient on low_MA is negative and significant at the one percent level in the first seven columns. The results suggest that high-ability managers are more likely to improve firm value whereas low-ability managers are more likely to destroy firm value.[1] A plausible reason is that low-ability managers are prone to make mistakes in investment decisions. Another possible explanation is that low-ability managers are more likely to emphasize private motives, resulting in firm-value reducing decisions. We repeat the analysis in Tables 9 and 10 and control for the effects of managerial incentives and board size; we find similar results and the results are therefore not tabulated.

In Table 11, we provide information on the effect of managerial ability on firm operating performance. We divide the sample period into three subperiods surrounding the financial crisis of 2007–2009: (1) pre-financial crisis; (2) during financial crisis; and (3) post financial crisis. We compare the operating performance of firms with high MA scores and firms with low MA scores. The performance measures include return on assets (ROA), return on equity (ROE), sales volume, sales growth, and earnings (EBIT_TA). We also provide information on dividend payout and leverage.

Panel A of Table 11 shows that during the pre-crisis period, hi_MA firms have significantly higher ROA, ROE, and earnings than low_MA firms. Hi_MA and low_MA firms have comparable dividend payout ratios, but hi_MA firms have a much lower leverage. The results remain consistent during the financial crisis of 2007–2009. During this period, both hi_MA and low_MA firms suffer and have negative ROA and ROE, but hi_MA firms suffer considerably less than low_MA firms. In the post-crisis period, ROA and ROE turn positive for hi_MA firms but remain negative for low_MA firms. During the post-crisis period, the average earnings of hi_MA firms is almost three times the average earnings of low_MA firms. As in the other subperiods, hi_MA firms continue to have a lower leverage than low_MA firms. In sum, hi_MA firms are in general more profitable, have higher earnings, and have lower leverage ratios.

6 Summary and conclusion

Conventional models ignore the role of managerial heterogeneity in firm decisions as managers are expected to act rationally and follow the mandate of firm value maximization. We examine the relation between managerial ability and the risk choices in corporate investment. Our view is that in addition to the effects of previously examined determinants, the risk choices are affected not just by the managers' explicit mandate to maximize firm value, but also by the ability of the manager in managing the firm. We add to the literature by showing that managerial ability significantly affects firm policies. In contrast to previous studies that find a positive linear relationship between managerial ability and firm investment behavior, we find that high-ability managers and low-ability managers have opposite effects on firm risk-taking behavior and firm value. High-ability managers are in general receptive to risk-taking whereas low-ability managers refrain from risk-taking. High-ability managers cut capital expenditures but spends significantly more on research and

[1] We thank an anonymous referee for pointing out that managerial ability may also be a measure of managerial risk aversion. Given that our results show a positive relation between hi_MA and firm value, we think that managerial ability is less likely a measure of risk aversion because firm value may not be enhanced by aggressive managers.

Table 9 Regressions of managerial ability effect on firm value

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Managerial Ability	2.4511***	2.6400***	2.0430***	2.2273***	2.1947***	0.9672***	2.7304***	1.9671***
	(28.58)	(31.34)	(35.86)	(41.88)	(39.95)	(4.81)	(34.04)	(7.23)
σ(ROA)	2.2233***							1.4166***
	(21.02)							(8.52)
σ(ROE)		0.4485***						0.1681***
		(13.10)						(3.07)
CAPEX_TA			1.6053***					1.3979***
			(19.76)					(13.57)
R&D_TA				3.3818***				3.5140***
				(31.51)				(20.20)
Acquisition_TA					− 1.7872***			− 0.9122***
					(− 28.57)			(− 10.07)
Herfindahl index-ff48						0.2466***		0.0952***
						(11.58)		(3.62)
Book Leverage							− 1.2412***	− 1.0966***
							(− 53.50)	(− 31.37)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FF48 Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	51,889	51,978	90,592	90,592	87,259	23,291	25,095	12,390
Adj R-Square	32.32%	32.24%	31.90%	33.11%	31.86%	47.49%	48.29%	53.71%

***, **, and * denote the significance levels of 1, 5, and 10%, respectively

Table 10 Compare the effects of high (top quartile) and low (bottom quartile) managerial ability on firm value

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Hi_MA	0.4024***	0.4290***	0.4167***	0.3570***	0.4107***	0.4148***	0.3775***	0.3263***
	(28.07)	(29.50)	(36.59)	(31.12)	(35.50)	(35.31)	(33.60)	(21.70)
Low_MA	− 0.0734***	− 0.0701***	− 0.0685***	− 0.0777***	− 0.0809***	− 0.0796***	− 0.0315***	− 0.0204
	(− 5.72)	(− 5.34)	(− 6.78)	(− 7.82)	(− 7.93)	(− 7.58)	(− 3.14)	(− 1.53)
σ(ROA)	2.2399***							1.3836***
	(20.94)							(8.31)
σ(ROE)		0.4460***						0.1850***
		(12.92)						(3.44)
CAPEX_TA			1.6419***					1.4119***
			(20.51)					(13.88)
R&D_TA				3.3532***				3.4702***
				(31.41)				(20.19)
Acquisition_TA					− 1.7757***			− 0.9177***
					(− 28.19)			(− 9.95)
Herfindahl index-ff48						0.2470***		0.1072***
						(11.76)		(4.12)
Book Leverage							− 1.22431***	− 1.1002***
							(− 53.64)	(− 32.28)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FF48 Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	51,889	51,978	90,592	90,592	87,259	85,647	90,462	44,829
Adj R-Square	31.61%	31.46%	31.32%	32.49%	31.31%	31.17%	32.84%	35.74%

***, **, and * denote the significance levels of 1, 5, and 10%, respectively

Table 11 Managerial ability and firm operating performance

	Hi_MA	Low_MA	High-Low	Difference between means (t-value)	Difference between medians (*p* value)
Panel A: pre-crisis (Before 2007)					
ROA	0.0014	− 0.0627	0.0641	34.15	<.0001
ROE	− 0.0721	− 0.2442	0.1721	23.67	<.0001
Log(*Sales*)	4.8789	4.8528	0.0261	1.28	<.0001
Sales growth	0.1214	0.1346	− 0.0132	− 4.37	<.0001
EBIT_TA	0.0957	0.0343	0.0614	27.39	<.0001
Dividends/earnings	0.0612	0.0697	− 0.0085	− 0.84	0.8563
Leverage	0.1820	0.2834	− 0.1014	− 59.74	<.0001
Panel B: during-crisis (from 2007 to 2009)					
ROA	− 0.0050	− 0.0613	0.0563	8.92	<.0001
ROE	− 0.0954	− 0.2414	0.1460	5.9	<.0001
Log(*Sales*)	5.6496	6.2693	− 0.6197	− 9.66	<.0001
Sales growth	0.0636	0.0424	0.0212	2.21	<.0001
EBIT_TA	0.0902	0.0304	0.0598	8.54	<.0001
Dividends/earnings	0.0812	− 0.0357	0.1169	1.09	0.0009
Leverage	0.1409	0.2608	− 0.1198	− 21.99	<.0001
Panel C: post-crisis (After 2009)					
ROA	0.0288	− 0.0443	0.0731	15.72	<.0001
ROE	0.0024	− 0.163	0.1658	9.39	<.0001
Log(*Sales*)	6.4825	6.0609	0.4216	7.6	0.0811
Sales growth	0.0993	0.1119	− 0.0126	− 1.75	0.0093
EBIT_TA	0.1171	0.0398	0.0772	15.18	<.0001
Dividends/earnings	0.1478	0.0713	0.0764	1.5	0.1097
Leverage	0.1700	0.2561	− 0.0860	− 18.33	<.0001

development projects; low-ability managers reduce both capital expenditures and research and development expenses significantly. High-ability managers are associated with higher levels of firm focus than low-ability managers. Our results are robust after taking into consideration the effects of managerial incentives and corporate governance on CEO behavior. Our results also show that high-ability managers are associated with increases in firm value whereas low-ability managers are associated with decreases in firm value. The observation suggests that managerial ability is integral to the long-term success of a firm. The result also provides justification for the lucrative compensation packages offered to attract capable managers.

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