Internet Appendix for "Top Management Human Capital, Inventor Mobility, and Corporate Innovation"

1. Development of Testable Hypotheses on the Effect of Individual Aspects of Top Management Team Quality on Corporate Innovation

In this section, we generate greater insight into how our seven individual aspects of top management team quality (discussed in Section III.B.1) may affect corporate innovation, by discussing how these individual aspects of top management team quality affect innovation in younger versus older firms. Broadly speaking, one can think of two stages in the life of a successful innovation: in the first ("early innovation") stage, the innovation is being developed, but is not ready for the market (since, at this stage, it is still being improved and perfected). In the second ("commercialization") stage, the innovation is commercialized, and is therefore in a position to eventually generate revenues for the firm. In general, firms may have a portfolio of innovations, some at the early innovation stage, others at the commercialization stage. While all the firms in our sample are publicly traded firms, it has been documented that the rate of developing new innovations by firms declines as the years go by after IPO (see, e.g., Bernstein (2015)), so that, for younger firms (0-2 years after IPO), a larger proportion of their innovative projects are likely to be at the early innovation stage, while for older firms (3 years or greater after IPO), a larger proportion of their innovative projects are likely to be at the commercialization stage. Given this, while we expect all seven individual aspects (measures) of the top management team discussed in the main paper to have a positive effect on the corporate innovation output of both younger and older firms, the magnitudes of the effect of these individual proxies on the innovation productivity of younger versus older firms may be different.

We now develop testable hypotheses regarding the differential impact of the above seven individual measures of top management team quality on the innovation productivity of younger versus older firms. First consider team size (TEAM_SIZE). While having good managers as members of the top management team is important for both younger and older firms, the size of the top management team may be more important for older firms. Such firms are likely to have more innovative products at the commercialization stage, so that it may be more important for them to have enough management team members to deal with various tasks related to commercialization (such as advertising, marketing, and finance as well as dealing with suppliers and potential customers) not directly related to developing innovations. Thus, having a larger team size (TEAM_SIZE) may have a significantly larger effect on the innovation productivity of older rather than younger firms.

We now turn to the percentage of the top management team with MBA degrees (MBA). While the MBA degrees of top management team members may be in different functional areas (like operations, marketing, finance), having a larger fraction of top management team members with MBA degrees may be more important for older firms, likely to have a larger fraction of innovative projects under commercialization. Having a larger fraction of MBAs is likely to increase top management's ability to perform commercialization tasks (not directly related to innovation) better, thus feeing up top management team's time to better manage the firm's innovative activities as well. Thus, we expect the magnitude of the effect of the MBA proxy to be significantly greater on the innovation output of older than younger firms.

We now turn to the fraction of the top management team with Ph.D. degrees (PHD). As discussed earlier, top managers with Ph.D. degrees in the area related to the firm's field of innovation (e.g., technology or biotech firms) may be better able to help choose the right innovation strategy for the firm and to attract the appropriate inventors (scientists and engineers) to the firm. This is clearly more important in younger firms (with a larger fraction of their projects at the early innovation stage) than in older firms (where the innovation strategy is already in place and the innovation team implementing this strategy is already in place). Thus, we expect the effect of the Ph.D. proxy to be significantly greater on the innovation output of younger rather than older firms.

We now turn to the work experience (WORK_EXP) and the board experience (BOARD_EXP) of top management team members. Work experience is likely to be an important attribute affecting corporate innovation output in both younger and older firms, but in different ways. In younger firms, experienced top managers may help the firm to set in place and implement their innovation strategies, since they are likely to have accomplished these tasks in prior firms. They may also help the firm select and hire higher quality inventors. In older firms, with a larger fraction of projects at the commercialization stage, they may help the firm also accomplish tasks related to commercialization better, thus freeing up the time and resources of the top management team members directly in charge of managing innovation. However, we do not a priori expect the magnitude of the effect of this individual proxy on innovation to be significantly higher in younger than in older firms or vice versa. The effect of prior board experience on corporate innovation is likely to be similar to that of work experience, with the difference that top management team members with prior board experience are likely to have higher level experience in performing the tasks associated with early innovation and commercialization that we discussed earlier. Thus, we also do not a priori expect the effect of this proxy on corporate innovation to be significantly higher in younger rather than in older firms, or vice versa.

Finally, we turn to employment-based connections (EMP_CONN) and education-based connections (EDU_CONN). Top management team connections may have important effects on innovation in both younger and older firms, but in somewhat different ways. Connections, in general, serve as a channel for information, which may be useful for the top management team in both younger and older firms, though the nature of information conveyed may be different for the two kinds of firms. For younger firms, more of the information conveyed may be about innovation opportunities, appropriate inventors to hire, etc. For older firms, the information conveyed may be more about opportunities for commercialization, about hiring employees who can help with commercialization, etc., which may also help the top management team members directly in charge of managing innovation perform their tasks related to innovation better. Thus, while we expect both of these proxies of top management quality to affect innovation significantly in younger and older firms, we do not expect a priori the magnitude of their effects on corporate innovation to be significantly higher in younger than in older firms, or vice versa.

2. Robustness Tests

2.1. Sample of Innovative Firms

In our main analysis, we use the entire BoardEx-KPSS patent-Compustat-CRSP merged sample and assign zero patents to those firms without any patent record following prior studies (see, e.g., Fang, Tian, and Tice (2014) and Seru (2014)). One concern here may be that some firms in our sample may not engage in any innovative activities at all (i.e., such firms may not appear as a patent assignee in the patent dataset). To address this concern, we re-estimate our baseline regressions using a sample consisting of innovative firms only, which refer to firms that have filed at least one patent application over our sample period of 1999–2009. We therefore alleviate the measurement error concern by studying a more accurate but smaller sample. The results are reported in Table IA-7 of our Internet Appendix.[1] The positive relation between our management quality factor and all three measures of innovation output continues to hold in this sample.

2.2. Alternative Management Quality Factor

In this section, we rerun our common factor analysis using all proxies other than management team size. We do this to clarify whether or not our results are driven by the team size proxy alone. Thus, we re-estimate the management quality factor after excluding team size and rerun our regressions to estimate the relation between this alternative management quality factor and corporate innovation.

The results of these tests are reported in Table IA-8 of our Internet Appendix. Panels A, B, and C report the OLS regression results using the number of patents, total number of citations and citations per patent as dependent variables, respectively. We find that, consistent with our previous results, all three measures of innovation output are positively related to this alternative management quality factor, showing that team size alone does not drive our results.

[1] While we use our full set of control variables in our regressions in Tables IA-B7, IA-B8, and IA-B9 in our Internet Appendix, we do not show the coefficient estimates for these controls to conserve space.

2.3. Additional Fixed Effects in Our Regression Analyses

As a robustness test, we also conduct our regression analyses on the relationship between our management quality factor and the quantity and quality of corporate innovation as well as the innovative efficiency of our sample firms controlling for industry, year, and state fixed effects, industry×year fixed effects, and industry×state×year fixed effects. We conduct these robustness tests to alleviate the concern that our results on the relationship between management quality and innovation are driven by some omitted variable at the industry×year or at the industry×year×state level. We report results controlling for industry×year×state fixed effects in Table IA-9 of our Internet Appendix. We find that our results remain qualitatively similar to the results we have presented in the main text.

References

Bernstein, S. "Does Going Public Affect Innovation?" *Journal of Finance*, 70 (2015), 1365–1403.

Fang, V. W.; X. Tian; and S. Tice. "Does Stock Liquidity Enhance or Impede Firm Innovation?" *Journal of Finance*, 69 (2014), 2085–2125.

Hirshleifer, D.; P.-H. Hsu; and D. Li. "Innovative Efficiency and Stock Returns." *Journal of Financial Economics*, 107 (2013), 632–654.

Seru, A. "Firm Boundaries Matter: Evidence from Conglomerates and R&D Activity." *Journal of Financial Economics*, 111 (2014), 381–405.

TABLE IA-1

The Effect of Management Quality on Corporate Innovative Efficiency

Table IA-1 reports the OLS regression results of innovative efficiency on our management quality factor (MQF). Following Hirshleifer, Hsu, and Li (2013), innovative efficiency is measured by PATENT/R&D and CITE/R&D. PATENT/R&D is defined as the natural logarithm of one plus the ratio of a firm's truncation-adjusted number of patents filed in a given year scaled by its R&D capital (the 5-year cumulative R&D expenses assuming an annual depreciation rate of 20%); i.e., $\text{PATENT/R\&D}_{i,t} = \ln(1+\frac{\text{PATENT}_{i,t}}{\sum_{k=0}^{4}(1-0.2*k)\text{R\&D}_{i,t-k}})$. CITE/R&D is defined as the natural logarithm of one plus the ratio of a firm's total adjusted number of citations filed in year t scaled by its R&D capital, i.e., $\text{CITE/R\&D}_{i,t} = \ln(1+\frac{\text{CITE}_{i,t}}{\sum_{k=0}^{4}(1-0.2*k)\text{R\&D}_{i,t-k}})$. ln(ASSETS) is the natural logarithm of a firm's total assets; MB is Tobin's Q, defined as market value of assets divided by the book value of assets, where the market value of assets is computed as the book value of assets plus the market value of common stock less the book value of common stock; ROA is defined as operating income before depreciation divided by total assets; CAPEX/ASSETS is defined as capital expenditures divided by total assets; R&D/ASSETS is defined as research and development expenses divided by total assets; RET is a firm's annual stock return; HHI is the industry Herfindahl-Hirschman Index; and AVG_TENURE is the average number of years that each manager has worked as VP or higher in this firm. Constant, year fixed effects, and 2-digit SIC industry fixed effects are included in all regressions. All standard errors are adjusted for clustering at the firm level and are reported in parentheses below the coefficient estimates. Coefficients and standard errors in Columns 4-6 are multiplied by 100 for ease of reading. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	$\text{PATENT/R\&D}_{t+1}$	$\text{PATENT/R\&D}_{t+2}$	$\text{PATENT/R\&D}_{t+3}$	$\text{CITE/R\&D}_{t+1}$	$\text{CITE/R\&D}_{t+2}$	$\text{CITE/R\&D}_{t+3}$
Variable	1	2	3	4	5	6
MQF	0.002**	0.002***	0.002***	0.008**	0.007**	0.008**
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)
ln(ASSETS)	-0.001**	-0.001**	-0.001	0.002	0.002	0.002
	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)
MB	0.002**	0.001	0.000	0.009*	0.008*	0.006
	(0.001)	(0.001)	(0.001)	(0.005)	(0.005)	(0.004)
ROA	0.005***	0.005**	0.004**	0.013	0.012	0.009
	(0.002)	(0.002)	(0.002)	(0.009)	(0.009)	(0.010)
CAPEX/ASSETS	0.025***	0.020***	0.015**	0.096**	0.039	0.020
	(0.006)	(0.007)	(0.007)	(0.038)	(0.037)	(0.033)
RET	-0.000	0.000	-0.000	-0.001	-0.001	-0.002
	(0.001)	(0.001)	(0.000)	(0.003)	(0.003)	(0.003)
HHI	-0.106**	-0.171***	-0.224***	-0.885***	-1.232***	-1.374**
	(0.041)	(0.044)	(0.065)	(0.322)	(0.420)	(0.591)
AVG_TENURE	0.000*	0.000*	0.000**	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
No. of obs.	15,998	14,235	12,378	15,998	14,235	12,378
Adjusted R^2	0.118	0.120	0.113	0.087	0.090	0.083
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

TABLE IA-2

The Effect of Management Quality on Market Value of Corporate Innovation

Table IA-2 reports the OLS regression results of the market value of patents filed by a firm in a given year on our management quality factor (MQF). ln(PATENT_MV) is the natural logarithm of one plus the market value of patents filed by a firm in a given year. The market value of a patent is computed as the firm's market-adjusted abnormal return over the three-day window around the date of patent approval multiplied by the firm's market capitalization on the day prior to the approval. ln(ASSET) is the natural logarithm of a firm's total assets; MB is Tobin's Q, defined as market value of assets divided by the book value of assets, where the market value of assets is computed as the book value of assets plus the market value of common stock less the book value of common stock; ROA is defined as operating income before depreciation divided by total assets; CAPEX/ASSETS is defined as capital expenditures divided by total assets; R&D/ASSETS is defined as research and development expenses divided by total assets; RET is a firm's annual stock return; HHI is the industry Herfindahl-Hirschman Index; and AVG_TENURE is the average number of years that each manager has worked as VP or higher in this firm. Constant, year fixed effects, and 2-digit SIC industry fixed effects are included in all regressions. All standard errors are adjusted for clustering at the firm level and are reported in parentheses below the coefficient estimates. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	$\ln(\text{PATENT\_MV})_{t+1}$	$\ln(\text{PATENT\_MV})_{t+2}$	$\ln(\text{PATENT\_MV})_{t+3}$
Variable	1	2	3
MQF	0.372***	0.378***	0.380***
	(0.030)	(0.032)	(0.034)
ln(ASSETS)	0.472***	0.454***	0.436***
	(0.015)	(0.015)	(0.016)
MB	0.459***	0.466***	0.447***
	(0.033)	(0.035)	(0.036)
ROA	-0.054	-0.025	-0.008
	(0.058)	(0.062)	(0.064)
CAPEX/ASSETS	-0.177	-0.109	-0.078
	(0.182)	(0.187)	(0.199)
R&D/ASSETS	0.691***	0.565***	0.496***
	(0.120)	(0.119)	(0.125)
RET	-0.076***	-0.076***	-0.047***
	(0.014)	(0.014)	(0.014)
HHI	0.906*	0.574	0.273
	(0.524)	(0.550)	(0.571)
AVG_TENURE	0.005	0.005	0.005
	(0.005)	(0.005)	(0.005)
No. of obs.	27,688	24,519	21,250
Adjusted R^2	0.438	0.425	0.410
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

TABLE IA-3

The Effect of Management Quality on Highly Successful, Unsuccessful, and Moderately Successful Innovations

Table IA-3 reports OLS regression results of the number of very successful (TOP_10), unsuccessful (NO_CITE), and moderately successful patents (M_CITE) on our management quality factor (MQF). Panels A, B, and C correspond to the regression results with dependent variables that are 1, 2, and 3 years ahead, respectively. TOP_10 is the natural logarithm of one plus a firm's number of patents that received cites within the top 10% among all patents in the same 3-digit patent class and application year; NO_CITE is the natural logarithm of one plus the number of patents that received no citation; M_CITE is the natural logarithm of one plus the number of patents that received at least one citation but below the top 10% among all patents. Columns 1-3 report the regression coefficients using Top_10, NO_CITE, and M_CITE as dependent variables, respectively; Columns 4-6 report and test the significance of difference between any two of the coefficient estimates in Columns 1-3. Control variables are the same as in Table 5 in all regressions and results are not reported to save space. Constant, year fixed effects, and 2-digit SIC industry fixed effects are included in all regressions. All standard errors are adjusted for clustering at the firm level and are reported in parentheses below the coefficient estimates. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. The Effect of MQF on 1-year-ahead Patenting

	TOP_10_{t+1}	NO_CITE_{t+1}	M_CITE_{t+1}	Dif 1-2	Dif 1-3	Dif 2-3
Variable	1	2	3	4	5	6
MQF	0.338***	0.146***	0.134***	0.192***	0.204***	0.012**
	(0.027)	(0.012)	(0.014)	(0.016)	(0.016)	(0.005)
No. of obs.	27,688	27,688	27,688			
Adjusted R^2	0.417	0.359	0.378			
Controls	Yes	Yes	Yes			
Industry FE	Yes	Yes	Yes			
Year FE	Yes	Yes	Yes			

Panel B. The Effect of MQF on 2-year-ahead Patenting

	TOP_10_{t+2}	NO_CITE_{t+2}	M_CITE_{t+2}	Dif 1-2	Dif 1-3	Dif 2-3
Variable	1	2	3	4	5	6
MQF	0.335***	0.148***	0.130***	0.187***	0.205***	0.018***
	(0.029)	(0.013)	(0.014)	(0.017)	(0.017)	(0.006)
No. of obs.	24,519	24,519	24,519			
Adjusted R^2	0.409	0.357	0.369			
Controls	Yes	Yes	Yes			
Industry FE	Yes	Yes	Yes			
Year FE	Yes	Yes	Yes			

Panel C. The Effect of MQF on 3-year-ahead Patenting

	TOP_10_{t+3}	NO_CITE_{t+3}	M_CITE_{t+3}	Dif 1-2	Dif 1-3	Dif 2-3
Variable	1	2	3	4	5	6
MQF	0.332***	0.146***	0.126***	0.186***	0.206***	0.020***
	(0.031)	(0.014)	(0.015)	(0.018)	(0.019)	(0.006)
No. of obs.	21,250	21,250	21,250			
Adjusted R^2	0.400	0.354	0.355			
Controls	Yes	Yes	Yes			
Industry FE	Yes	Yes	Yes			
Year FE	Yes	Yes	Yes			

TABLE IA-4

The Effect of Management Quality on Corporate Innovation: Interaction Tests

Table IA-4 reports the main regression results interacted with relevant variables. Columns 1-3 summarize the regression results with our management quality factor (MQF) interacted with industry financial constraints, using the number of patents, the total number of citations, and the number of citations per patent for a firm in a given year as dependent variables, respectively. CONSTRAINED is a dummy variable, which is equal to one if the value of external finance dependence is larger than zero and zero otherwise. External finance dependence for an industry (defined at 2-digit SIC level) in a given year is defined by the method outlined in Rajan and Zingales (1998). Columns 4-6 summarize regression results with MQF interacted with industry Herfindahl-Hirschman Index (HHI), using the number of patents, the total number of citations, and the number of citations per patent for a firm in a given year as dependent variables, respectively. ln(PATENT) is the natural logarithm of one plus the truncation-adjusted number of patents filed by a firm in a given year; ln(CITE) is the natural logarithm of one plus the total adjusted number of citations received by the patents filed by a firm in a given year; ln(CPP) is the natural logarithm of one plus the adjusted number of citations per patent. Control variables are the same as in Table 5 in all regressions and results are not reported to save space. Constant, year fixed effects, and 2-digit SIC industry fixed effects are included in all regressions. All standard errors are adjusted for clustering at the firm level and are reported in parentheses below the coefficient estimates. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	$\ln(PATENT)_{t+1}$	$\ln(CITE)_{t+1}$	$\ln(CPP)_{t+1}$	$\ln(PATENT)_{t+1}$	$\ln(CITE)_{t+1}$	$\ln(CPP)_{t+1}$
Variable	1	2	3	4	5	6
MQF	0.105***	0.013***	0.001***	0.174***	0.021***	0.001***
	(0.012)	(0.002)	(0.000)	(0.015)	(0.002)	(0.000)
MQF×CONSTRAINED	0.077***	0.010***	-0.000			
	(0.021)	(0.003)	(0.000)			
CONSTRAINED	0.011	-0.005***	-0.000***			
	(0.011)	(0.002)	(0.000)			
MQF×HHI				-0.775***	-0.078***	-0.002*
				(0.140)	(0.022)	(0.001)
HHI	0.127	-0.011	-0.005**	0.128	-0.019	-0.005**
	(0.184)	(0.033)	(0.002)	(0.179)	(0.032)	(0.002)
No. of obs.	27,688	27,688	27,688	27,688	27,688	27,688
Adjusted R^2	0.392	0.258	0.140	0.393	0.257	0.140
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

TABLE IA-5

The Effect of Management Quality on the Net Change in the Average Quality of Inventors

Table IA-5 reports the OLS regression results of the change in the average quality of inventors for a firm in a given year on our management quality factor (MQF). NET_QUALITY_CHG is defined as the difference between INCOMING_QUALITY and OUTGOING_QUALITY, where INCOMING_QUALITY is the natural logarithm of one plus the average quality of all the inventors that move into the firm in a given year and OUTGOING_QUALITY is natural logarithm of one plus the average quality of all the inventors that move out of the firm in a given year. Inventor quality is measured by the number of citations scaled by total number of patents that an inventor has filed prior to the current year. ln(ASSETS) is the natural logarithm of a firm's total assets; MB is Tobin's Q, defined as market value of assets divided by the book value of assets, where the market value of assets is computed as the book value of assets plus the market value of common stock less the book value of common stock; ROA is defined as operating income before depreciation divided by total assets; CAPEX/ASSETS is defined as capital expenditures divided by total assets; R&D/ASSETS is defined as research and development expenses divided by total assets; RET is a firm's annual stock return; HHI is the industry Herfindahl-Hirschman Index; and AVG_TENURE is the average number of years that each manager has worked as VP or higher in this firm. Constant, year fixed effects, 2-digit SIC industry fixed effects, and state fixed effects are included in all regressions. All standard errors are adjusted for clustering at the firm level and are reported in parentheses below the coefficient estimates. Coefficients and standard errors are multiplied by 100 for ease of reading. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	$NET\_QUALITY\_CHG_{t+1}$	$NET\_QUALITY\_CHG_{t+2}$	$NET\_QUALITY\_CHG_{t+3}$
Variable	1	2	3
MQF	0.017***	0.016***	0.021***
	(0.006)	(0.005)	(0.005)
ln(ASSETS)	0.030***	0.027***	0.024***
	(0.002)	(0.002)	(0.002)
MB	0.025***	0.025***	0.024***
	(0.006)	(0.006)	(0.006)
ROA	0.010	0.007	0.012
	(0.013)	(0.013)	(0.013)
CAPEX/ASSETS	0.074**	0.086**	0.034
	(0.037)	(0.039)	(0.039)
R&D/ASSETS	0.102***	0.056**	0.038
	(0.031)	(0.027)	(0.028)
RET	-0.008*	-0.001	-0.002
	(0.004)	(0.004)	(0.004)
HHI	-0.204	-0.161	-0.101
	(0.156)	(0.144)	(0.148)
AVG_TENURE	-0.001	-0.001	-0.000
	(0.001)	(0.001)	(0.001)
No. of obs.	25,945	23,096	20,119
Adjusted R^2	0.087	0.083	0.079
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes

TABLE IA-6

The Effect of Management Quality on the Total Number of Citations and Citations per Patent: Instrumental Variable Analysis

Panels A and B of Table IA-6 report second-stage regression results of the total number of citations and the number of citations per patent on our management quality factor (MQF). The instrumental variable that we use is described in Section VI.A. ln(CITE) is the natural logarithm of one plus the total adjusted number of citations received by the patents filed by a firm in a given year; ln(CPP) is the natural logarithm of one plus the adjusted number of citations per patent. ACQ_{t-5} is the total number of acquisitions in the sample firm's industry 5 years prior. ln(ASSETS) is the natural logarithm of a firm's total assets; MB is Tobin's Q, defined as market value of assets divided by the book value of assets, where the market value of assets is computed as the book value of assets plus the market value of common stock less the book value of common stock; ROA is defined as operating income before depreciation divided by total assets; CAPEX/ASSETS is defined as capital expenditures divided by total assets; R&D/ASSETS is defined as research and development expenses divided by total assets; RET is a firm's annual stock return; HHI is the industry Herfindahl-Hirschman Index; and AVG_TENURE is the average number of years that each manager has worked as VP or higher in this firm. Constant, year fixed effects, 2-digit SIC industry fixed effects, and state fixed effects are included in all regressions. All standard errors are adjusted for clustering at the firm level and are reported in parentheses below the coefficient estimates. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Second-Stage Results of the Total Number of Citations on MQF

	$\ln(\text{CITE})_{t+1}$	$\ln(\text{CITE})_{t+2}$	$\ln(\text{CITE})_{t+3}$
Variable	1	2	3
MQF	0.083***	0.054**	0.057**
	(0.022)	(0.024)	(0.028)
ACQ_{t-5}	0.000	0.000*	0.000
	(0.000)	(0.000)	(0.000)
ln(ASSETS)	0.013***	0.014***	0.014***
	(0.002)	(0.002)	(0.002)
MB	0.001	0.006	0.005
	(0.004)	(0.005)	(0.005)
ROA	0.003	-0.002	-0.001
	(0.005)	(0.005)	(0.006)
CAPEX/ASSETS	0.046**	0.021	0.022
	(0.020)	(0.020)	(0.021)
R&D/ASSETS	-0.018**	-0.015**	-0.016**
	(0.008)	(0.007)	(0.008)
RET	0.000	-0.001	-0.000
	(0.001)	(0.001)	(0.002)
AVG_TENURE	0.003***	0.002**	0.002*
	(0.001)	(0.001)	(0.001)
HHI	0.001	-0.009	-0.001
	(0.039)	(0.037)	(0.035)
No. of obs.	25,945	23,096	20,119
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes

Panel B. Second-Stage Results of the Number of Citations per Patent on MQF

	$\ln(\text{CPP})_{t+1}$	$\ln(\text{CPP})_{t+2}$	$\ln(\text{CPP})_{t+3}$
Variable	1	2	3
MQF	0.004**	0.004**	0.001
	(0.002)	(0.002)	(0.002)
ACQ_{t-5}	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)

ln(ASSETS)	0.000***	0.000***	0.001***
	(0.000)	(0.000)	(0.000)
MB	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)
ROA	0.001	0.000	-0.000
	(0.000)	(0.000)	(0.000)
CAPEX/ASSETS	0.002	0.002	-0.000
	(0.001)	(0.001)	(0.002)
R&D/ASSETS	-0.000	-0.001	0.000
	(0.001)	(0.001)	(0.001)
RET	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)
AVG_TENURE	0.000**	0.000*	0.000
	(0.000)	(0.000)	(0.000)
HHI	-0.004	-0.003	-0.002
	(0.003)	(0.003)	(0.002)
No. of obs.	25,945	23,096	20,119
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes

TABLE IA-7

Robustness Test: The Effect of Management Quality on Corporate Innovation for Innovative Firms Only

Table IA-7 reports the OLS regression results of corporate innovation on our management quality factor (MQF) using innovative firms only. Innovative firms are defined as firms that have filed at least one patent application over our sample period of 1999-2009. Panels A, B, and C report regression results with the number of patents, the total number of citations, and the number of citations per patent as dependent variables, respectively. ln(PATENT) is the natural logarithm of one plus the truncation-adjusted number of patents filed by a firm in a given year; ln(CITE) is the natural logarithm of one plus the total adjusted number of citations received by the patents filed by a firm in a given year; ln(CPP) is the natural logarithm of one plus the adjusted number of citations per patent. Control variables are the same as in Table 5 in all regressions and results are not reported to save space. Constant, year fixed effects, and 2-digit SIC industry fixed effects are included in all regressions. All standard errors are adjusted for clustering at the firm level and are reported in parentheses below the coefficient estimates. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A.. The Effect of MQF on the Number of Patents

	$\ln(\text{PATENT})_{t+1}$	$\ln(\text{PATENT})_{t+2}$	$\ln(\text{PATENT})_{t+3}$
Variable	1	2	3
MQF	0.134***	0.138***	0.136***
	(0.016)	(0.017)	(0.017)
No. of obs.	15,251	13,742	12,118
Adjusted R^2	0.426	0.423	0.416
Controls	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Panel B. The Effect of MQF on the Total Number of Citations

	$\ln(\text{CITE})_{t+1}$	$\ln(\text{CITE})_{t+2}$	$\ln(\text{CITE})_{t+3}$
Variable	1	2	3
MQF	0.018***	0.018***	0.018***
	(0.003)	(0.003)	(0.003)
No. of obs.	15,251	13,742	12,118
Adjusted R^2	0.292	0.286	0.274
Controls	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Panel C. The Effect of MQF on the Number of Citations per Patent

	$\ln(\text{CPP})_{t+1}$	$\ln(\text{CPP})_{t+2}$	$\ln(\text{CPP})_{t+3}$
Variable	1	2	3
MQF	0.000***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
No. of obs.	15,251	13,742	12,118
Adjusted R^2	0.110	0.113	0.113
Controls	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

TABLE IA-8

Robustness Test: MQF without Team Size

Table IA-8 reports the OLS regression results for corporate innovation with management quality factor without team size (MQF_NO_TEAM_SIZE) as the key independent variable. MQF_NO_TEAM_SIZE is defined in the same way as MQF except that we exclude team size in the common factor analysis. Panels A, B, and C report regression results with the number of patents, the total number of citations, and the number of citations per patent as dependent variables, respectively. ln(PATENT) is the natural logarithm of one plus the truncation-adjusted number of patents filed by a firm in a given year; ln(CITE) is the natural logarithm of one plus the total adjusted number of citations received by the patents filed by a firm in a given year; ln(CPP) is the natural logarithm of one plus the adjusted number of citations per patent. Control variables are the same as in Table 5 in all regressions and results are not reported to save space. Constant, year fixed effects, and 2-digit SIC industry fixed effects are included in all regressions. All standard errors are adjusted for clustering at the firm level and are reported in parentheses below the coefficient estimates. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. The Effect of MQF-No Team Size on the Number of Patents

	ln(PATENT)$_{t+1}$	ln(PATENT)$_{t+2}$	ln(PATENT)$_{t+3}$
Variable	1	2	3
MQF_NO_TEAM_SIZE	0.083***	0.077***	0.068***
	(0.011)	(0.011)	(0.012)
No. of obs.	27,688	24,519	21,250
Adjusted R^2	0.375	0.368	0.359
Controls	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Panel B. The Effect of MQF-No Team Size on the Total Number of Citations

	ln(CITE)$_{t+1}$	ln(CITE)$_{t+2}$	ln(CITE)$_{t+3}$
Variable	1	2	3
MQF_NO_TEAM_SIZE	0.008***	0.007***	0.006***
	(0.002)	(0.002)	(0.002)
No. of obs.	27,688	24,519	21,250
Adjusted R^2	0.242	0.237	0.227
Controls	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Panel C. The Effect of MQF-No Team Size on the Number of Citations per Patent

	ln(CPP)$_{t+1}$	ln(CPP)$_{t+2}$	ln(CPP)$_{t+3}$
Variable	1	2	3
MQF_NO_TEAM_SIZE	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
No. of obs.	27,688	24,519	21,250
Adjusted R^2	0.136	0.135	0.131
Controls	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

TABLE IA-9

Robustness Test: Controlling for Industry×Year×State Fixed Effects

Table IA-9 replicates the baseline regression results of corporate innovation on our management quality factor (MQF) as in Table 5 controlling for industry×year×state fixed effects. Panels A, B, and C report the OLS regression results with the number of patents, the total number of citations, and the number of citations per patent as dependent variables, respectively. ln(PATENT) is the natural logarithm of one plus the truncation-adjusted number of patents filed by a firm in a given year; ln(CITE) is the natural logarithm of one plus the total adjusted number of citations received by the patents filed by a firm in a given year; ln(CCP) is the natural logarithm of one plus the adjusted number of citations per patent. Control variables are the same as in Table 5 in all regressions and results are not reported to save space. Constant and industry×year×state fixed effects are included in all regressions. All standard errors are adjusted for clustering at the firm level and are reported in parentheses below the coefficient estimates. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. The Effect of MQF on the Number of Patents

	$\ln(\text{PATENT})_{t+1}$	$\ln(\text{PATENT})_{t+2}$	$\ln(\text{PATENT})_{t+3}$
Variable	1	2	3
MQF	0.158***	0.158***	0.157***
	(0.015)	(0.016)	(0.016)
No. of obs.	25,945	23,096	20,119
Adjusted R^2	0.370	0.365	0.351
Controls	Yes	Yes	Yes
Industry×Year×State FE	Yes	Yes	Yes

Panel B. The Effect of MQF on the Total Number of Citations

	$\ln(\text{CITE})_{t+1}$	$\ln(\text{CITE})_{t+2}$	$\ln(\text{CITE})_{t+3}$
Variable	1	2	3
MQF	0.020***	0.019***	0.019***
	(0.002)	(0.002)	(0.003)
No. of obs.	25,945	23,096	20,119
Adjusted R^2	0.237	0.232	0.217
Controls	Yes	Yes	Yes
Industry×Year×State FE	Yes	Yes	Yes

Panel C. The Effect of MQF on the Number of Citations per Patent

	$\ln(\text{CPP})_{t+1}$	$\ln(\text{CPP})_{t+2}$	$\ln(\text{CPP})_{t+3}$
Variable	1	2	3
MQF	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
No. of obs.	25,945	23,096	20,119
Adjusted R^2	0.153	0.144	0.133
Controls	Yes	Yes	Yes
Industry×Year×State FE	Yes	Yes	Yes