Internet Appendix for

"The Exploratory Mindset and Corporate Innovation"

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In this Internet Appendix, we discuss additional robustness checks and results. As including too many endogenous controls could bias the coefficients on PHD_CEO, we rerun our baseline specification without any controls. Panel A of Table IA.14 shows very similar results as those in Table 2. We also add more controls of potential CEO characteristics that could be driving the observed relation between PhD CEOs and innovation. These variables are CEO_OVERCONFIDENCE, INVENTOR_CEO, HIGH_LATENT_ABILITY, IVY_LEAGUE, RECESSION_CEO, CEO_ENGINEER/SCIENCE, and GENERAL_ABILITY. Panel B finds that the relation is robust to the inclusion of these measures and remains similar magnitudes as discussed previously.

To address the possibilities that these traits might lead PhD CEOs to respond differently to the passage of PP laws, we control for interactions of PP_LAW and these characteristics using Equation (3). We find in Table IA.15 that our key results are unaffected, suggesting that PhD CEOs' innovative behavior cannot be solely explained by their superior ability, confidence, the experience of being an inventor and engineer/science backgrounds. We also find little evidence that CEOs with these traits innovate or explore more after the legal shock. In unreported tests, our results hold after controlling interactions of the law indicator with all baseline controls.

Table IA.16 presents additional robustness checks. We find that the main conclusions derived earlier remain strong. In Panel A, we employ an estimation that includes industry × year fixed effects to control for time-varying innovation shocks to a specific industry. Panel B shows the results after excluding firms headquartered in California or Massachusetts to assure that our findings are not driven by the two states that both have clusters of innovative firms and research universities. To address the concern that high-tech industries where innovation is particularly important might be responsible for the observed effects, we remove these industries and report results in Panel C. We also exclude the dot.com boom period of 1998-2000, and find similar results in Panel D. Lastly, the effects we document might be driven by degrees in technical fields. We thus control for CEOs with technical degrees at all academic levels using available information. We see in Panel E that our main results still hold.

Table IA.1. PhD Degrees in Tech/Science Fields

This table presents the Tobit regression results on firm innovation after including PHD_ENGINEER/SCIENCE and PHD_ MEDICINE. **Panel A** reports results for 1-year forward innovation measures. The dependent variables are the natural logarithm of one plus total number of patents (ln(PAT)), the natural logarithm of one plus total number of citations (ln(CITE)), the natural logarithm of one plus total number of adjusted citations (ln(ADJ_CITE)), the natural logarithm of one plus citations per patent (ln(CITE_PAT)) and the average generality (GEN) and originality (ORG) scores of patents. **Panel B** reports results for 1-year forward exploratory innovation measures. The dependent variables are the natural logarithm of one plus total number of exploratory patents (ln(EXPLORE60) or ln(EXPLORE80)), the natural logarithm of one plus highly cited innovations (ln(TOP_CITE5) or ln(TOP_CITE10)), the natural logarithm of one plus failed innovations (ln(UNCITED)), and the natural logarithm of one plus number of patents filed in technology classes new to the firm (ln(NEW_CLASS)). PHD_CEO equals one if the CEO has doctorate degrees, and zero otherwise. All regressions include baseline controls. The t-statistics in parentheses are based on robust standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Innovation

Dependent Variable:	ln(PAT)	ln(CITE)	ln(ADJ_ CITE)	ln(CITE_PAT)	GEN	ORG
	(1)	(2)	(3)	(4)	(5)	(6)
PHD_CEO	0.602***	0.910***	0.629***	0.424***	0.078***	0.098***
	(3.701)	(3.409)	(3.350)	(3.246)	(3.129)	(3.345)
PHD_ENGINEER/SCIENCE	0.947***	1.728***	1.094***	0.788**	0.108	0.073
	(3.395)	(3.264)	(2.757)	(2.513)	(1.423)	(1.154)
PHD_ MEDICINE	-0.009	-0.279	0.040	-0.321	-0.051	-0.070
	(-0.011)	(-0.209)	(0.045)	(-0.485)	(-0.349)	(-0.489)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry & year FEs	Yes	Yes	Yes	Yes	Yes	Yes
N	12895	12895	12895	12895	12895	12895
Pseudo R^2	0.2587	0.2229	0.2480	0.2276	0.4666	0.3600

Panel B. Exploratory Innovation

Dependent Variable:	ln(EXPLOR E60)	ln(EXPLOR E80)	ln(TOP_CITE 5)	ln(TOP_CITE 10)	ln(UNCIT ED)	ln(NEW_ CLASS)
	(1)	(2)	(3)	(4)	(5)	(6)
PHD_CEO	0.523***	0.483***	0.326**	0.603***	0.442***	0.333***
	(3.551)	(3.465)	(2.093)	(2.926)	(3.156)	(3.900)
PHD_ENGINEER/SCIENCE	0.662**	0.603**	0.806*	1.011*	0.573	0.413**
	(2.322)	(2.057)	(1.951)	(1.792)	(1.528)	(2.018)
PHD_ MEDICINE	0.043	0.211	0.245	0.447	0.662	-1.051**
	(0.057)	(0.289)	(0.383)	(0.542)	(0.979)	(-2.512)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry & year FEs	Yes	Yes	Yes	Yes	Yes	Yes
N	12895	12895	12895	12895	12895	12895
Pseudo R^2	0.2679	0.2736	0.2847	0.2563	0.2960	0.2640

Table IA.2. Alternative Mechanism of Poison Pill Laws on Innovation: Career Concern Channel

This table reports the regression results examining the differential effect of state adoption of poison pill laws on innovation of firms with more conservative CEOs who tend to have greater career concerns. The dependent variables are three-year forward measures of the natural logarithm of one plus total number of patents (ln(PAT)), the natural logarithm of one plus total number of citations (ln(CITE)), and the natural logarithm of one plus total number of exploratory patents (ln(EXPLORE60)). PP_Law is an indicator equal to one if a poison pill law is in place in the firm's state of incorporation in a given year, and zero otherwise. LOW_CONFIDENCE is an indicator equal to one if a CEO is not overly confident proxied by his stock option exercising behavior. RECESSION_CEO is an indicator equal to one if a CEO entered the labor market during a recession when he turned 24 years old. Recession years are based on the business cycle dating database of the National Bureau of Economic Research (NBER). All regressions include controls, firm fixed effects, industry × year, state of headquarters × year and state of incorporation fixed effects. The t-statistics in parentheses are based on robust standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Dependent Variable:	ln(PAT)	ln(CITE)	ln(EXPLORE 60)	ln(PAT)	ln(CITE)	ln(EXPLORE60)
	(1)	(2)	(3)	(4)	(5)	(6)
PP_LAW	0.021	0.001	0.040			
× LOW_CONFIDENCE	(0.463)	(0.017)	(0.926)			
LOW_CONFIDENCE	-0.024	-0.102***	-0.053***			
	(-1.559)	(-3.101)	(-4.028)			
PP_LAW				-0.099	-0.292*	-0.061
× RECESSION_CEO				(-1.177)	(-1.906)	(-0.775)
RECESSION_CEO				0.039	0.147***	-0.052*
				(1.285)	(3.554)	(-1.939)
PP_LAW	-0.105	0.046	-0.234**	-0.067	0.121	-0.216*
	(-1.462)	(0.255)	(-2.185)	(-0.955)	(0.726)	(-1.947)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State of HQ × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State of Incorporation FE	Yes	Yes	Yes	Yes	Yes	Yes
N	7754	7754	7754	7754	7754	7754
Adjusted R^2	0.9293	0.8938	0.8855	0.9293	0.8938	0.8855

Table IA.3. Timing of the Differential Treatment Effect of Poison Pill Laws

This table reports the regression results examining the timing of the differential treatment effect on innovation of firms with and without PhD CEOs after state adoption of poison pill laws. Innovation outcomes are measured by ln(PAT), ln(CITE), and ln(EXPLORE60). The dependent variable is one of the innovation measures in three-year prior to, two-year prior to, one-year prior to, current year, one-year post to, two-year post to, and three-year post to the passage of PP laws, respectively. PP_LAW is an indicator equal to one if a poison pill law is in place in the firm's state of incorporation in a given year, and zero otherwise. PHD_CEO equals one if the CEO has doctorate degrees, and zero otherwise. All regressions include all controls, firm fixed effects, industry × year fixed effects, state of headquarters × year fixed effects and state of incorporation fixed effects. The t-statistics in parentheses are based on robust standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable: ln(PAT) in year	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$
PP_LAW × PHD_CEO	0.133	0.195	0.160	0.186	**0.250***	**0.425*****	**0.547*****
	(1.186)	(1.415)	(1.078)	(1.481)	**(1.972)**	**(3.220)**	**(3.710)**
N	9404	10798	12406	14261	12614	10049	7754
Adjusted R^2	0.9216	0.9182	0.9155	0.9127	0.9169	0.9229	0.9297
Dependent Variable: ln(CITE) in year	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$
PP_LAW × PHD_CEO	0.132	0.169	0.054	0.106	0.133	**0.428*****	**0.639*****
	(0.774)	(0.873)	(0.264)	(0.678)	(0.825)	**(3.108)**	**(4.823)**
N	9404	10798	12406	14261	12614	10049	7754
Adjusted R^2	0.8841	0.8814	0.8781	0.8745	0.8805	0.8861	0.8939
Dependent Variable: ln(EXPLORE60) in year	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$
PP_LAW × PHD_CEO	0.137	0.240	0.192	0.183	0.189	**0.315****	**0.429****
	(1.196)	(1.590)	(1.133)	(1.234)	(1.232)	**(2.168)**	**(2.579)**
N	9404	10798	12406	14261	12614	10049	7754
Adjusted R^2	0.9092	0.8978	0.8931	0.8882	0.8792	0.8831	0.8857
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State of headquarters × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State of incorporation FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table IA.4. Possible Time-varying State-level Heterogeneity

This table reports the regression results examining the differential effect of state adoption of poison pill laws on innovation of firms run by PhD CEOs. The dependent variables are three-year forward measures of the natural logarithm of one plus total number of patents (ln(PAT)), the natural logarithm of one plus total number of citations (ln(CITE)), the natural logarithm of one plus total number of adjusted citations (ln(ADJ_CITE)), the natural logarithm of one plus total number of exploratory patents (ln(EXPLORE60) or ln(EXPLORE80)), and the natural logarithm of one plus market value of all new patents. PP_LAW is an indicator equal to one if a poison pill law is in place in the firm's state of incorporation in a given year, and zero otherwise. PHD_CEO equals one if the CEO has doctorate degrees, and zero otherwise. All regressions include controls, firm fixed effects, industry × year, state of headquarters × year and state of incorporation × year fixed effects. The t-statistics in parentheses are based on robust standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Dependent Variable:	ln(PAT)	ln(CITE)	ln(ADJ_CITE)	ln(EXPLORE 60)	ln(EXPLORE 80)	ln(PAT_ VAL)
	(1)	(2)	(3)	(4)	(5)	(6)
PP_LAW × PHD_CEO	0.517***	0.539***	0.456***	0.373**	0.361*	0.659**
	(3.045)	(3.760)	(3.192)	(2.207)	(2.018)	(2.650)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State of Headquarters × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State of Incorporation FE × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	7555	7555	7555	7555	7555	7555
Adjusted R^2	0.9296	0.8943	0.9100	0.8845	0.8730	0.9061

Table IA.5. First-Differences Regressions

This table presents the OLS regression results of change in firm innovation on change in PhD CEO using a first-differences specification. The dependent variables are changes of one-year forward changes in the innovation measures: the natural logarithm of one plus total number of patents (ln(PAT)), the natural logarithm of one plus total number of citations (ln(CITE)), the natural logarithm of one plus total number of adjusted citations (ln(ADJ_CITE)), the natural logarithm of one plus citations per patent (ln(CITE_PAT)) and the average generality and originality scores of patents. Δ PHD_CEO is the change in PHD_CEO, which is an indicator equal to one if the CEO has doctorate degrees, and zero otherwise. All the regressions include year and industry (2-digit SIC code) fixed effects. The sample comprises all non-financial and non-utility U.S. industrial firms from 1992 to 2009 in the intersection of ExecuComp, BoardEx, Compustat, KPSS patent database, and CRSP. All variables are defined in Appendix A. The t-statistics in parentheses are based on robust standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Dependent Variable:	Δ ln(PAT)	Δ ln(CITE)	Δ ln(ADJ_CITE)	Δ ln(CITE_PAT)	Δ GEN	Δ ORG
	(1)	(2)	(3)	(4)	(5)	(6)
Δ PHD_CEO	0.138***	0.252***	0.135***	0.139***	0.025**	0.033**
	(3.525)	(3.578)	(2.608)	(2.876)	(2.106)	(2.157)
Δ CEO_MBA_DEGREE	0.029	0.079*	0.046	0.055*	0.013*	0.000
	(1.124)	(1.768)	(1.367)	(1.860)	(1.850)	(0.028)
Δ CEO_LAW_DEGREE	-0.050	-0.012	-0.064	0.038	0.011	-0.004
	(-1.285)	(-0.150)	(-0.913)	(0.744)	(1.059)	(-0.322)
Δ SIZE	0.112***	0.188***	0.126***	0.069	0.014	-0.001
	(3.652)	(2.739)	(3.076)	(1.587)	(1.612)	(-0.056)
Δ ln(AGE)	0.185**	0.360**	0.161	0.078	0.002	-0.015
	(2.275)	(2.026)	(1.550)	(0.641)	(0.094)	(-0.545)
Δ TANGIBILITY	0.209**	0.340	0.127	0.111	0.018	0.018
	(2.073)	(1.530)	(0.963)	(0.748)	(0.558)	(0.438)
Δ TOBINS_Q	-0.009	-0.006	-0.011	-0.006	-0.001	-0.002
	(-1.001)	(-0.281)	(-0.920)	(-0.396)	(-0.262)	(-0.652)
Δ SALES_GROWTH	-0.047**	-0.086*	-0.048*	-0.033	-0.008	-0.005
	(-2.150)	(-1.854)	(-1.741)	(-0.973)	(-1.121)	(-0.514)
Δ LEVERAGE	-0.018	-0.022	0.030	-0.016	-0.018	0.027
	(-0.251)	(-0.152)	(0.309)	(-0.166)	(-0.759)	(1.054)
Δ STOCK_RETURN	0.002	-0.005	-0.011	-0.002	-0.002	0.002
	(0.262)	(-0.386)	(-1.407)	(-0.205)	(-0.916)	(0.756)
Δ INST_OWN	-0.098*	-0.139	-0.123*	-0.025	0.010	-0.030*
	(-1.697)	(-1.432)	(-1.755)	(-0.402)	(0.737)	(-1.702)
Δ ln(CEO_DELTA)	-0.001	0.004	0.009	0.001	-0.000	-0.001
	(-0.127)	(0.229)	(0.770)	(0.049)	(-0.058)	(-0.301)
Δ ln(CEO_VEGA)	-0.008	-0.012	-0.007	-0.004	0.000	-0.001
	(-1.213)	(-0.828)	(-0.816)	(-0.345)	(0.110)	(-0.347)
Δ CEO_STOCK_OWN	0.245	0.455	0.246	0.276	0.023	0.056
	(1.000)	(0.676)	(0.797)	(0.610)	(0.372)	(0.774)
Industry & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	10842	10842	10842	10842	10842	10842
Adjusted R^2	0.0083	0.0154	0.0124	0.0090	0.0028	0.0038

Table IA.6. Propensity Score Matching Analysis

This table presents the results on the relation between PhD CEOs and firm innovation using a propensity score matched sample. Treated firms are defined as firms that hired a PhD CEO. Each treated firm is matched to firms that hired a non-PhD CEO using propensity score matching (with replacement and a radius of 1%). Firms are matched in the hiring year by firm's SIZE, TOBINS_Q, ln(AGE), LEVERAGE, TANGIBILITY, R&D, IND_ADJ_PROFIT_MARGIN, MARKET_ADJ_RETURN, and ln(PAT) . **Panel A** reports the results of balance tests of matched treatment and control groups in the first year of CEO appointment. **Panel B** presents the OLS regression results using the matched samples. The dependent variables are one-year forward: the natural logarithm of one plus total number of patents (ln(PAT)), the natural logarithm of one plus total number of citations (ln(CITE)), the natural logarithm of one plus total number of adjusted citations (ln(ADJ_ CITE)), the natural logarithm of one plus citations per patent (ln(CITE_PAT)) and the average generality and originality scores of patents. The full sample comprises all non-financial and non-utility U.S. industrial firms from 1992 to 2009 in the intersection of ExecuComp, BoardEx, Compustat, KPSS patent database, and CRSP. All variables are defined in Appendix A. The t-statistics in parentheses are based on robust standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Balance Tests

Sample	Firms hiring PhD CEOs n=51	Firms hiring non-PhD CEOs n=238		
Variable	Mean	Mean	Diff.	p-value
SIZE	7.96	7.48	0.49	0.05*
R&D	0.04	0.04	0.00	0.67
IND_ADJ_PROFIT_MARGIN	-0.03	-0.03	-0.01	0.72
MARKET_ADJ_RETURN	-0.01	0.02	-0.03	0.69
TOBINS_Q	1.93	1.86	0.07	0.72
ln(AGE)	3.20	3.06	0.14	0.20
LEVERAGE	0.21	0.20	0.01	0.63
TANGIBILITY	0.30	0.29	0.01	0.71

Panel B. Multivariate Tests

Dependent Variable:	ln(PAT)	ln(CITE)	ln(ADJ_ CITE)	ln(CITE_PAT)	GEN	ORG
	(1)	(2)	(3)	(4)	(5)	(6)
PHD_CEO	0.521***	0.928***	0.555**	0.363**	0.057**	0.047*
	(2.674)	(2.807)	(2.537)	(2.145)	(2.157)	(1.927)
R&D	14.118***	19.871***	14.232***	7.194***	1.259***	1.498***
	(7.550)	(6.518)	(6.858)	(4.901)	(4.505)	(5.481)
IND_ADJ_PROFIT_MARGIN	0.591*	1.151**	0.336	0.693**	0.112**	0.068
	(1.855)	(2.250)	(0.908)	(2.558)	(2.312)	(1.072)
MARKET_ADJ_RETURN	-0.094*	-0.045	-0.086	0.012	-0.001	0.006
	(-1.813)	(-0.489)	(-1.357)	(0.229)	(-0.128)	(0.632)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	1528	1528	1528	1528	1528	1528
Adjusted R^2	0.6811	0.5995	0.5887	0.4358	0.3611	0.4508

Table IA.7. Excluding Firms with Short-Tenured CEOs

This table presents the Tobit regression results on the relation between PhD CEOs and innovation after excluding firms with CEOs having tenure less than three years (Panel A) or five years (Panel B). The dependent variables are one-year forward natural logarithm of one plus total number of patents (ln(PAT)), the natural logarithm of one plus total number of citations (ln(CITE)), the natural logarithm of one plus total number of adjusted citations (ln(ADJ_CITE)), the natural logarithm of one plus citations per patent (ln(CITE_PAT)) and the average generality (GEN) and originality (ORG) scores of patents. PHD_CEO is an indicator equal to one if a CEO has doctorate degrees, and zero otherwise. All the regressions include baseline controls, year and industry (2-digit SIC code) fixed effects. The sample comprises all non-financial and non-utility U.S. industrial firms from 1992 to 2009 in the intersection of ExecuComp, BoardEx, Compustat, KPSS patent database, and CRSP. All variables are defined in Appendix A. The t-statistics in parentheses are based on robust standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Excluding CEOs Having Tenure Less Than Three Years

Dependent Variable:	ln(PAT)	ln(CITE)	ln(ADJ_ CITE)	ln(CITE_PAT)	GEN	ORG
	(1)	(2)	(3)	(4)	(5)	(6)
PHD_CEO	0.724***	1.135***	0.798***	0.526***	0.099***	0.112***
	(3.772)	(3.528)	(3.599)	(3.298)	(3.270)	(3.196)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	8117	8117	8117	8117	8117	8117
Pseudo R^2	0.2619	0.2257	0.2502	0.2354	0.4707	0.3701

Panel B. Excluding CEOs Having Tenure Less Than Five Years

Dependent Variable:	ln(PAT)	ln(CITE)	ln(ADJ_ CITE)	ln(CITE_PAT)	GEN	ORG
	(1)	(2)	(3)	(4)	(5)	(6)
PHD_CEO	0.674***	1.071***	0.753***	0.517***	0.085**	0.109***
	(3.116)	(2.937)	(3.016)	(2.878)	(2.409)	(2.775)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	6227	6227	6227	6227	6227	6227
Pseudo R^2	0.2651	0.2284	0.2522	0.2403	0.4720	0.3730

Table IA.8. Longer-Term Investments in Research under Greater Pressure

This table presents the OLS regression results on the relation between PhD CEOs and longer-term R&D spending among CEOs under greater pressure or career concerns. The dependent variable is R&D (over assets) in year $t + 3$. Model (1) uses the subsample of CEOs in relatively high-pressure environments—firms with above median analyst coverage. Model (2) focuses on CEOs under greater career concerns—in industries with more CEOs hired from outside the firms (homogenous industries). PHD_CEO equals one if the CEO has doctorate degrees, and zero otherwise. The full sample comprises all non-financial and non-utility U.S. industrial firms from 1992 to 2009 in the intersection of ExecuComp, BoardEx, Compustat, KPSS patent database, and CRSP. All the regressions control for year and industry fixed effects (defined at the 2-digit SIC code level). All variables are defined in Appendix A. The t-statistics in parentheses are based on robust standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Dependent Variable	$R\&D_{t+3}$	
Subsample	Firms with High Analyst Coverage	Firms in Homo. Industries
	(1)	(2)
PHD_CEO	0.024***	0.030***
	(3.203)	(3.070)
CEO_MBA_DEGREE	0.006*	0.004
	(1.884)	(1.049)
CEO_LAW_DEGREE	-0.000	-0.006
	(-0.077)	(-1.136)
SIZE	-0.003*	-0.005***
	(-1.945)	(-2.930)
ln(AGE)	-0.005**	-0.003
	(-2.551)	(-1.291)
TANGIBILITY	0.006***	0.007***
	(6.262)	(6.025)
ROA	-0.089***	-0.145***
	(-5.204)	(-6.472)
LEVERAGE	-0.040***	-0.041***
	(-5.125)	(-4.740)
INST_OWN	0.013	0.001
	(1.440)	(0.222)
ln(CEO_TENURE)	0.000	0.000
	(0.260)	(0.006)
ln(CEO_AGE)	-0.016	-0.007
	(-1.582)	(-0.548)
CEO_STOCK_OWN	0.010	-0.037
	(0.393)	(-1.151)
ln(CEO_DELTA)	-0.000	0.000
	(-0.157)	(0.237)
ln(CEO_VEGA)	0.003***	0.004***
	(3.364)	(2.993)
Industry & year FE	Yes	Yes
N	4611	3694
Adjusted R^2	0.5001	0.4425

Table IA.9. PhD CEOs and Merger Performance

This table reports OLS regression results examining the relation between PhD CEOs and merger announcement returns. The dependent variable is the acquirer's cumulative abnormal returns (CARs) during the [−1, 1] announcement window, which is calculated using the market model estimated over the 155-day period ending 15 days before the acquisition announcement dates, with the CRSP value-weighted return as the market index. Model (1) shows the results for the full sample; models (2)–(7) report results of subsamples split by bidder's R&D intensity, target public status, and CEO tenure. PHD_CEO is a dummy equal to one if the CEO has doctorate degrees, and zero otherwise. Other variables are defined in Appendix A. All the regressions include year and industry fixed effects. The sample consists of completed mergers involving a public U.S. acquirer and a U.S. target over 1992—2009. We require that the bidder purchases 50% or more of the target's shares during the transaction and possesses less than 50% of the target prior to the acquisition. Deal information is from the SDC M&A database. The t-statistics in parentheses are based on standard errors clustered by acquirer. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Dependent Variable:	Merger cumulative abnormal stock returns of the bidder during [−1, 1] event days						
Sample	All Firms	by Acquirer R&D		by Target Status		by CEO tenure	
		High	Low	Private	Public	<= 5 years	> 5 years
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
PHD_CEO	**-0.007***	**-0.012****	-0.001	**-0.010****	-0.003	**-0.010***	-0.001
	(-1.894)	**(-2.100)**	(-0.340)	**(-2.043)**	(-0.802)	**(-1.959)**	(-0.261)
CEO_MBA_DEGREE	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.000
	(-0.323)	(-0.161)	(-0.372)	(-0.386)	(-0.333)	(-0.510)	(-0.034)
CEO_LAW_DEGREE	0.004	0.001	0.004	0.002	0.005	0.003	0.003
	(0.821)	(0.123)	(0.688)	(0.351)	(0.855)	(0.530)	(0.352)
ACQUIRER CASH FLOW	0.016	0.027	-0.001	0.054*	-0.018	-0.000	0.031
	(0.686)	(0.655)	(-0.036)	(1.715)	(-0.623)	(-0.012)	(0.982)
ACQUIRER SIZE	-0.002***	-0.002	-0.003***	-0.002	-0.003**	-0.003***	-0.001
	(-2.765)	(-1.286)	(-2.923)	(-1.471)	(-2.559)	(-3.339)	(-1.072)
ACQUIRER LEVERAGE	0.007	-0.008	0.009	0.020	-0.005	0.013	-0.005
	(0.834)	(-0.413)	(0.969)	(1.530)	(-0.512)	(1.244)	(-0.367)
ACQUIRER TOBIN'S Q	-0.001	-0.002	-0.001	-0.001	-0.001	-0.001	-0.002*
	(-1.045)	(-1.392)	(-0.624)	(-0.862)	(-0.989)	(-0.559)	(-1.697)
PRIVATE TARGET	-0.004*	-0.009	-0.003	0.000	0.000	-0.006*	-0.002
	(-1.867)	(-1.499)	(-1.371)			(-1.820)	(-0.566)
PUBLIC TARGET	-0.024***	-0.024***	-0.024***			-0.025***	-0.020***
	(-6.703)	(-2.855)	(-6.365)			(-5.862)	(-3.387)
DIVERSIFYING MERGER	-0.002	0.001	-0.003	0.001	-0.003	-0.003	-0.001
	(-0.967)	(0.183)	(-1.398)	(0.175)	(-1.344)	(-1.051)	(-0.153)
DOMESTIC MERGER	0.000	-0.002	0.001	-0.001	0.001	-0.001	0.003
	(0.152)	(-0.422)	(0.506)	(-0.200)	(0.198)	(-0.568)	(1.096)
STOCK DEAL	-0.004	0.003	-0.006	0.005	-0.015***	-0.007	-0.003
	(-1.384)	(0.442)	(-1.602)	(1.079)	(-3.329)	(-1.608)	(-0.602)
ALL CASH DEAL	0.004**	0.008	0.002	0.003	0.004*	0.002	0.006*
	(2.025)	(1.557)	(1.173)	(0.818)	(1.685)	(0.717)	(1.863)
ln(CEO_AGE)	-0.002	-0.019	0.000	-0.011	0.004	-0.004	0.003
	(-0.272)	(-0.992)	(0.022)	(-0.892)	(0.384)	(-0.417)	(0.197)
ln(CEO_TENURE)	0.001	0.005*	-0.001	0.000	-0.000	0.001	-0.000
	(0.412)	(1.705)	(-0.955)	(0.226)	(-0.048)	(0.327)	(-0.027)
RELATIVE DEAL SIZE	0.000	-0.066***	0.011	0.043**	-0.007	-0.002	0.002
	(0.012)	(-2.659)	(1.351)	(2.051)	(-0.732)	(-0.161)	(0.158)
TENDER OFFER	0.018***	0.021***	0.018***	0.030***	0.013***	0.016***	0.019**
	(4.106)	(2.801)	(3.281)	(2.741)	(2.919)	(3.091)	(2.513)
HOSTILE	0.002	-0.009	0.005		0.003	0.008	-0.007
	(0.125)	(-0.561)	(0.348)		(0.274)	(0.426)	(-0.462)
TOEHOLD	0.001	-0.004	0.006	-0.000	-0.000	0.006	-0.008
	(0.210)	(-0.298)	(0.827)	(-0.009)	(-0.028)	(0.888)	(-0.571)
Industry & Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	4993	1429	3564	2114	2879	2910	2083
Adjusted R^2	0.0263	0.0392	0.0270	0.0019	0.0465	0.0364	0.0161

Table IA.10. Alternative Hypothesis I—CEO Overconfidence

This table presents the OLS regression results on the relation between PhD CEOs and innovation after controlling for CEO overconfidence using specification in Hirshleifer, Low, and Teoh (2012). CEO_OVERCONFIDENCE is an indicator equal to one subsequent to the year in which a CEO holds stock options that are more than 67% in the money. The dependent variables are one-year forward natural logarithm of one plus the total number of patents, the natural logarithm of one plus total number of citations, the natural logarithm of one plus total number of weighted citations (using the weighting index in the NBER patent database), the natural logarithm of one plus citations per patent, and the average generality and originality scores of patents. PHD_CEO is an indicator equal to one if a CEO has doctorate degrees, and zero otherwise. All the regressions include year and industry (2-digit SIC code) fixed effects. The sample comprises all non-financial and non-utility U.S. industrial firms from 1992 to 2005 in the intersection of ExecuComp, BoardEx, Compustat, NBER patent database, and CRSP. All variables are defined in Appendix A. The t-statistics in parentheses are based on robust standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Dependent Variable	ln(PAT)	ln(CITE)	ln(WEIGHT_CITE)	ln(CITE_PAT)	GEN	ORG
	(1)	(2)	(3)	(4)	(5)	(6)
PHD_CEO	0.252**	0.305**	0.417***	0.098**	0.041***	0.042**
	(2.252)	(2.254)	(2.602)	(2.376)	(2.756)	(2.203)
CEO_OVERCONFIDENCE	0.112**	0.215***	0.214***	0.057***	0.007	0.002
	(2.364)	(3.727)	(3.055)	(2.863)	(0.876)	(0.196)
SIZE	0.416***	0.403***	0.481***	0.056***	0.034***	0.038***
	(11.843)	(10.150)	(10.207)	(4.852)	(7.999)	(7.931)
TANGIBILITY	-0.218	-0.150	-0.301	-0.100	-0.002	-0.062*
	(-0.782)	(-0.485)	(-0.801)	(-1.102)	(-0.064)	(-1.691)
STOCK_RETURN	0.066***	0.129***	0.132***	0.052***	0.005	0.010**
	(3.319)	(4.908)	(3.976)	(5.201)	(1.328)	(2.508)
INST_OWN	0.143	0.264**	0.323**	0.136***	0.042***	0.040**
	(1.387)	(2.191)	(2.206)	(3.537)	(2.933)	(2.385)
ln(CEO_TENURE)	-0.042	-0.065*	-0.072	-0.013	-0.005	0.002
	(-1.423)	(-1.688)	(-1.588)	(-0.980)	(-0.904)	(0.328)
ln(CEO_DELTA)	0.011	0.006	0.009	-0.007	-0.005	-0.012***
	(0.400)	(0.180)	(0.225)	(-0.624)	(-1.301)	(-2.622)
ln(CEO_VEGA)	0.094***	0.070*	0.125***	0.028**	0.011**	0.021***
	(3.178)	(1.889)	(2.841)	(2.271)	(2.532)	(4.069)
Industry & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	8830	8830	8830	8830	8830	8830
Adjusted R^2	0.5077	0.4919	0.4877	0.4621	0.3590	0.3803

Table IA.11. Alternative Hypothesis II—Inventor CEOs and Innovation Experience

This table presents the Tobit regression results on the relation between PhD CEOs and innovation after accounting for CEO innovation experience. INVENTOR_CEO is a dummy equal to one if the CEO is listed as the inventor for the patent applied before the given fiscal year. INNOVATIVE_EXPERIENCE is an indicator equal to one if a CEO has previously worked in innovative sectors. Ln(YEARS_INNOV_SECTORS) is natural logarithm of one plus the number of years working in innovative sectors in the past. The dependent variables are one-year forward natural logarithm of one plus total number of patents (ln(PAT)), the natural logarithm of one plus total number of citations (ln(CITE)), the natural logarithm of one plus total number of adjusted citations (ln(ADJ_CITE)), the natural logarithm of one plus citations per patent (ln(CITE_PAT)) and the average generality (GEN) and originality (ORG) scores of patents. PHD_CEO is an indicator equal to one if a CEO has doctorate degrees, and zero otherwise. All the regressions include baseline controls, year and industry (2-digit SIC code) fixed effects. The sample comprises all non-financial and non-utility U.S. industrial firms from 1992 to 2009 in the intersection of ExecuComp, BoardEx, Compustat, KPSS patent database, and CRSP. The t-statistics in parentheses are based on robust standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Controlling for Inventor CEOs

Dependent Variable:	ln(PAT)	ln(CITE)	ln(ADJ_ CITE)	ln(CITE_PAT)	GEN	ORG
	(1)	(2)	(3)	(4)	(5)	(6)
PHD_CEO	0.562***	0.849***	0.590***	0.390***	0.069***	0.085***
	(3.728)	(3.413)	(3.399)	(3.143)	(2.895)	(3.050)
INVENTOR_CEO	0.798***	1.254***	0.872***	0.560***	0.115***	0.123***
	(4.701)	(4.631)	(4.477)	(4.248)	(4.388)	(4.042)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	12893	12893	12893	12893	12893	12893
Pseudo R^2	0.2609	0.2246	0.2499	0.2290	0.4696	0.3628

Panel B. Excluding Inventor CEOs

Dependent Variable:	ln(PAT)	ln(CITE)	ln(ADJ_ CITE)	ln(CITE_PAT)	GEN	ORG
	(1)	(2)	(3)	(4)	(5)	(6)
PHD_CEO	0.646***	0.990***	0.632***	0.495***	0.090***	0.114***
	(3.823)	(3.452)	(3.207)	(3.354)	(3.191)	(3.498)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	11799	11799	11799	11799	11799	11799
Pseudo R^2	0.2658	0.2301	0.2563	0.2340	0.4658	0.3614

Panel C. Dummy of Experience in Innovative Sectors

Dependent Variable:	ln(PAT)	ln(CITE)	ln(ADJ_ CITE)	ln(CITE_PAT)	GEN	ORG
	(1)	(2)	(3)	(4)	(5)	(6)
PHD_CEO	0.615***	0.929***	0.649***	0.420***	0.074***	0.092***
	(4.006)	(3.693)	(3.676)	(3.391)	(3.122)	(3.322)
INNOVATIVE_	0.351***	0.600***	0.399***	0.318***	0.078***	0.065**
EXPERIENCE	(2.716)	(2.803)	(2.666)	(2.975)	(3.327)	(2.511)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	12895	12895	12895	12895	12895	12895
Pseudo R^2	0.2594	0.2235	0.2487	0.2284	0.4692	0.3615

Panel D. Years of Experience in Innovative Sectors

Dependent Variable:	ln(PAT)	ln(CITE)	ln(ADJ_ CITE)	ln(CITE_PAT)	GEN	ORG
	(1)	(2)	(3)	(4)	(5)	(6)
PHD_CEO	0.622***	0.941***	0.657***	0.426***	0.078***	0.094***
	(4.038)	(3.716)	(3.703)	(3.398)	(3.225)	(3.356)
ln(YEARS_INNOV_	0.146***	0.247***	0.164**	0.135***	0.023**	0.024**
SECTORS)	(2.607)	(2.649)	(2.537)	(2.905)	(2.285)	(2.226)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	12895	12895	12895	12895	12895	12895
Pseudo R^2	0.2593	0.2234	0.2486	0.2284	0.4675	0.3611

Table IA.12. Alternative Hypothesis III—CEO Power

This table presents the Tobit regression results on the relation between PhD CEOs and innovation after controlling for proxies of CEO power. CEO_CHAIRMAN is an indicator equal to one if the CEO also serves as board chair, and zero otherwise. CEO_FOUNDER is an indicator equal to one if the CEO is also the founder or co-founder of the company. The dependent variables are one-year forward natural logarithm of one plus total number of patents (ln(PAT)), the natural logarithm of one plus total number of citations (ln(CITE)), the natural logarithm of one plus total number of adjusted citations (ln(ADJ_CITE)), the natural logarithm of one plus citations per patent (ln(CITE_PAT)) and the average generality (GEN) and originality (ORG) scores of patents. PHD_CEO is an indicator equal to one if a CEO has doctorate degrees, and zero otherwise. All the regressions include baseline controls, year and industry (2-digit SIC code) fixed effects. The full sample comprises all non-financial and non-utility U.S. industrial firms from 1992 to 2009 in the intersection of ExecuComp, BoardEx, Compustat, KPSS patent database, and CRSP. All variables are defined in Appendix A. The t-statistics in parentheses are based on robust standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Dependent Variable:	ln(PAT)	ln(CITE)	ln(ADJ_ CITE)	ln(CITE_PAT)	GEN	ORG
	(1)	(2)	(3)	(4)	(5)	(6)
PHD_CEO	0.580***	0.881***	0.613***	0.409***	0.074***	0.091***
	(3.804)	(3.503)	(3.503)	(3.246)	(3.047)	(3.215)
CEO_CHAIRMAN	0.195**	0.265*	0.187*	0.108	0.018	0.041**
	(1.985)	(1.666)	(1.671)	(1.374)	(1.134)	(2.252)
CEO_FOUNDER	0.547***	0.844***	0.588***	0.345**	0.061**	0.058**
	(3.349)	(3.090)	(3.048)	(2.542)	(2.210)	(1.965)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	12895	12895	12895	12895	12895	12895
Pseudo R^2	0.2605	0.2241	0.2495	0.2284	0.4677	0.3619

Table IA.13. Alternative Hypothesis IV—Innate Talent and Ability

This table presents the Tobit regression results of the relation between PhD CEOs and firm innovation after controlling for CEO innate talent and ability. HIGH_LATENT_ABILITY is a dummy variable equals one if the age at which the individual took the first CEO position falls in the bottom decile among all the CEOs in the sample, and zero otherwise. IVY_LEAGUE is a dummy variable equals one if the CEO attended an Ivy League institution at any academic level, and zero otherwise. RECESSION_CEO is an indicator equal to one if a CEO entered the labor market during a recession when he turned 24 years old. The dependent variables are one-year forward natural logarithm of one plus total number of patents (ln(PAT)), the natural logarithm of one plus total number of citations (ln(CITE)), the natural logarithm of one plus total number of adjusted citations (ln(ADJ_CITE)), the natural logarithm of one plus citations per patent (ln(CITE_PAT)) and the average generality (GEN) and originality (ORG) scores of patents. PHD_CEO equals one if a CEO has doctorate degrees, and zero otherwise. Other variables are defined in Appendix A. All the regressions include controls and year and industry fixed effects. The t-statistics in parentheses are based on robust standard errors clustered at the firm level, except for Panel A. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Dependent Variable:	ln(PAT)	ln(CITE)	ln(ADJ_CITE)	ln(CITE_PAT)	GEN	ORG
	(1)	(2)	(3)	(4)	(5)	(6)
PHD_CEO	0.575***	0.892***	0.614***	0.420***	0.073***	0.086***
	(3.778)	(3.547)	(3.486)	(3.344)	(3.044)	(3.097)
HIGH_LATENT_ABILITY	0.182	0.195	0.199	0.021	0.009	0.017
	(0.989)	(0.665)	(0.952)	(0.147)	(0.319)	(0.536)
IVY_LEAGUE	0.052	-0.006	0.022	-0.006	0.000	0.020
	(0.491)	(-0.037)	(0.179)	(-0.065)	(0.014)	(0.953)
RECESSION_CEO	-0.013	-0.015	-0.006	0.011	-0.003	0.001
	(-0.145)	(-0.102)	(-0.053)	(0.149)	(-0.165)	(0.079)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry & year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	12650	12650	12650	12650	12650	12650
Pseudo R^2	0.2581	0.2221	0.2473	0.2262	0.4650	0.3584

Table IA.14. Possible Alternative Controls

This table presents the Tobit regression results of the relation between PhD CEOs and firm innovation without any controls or with more controls of manager characteristics. The dependent variables are one-year forward natural logarithm of one plus total number of patents (ln(PAT)), the natural logarithm of one plus total number of citations (ln(CITE)), the natural logarithm of one plus total number of adjusted citations (ln(ADJ_CITE)), the natural logarithm of one plus citations per patent (ln(CITE_PAT)) and the average generality (GEN) and originality (ORG) scores of patents. PHD_CEO equals one if a CEO has doctorate degrees, and zero otherwise. CEO_OVERCONFIDENCE is an indicator equal to one subsequent to the year in which a CEO holds stock options that are more than 67% in the money. INVENTOR_CEO is a dummy equal to one if the CEO is listed as the inventor for the patent applied before the given fiscal year. HIGH_LATENT_ABILITY is a dummy variable equals one if the age at which the individual took the first CEO position falls in the bottom decile among all the CEOs in the sample, and zero otherwise. IVY_LEAGUE is a dummy variable equals one if the CEO attended an Ivy League institution at any academic level, and zero otherwise. RECESSION_CEO is an indicator equal to one if a CEO entered the labor market during a recession when he turned 24 years old. CEO_ENGINEER/SCIENCE is a dummy equal to one if the CEO has an engineering or science-related degree. GENERAL_ABILITY is an index measuring managerial general skills from Custodio, Ferreira, and Matos (2013). All the regressions include baseline controls and year and industry fixed effects. The t-statistics in parentheses are based on robust standard errors clustered at the firm level, except for Panel A. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. No Baseline Controls

Dependent Variable:	ln(PAT)	ln(CITE)	ln(ADJ_CITE)	ln(CITE_PAT)	GEN	ORG
	(1)	(2)	(3)	(4)	(5)	(6)
PHD_CEO	0.602***	0.961***	0.641***	0.457***	0.077***	0.090***
	(3.047)	(3.147)	(2.904)	(3.461)	(3.010)	(3.099)
Industry & year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	12895	12895	12895	12895	12895	12895
Pseudo R^2	0.1587	0.1523	0.1556	0.1878	0.3982	0.2977

Panel B. More Controls of CEO Characteristics

Dependent Variable:	ln(PAT)	ln(CITE)	ln(ADJ_CITE)	ln(CITE_PAT)	GEN	ORG
	(1)	(2)	(3)	(4)	(5)	(6)
PHD_CEO	0.449***	0.745***	0.503***	0.357***	0.054**	0.067**
	(2.871)	(2.818)	(2.792)	(2.638)	(2.207)	(2.406)
CEO_OVERCONFIDENCE	-0.125	-0.173	-0.140	-0.074	-0.026*	-0.033*
	(-1.380)	(-1.133)	(-1.351)	(-0.945)	(-1.657)	(-1.901)
INVENTOR_CEO	0.648***	1.072***	0.686***	0.501***	0.103***	0.100***
	(3.549)	(3.667)	(3.293)	(3.524)	(3.946)	(3.315)
HIGH_LATENT_ABILITY	0.103	0.038	0.081	-0.047	0.000	0.001
	(0.524)	(0.119)	(0.368)	(-0.305)	(0.016)	(0.021)
IVY_LEAGUE	0.060	0.019	0.046	-0.001	-0.002	0.018
	(0.554)	(0.104)	(0.373)	(-0.008)	(-0.120)	(0.869)
RECESSION_CEO	-0.019	-0.008	-0.010	0.022	0.002	0.003
	(-0.198)	(-0.047)	(-0.093)	(0.268)	(0.149)	(0.156)
CEO_ENGINEER/SCIENCE	0.377***	0.610***	0.387**	0.310***	0.056***	0.066***
	(2.784)	(2.807)	(2.530)	(2.927)	(2.742)	(2.903)
GENERAL_ABILITY	0.123**	0.235***	0.137**	0.132***	0.030***	0.029***
	(2.375)	(2.709)	(2.361)	(3.003)	(3.530)	(3.113)
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry & year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	10210	10210	10210	10210	10210	10210
Pseudo R^2	0.2706	0.2209	0.2551	0.2172	0.4257	0.3833

Table IA.15. Robustness Tests of PP Laws: Accounting for Other CEO Traits

This table reports the regression results examining the differential effect of state adoption of poison pill laws on innovation of firms with and without PhD CEOs after controlling for other managerial traits that could account for the differential responses. The dependent variables are three-year forward measures of the natural logarithm of one plus total number of patents (ln(PAT)), the natural logarithm of one plus total number of citations (ln(CITE)), and the natural logarithm of one plus total number of exploratory patents (ln(EXPLORE60). PP_LAW is an indicator equal to one if a poison pill law is in place in the firm's state of incorporation in a given year. PHD_CEO equals one if the CEO has doctorate degrees, and zero otherwise. HIGH_LATENT_ABILITY is a dummy variable equals one if the age at which the individual took the first CEO position falls in the bottom decile among all the CEOs in the sample, and zero otherwise. IVY_LEAGUE is a dummy variable equals one if the CEO attended an Ivy League institution at any academic level, and zero otherwise. CEO_OVERCONFIDENCE is an indicator equal to one subsequent to the year in which a CEO holds stock options that are more than 67% in the money. INVENTOR_CEO is a dummy equal to one if the CEO is listed as the inventor for the patent applied before the given fiscal year. CEO_ENGINEER/SCIENCE is a dummy equal to one if the CEO has an engineering or science-related degree. All regressions include controls, firm fixed effects, industry × year, state of headquarters × year and state of incorporation × year fixed effects. The t-statistics in parentheses are based on robust standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Dependent Variable:	ln(PAT)	ln(CITE)	ln(EXPLORE 60)	ln(PAT)	ln(CITE)	ln(EXPLORE 60)
	(1)	(2)	(3)	(4)	(5)	(6)
PP_LAW × PHD_CEO	**0.516*** **	**0.584*** **	**0.408** **	**0.457*** **	**0.598*** **	**0.380** **
	(3.519)	**(3.533)**	**(2.376)**	**(3.630)**	**(3.872)**	**(2.121)**
PP_LAW	0.127	-0.376	0.162	0.134	-0.327	0.169
× HIGH_LATENT_ABILITY	(1.094)	(-1.207)	(1.651)	(1.160)	(-1.026)	(1.654)
PP_LAW	-0.053	-0.164	-0.067	-0.071	-0.219	-0.066
× IVY_LEAGUE	(-0.452)	(-1.073)	(-0.682)	(-0.671)	(-1.628)	(-0.780)
PP_LAW	-0.092	-0.326**	-0.067	-0.076	-0.321**	-0.074
× RECESSION_CEO	(-0.932)	(-2.345)	(-0.706)	(-0.795)	(-2.401)	(-0.764)
PHD_CEO	-0.258**	-0.116	-0.131	-0.252**	-0.076	-0.152*
	(-2.196)	(-0.895)	(-1.371)	(-2.220)	(-0.524)	(-1.888)
HIGH_LATENT_ABILITY	-0.120***	-0.058	-0.115*	-0.159***	-0.080	-0.151**
	(-3.013)	(-0.541)	(-1.981)	(-5.074)	(-0.856)	(-2.328)
IVY_LEAGUE	0.012	-0.068	-0.000	0.028	-0.049	0.007
	(0.189)	(-0.725)	(-0.006)	(0.500)	(-0.471)	(0.114)
RECESSION_CEO	0.039	0.172***	-0.053*	0.038	0.179***	-0.049
	(1.378)	(4.808)	(-2.003)	(1.373)	(4.435)	(-1.499)
PP_LAW	-0.066	0.152	-0.215*	-0.097	0.140	-0.251*
	(-0.901)	(0.994)	(-1.981)	(-1.355)	(0.929)	(-1.998)
PP_LAW				-0.004	0.007	-0.023
× CEO_OVERCONFIDENCE				(-0.094)	(0.077)	(-0.500)
PP_LAW				0.233	-0.218	0.223
× INVENTOR_CEO				(0.834)	(-1.097)	(0.809)
PP_LAW				0.271	0.308	0.255
× CEO_ENGINEER/SCIENCE				(1.192)	(1.203)	(1.148)
PP_LAW				-0.008	0.066	-0.083
× GENERAL_ABILITY				(-0.149)	(0.562)	(-1.342)
CEO_OVERCONFIDENCE				0.027*	0.089**	0.054***
				(1.815)	(2.505)	(4.023)
INVENTOR_CEO				0.305***	0.148*	0.195*
				(6.565)	(1.857)	(1.887)
CEO_ENGINEER/SCIENCE				0.011	-0.280***	0.033
				(0.304)	(-3.659)	(1.203)
GENERAL_ABILITY				0.006	-0.013	0.061***
				(0.259)	(-0.513)	(3.680)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State of headquarters × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State of incorporation FE	Yes	Yes	Yes	Yes	Yes	Yes
N	7600	7600	7600	7382	7382	7382
Adjusted R^2	0.9304	0.8953	0.8862	0.9310	0.8945	0.8864

Table IA.16. Additional Robustness Checks

This table presents the Tobit regression results of robustness checks on the relation between PhD CEOs and innovation. In each panel, the dependent variables are one-year forward natural logarithm of one plus total number of patents (ln(PAT)), the natural logarithm of one plus total number of citations (ln(CITE)), the natural logarithm of one plus total number of adjusted citations (ln(ADJ_CITE)), the natural logarithm of one plus citations per patent (ln(CITE_PAT)) and the average generality (GEN) and originality (ORG) scores of patents. Panel A reports the OLS estimates for innovation in the next year while controlling for industry-year fixed effects. Panel B presents the results after excluding firms headquartered in California or Massachusetts. Panel C reports results using a subsample of firms not in high-tech industries. Panel D shows the results after excluding the Dot.com bubble period of 1998-2000. Panel E presents the estimates after controlling for CEO's technical background. All the regressions include baseline controls, year and industry fixed effects. The t-statistics in parentheses are based on robust standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Dependent Variable:	ln(PAT)	ln(CITE)	ln(ADJ_ CITE)	ln(CITE_ PAT)	GEN	ORG
	(1)	(2)	(3)	(4)	(5)	(6)
A. OLS with Industry-year Fixed Effects						
PHD_CEO	0.343***	0.528***	0.340***	0.239***	0.034***	0.045***
	(3.084)	(3.053)	(2.747)	(3.081)	(2.850)	(2.786)
N	12895	12895	12895	12895	12895	12895
Adjusted R^2	0.5199	0.5295	0.4930	0.4598	0.4028	0.3416
B. Exclude Firms in California and Massachusetts						
PHD_CEO	0.700***	0.977***	0.687***	0.425**	0.083**	0.123***
	(3.081)	(2.590)	(2.705)	(2.227)	(2.139)	(2.798)
N	10061	10061	10061	10061	10061	10061
Pseudo R^2	0.2552	0.2231	0.2482	0.2269	0.4469	0.3364
C. Exclude High-tech Industries						
PHD_CEO	0.878***	1.333***	0.891***	0.624***	0.123***	0.161***
	(4.288)	(3.745)	(3.633)	(3.179)	(3.112)	(3.443)
N	9129	9129	9129	9129	9129	9129
Pseudo R^2	0.2820	0.2477	0.2757	0.2505	0.4742	0.3680
D. Exclude Dot.com Bubble Period						
PHD_CEO	0.608***	0.884***	0.648***	0.398***	0.075***	0.096***
	(3.974)	(3.595)	(3.631)	(3.354)	(3.177)	(3.324)
N	10753	10753	10753	10753	10753	10753
Pseudo R^2	0.2579	0.2264	0.2479	0.2349	0.4818	0.3558
E. Control for CEO with Tech background						
PHD_CEO	0.490***	0.758***	0.517***	0.354***	0.061**	0.073***
	(3.129)	(2.968)	(2.857)	(2.830)	(2.478)	(2.597)
CEO_ENGINEER/SCIENCE	0.529***	0.824***	0.568***	0.391***	0.076***	0.093***
	(4.106)	(4.053)	(3.842)	(4.045)	(3.901)	(4.150)
MEDICAL_DEGREE	-0.035	-0.395	-0.056	-0.396	-0.049	-0.064
	(-0.051)	(-0.357)	(-0.076)	(-0.724)	(-0.420)	(-0.548)
N	12895	12895	12895	12895	12895	12895
Pseudo R^2	0.2604	0.2241	0.2494	0.2289	0.4687	0.3628

Table IA.17. Additional Variable Definitions

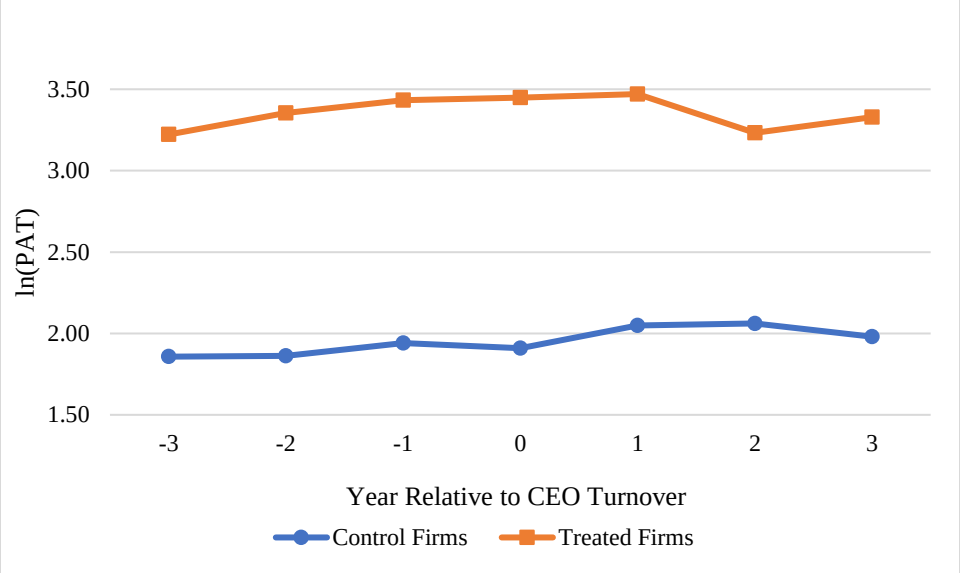
Variable	Definition
HIGH_LATENT_ABILITY	a dummy variable equals one if the age at which the individual took the first CEO position is in the bottom decile among all the CEOs in the sample, and zero otherwise (Falato, Li, and Milbourn 2015)
IVY_LEAGUE	a dummy variable equals one if the CEO attended an Ivy League institution (Brown University, Columbia University, Cornell University, Dartmouth College, Harvard University, Princeton University, University of Pennsylvania, and Yale University) at any academic level, and zero otherwise (Custódio, Ferreira, Matos 2013).
GENERAL_ABILITY	the first factor of the principle components analysis of five proxies for general ability: past number of different positions, number of firms, number of industries, past CEO experience, and conglomerate firm experience (Custodio, Ferreira, and Matos 2013).
CEO_OVERCONFIDENCE	an indicator equal to one subsequent to the year in which a CEO holds stock options that are more than 67% in the money (Malmendier and Tate 2005; Campbell et al. 2011; Hirshleifer, Low, and Teoh 2012); *Low Confidence* equals one minus *CEO_OVERCONFIDENCE*
RECESSION_CEO	is an indicator equal to one if a CEO entered the labor market during a recession when he turned 24 years old. Recession years are based on the business cycle dating database of the National Bureau of Economic Research (Schoar and Zuo 2017).
INVENTOR_CEO	a dummy equal to one if the CEO is listed as the inventor for the patent applied before the given fiscal year.
CEO_CHAIRMAN	a dummy equal to one if the CEO also serves as board chair, and zero otherwise
CEO_FOUNDER	a dummy equal to one if the CEO is the founder or co-founder of the firm, and zero otherwise
ABS_ACCRUALS	the absolute value of accruals over lag assets. Accruals are calculated using the balance sheet method as the change in current assets less the change in cash assets minus the change in current liabilities plus the change in short-term debt excluding depreciation and amortization expense (Kothari, Leone, and Wasley 2005)
ABS_DISC_ACCRUALS	the absolute value of discretionary accruals using modified Jones (1991) model that adjusts for operating performance. The discretionary accruals are computed as the residuals from the following cross-sectional regression, which is estimated each year for each industry (at the 2-digit SIC code) with at least 15 observations. $(Accruals_t/Assets_{t-1}) = \alpha + \beta_1 \times (1/Assets_{t-1}) + \beta_2 \times ((\Delta Sales_t - \Delta Account\ Receivables_t)/Assets_{t-1}) + \beta_3 \times (PPE_t/Assets_{t-1}) + \beta_4 \times ROA_t + \varepsilon_t$
ABNORMAL_CFO	the firm's actual cash flow from operations (CFO) minus normal level of CFO, where normal CFO is the predicted value from the following cross-sectional regression estimated for each industry-year with at least 15 observations (Roychowdhury 2006). $(CFO_t/Assets_{t-1}) = a + \beta_1 \times (1/Assets_{t-1}) + \beta_2 \times (Sales_t/Assets_{t-1}) + \beta_3 \times (\Delta Sales_t/Assets_{t-1}) + \varepsilon_t$
ABNORMAL_PROD	the firm's actual production costs (PROD) minus normal level of PROD, where normal PROD is the predicted value from the following cross-sectional regression estimated for each industry-year with at least 15 observations. $(PROD_t/Assets_{t-1}) = a + \beta_1 \times (1/Assets_{t-1}) + \beta_2 \times (Sales_t/Assets_{t-1}) + \beta_3 \times (\Delta Sales_t/Assets_{t-1}) + \beta_4 \times (\Delta Sales_{t-1}/Assets_{t-1}) + \varepsilon_t$ where PROD is the sum of cost of goods sold and Δ inventory from previous year
ABNORMAL_DEXP	the firm's actual discretionary expenditures (DEXP) minus normal level of DEXP, where normal DEXP is the predicted value from the following cross-sectional regression estimated for each industry-year with at least 15 observations. $(DEXP_t/Assets_{t-1}) = a + \beta_1 \times (1/Assets_{t-1}) + \beta_2 \times (Sales_{t-1}/Assets_{t-1}) + \varepsilon_t$ where DEXP is the sum of R&D, Advertising, and SG&A expenses; missing values of R&D and Advertising are set to zero.
HIGH_ANALYST_COVERAGE	an indicator equal to one for firms followed by above-median number of financial analysts in the sample for any given year
HOMOGENOUS_INDUSTRIES	an indicator equal to one for industries in which the fraction of externally hired CEOs is above the sample median in any given year (Cremers and Grinstein 2014)

MERGER_ ANNOUNCEMENT_ RETURNS	the acquirer's cumulative abnormal returns (CARs) during the [−1, 1] announcement window, which is calculated using the market model estimated over the 155–day period ending 15 days before the acquisition announcement dates, with the CRSP value-weighted return as the market index. Deal information is from the SDC M&A database.

Figure IA.1. Trends of Innovative Activity around Exogenous CEO Turnovers

This figure plots yearly means of innovation outcomes using ln(PAT) or ln(CITE) for treated and matched control firms during three years before and after likely-exogenous CEO turnovers. Treated firms are those replacing a PhD CEO with a non-PhD CEO. Control group is formed from turnovers in which a non-PhD CEO succeeds a non-PhD CEO. We require a matched firm to be in the same industry as the treated firm and have comparable firm size.

Panel A. Patents



Panel B. Citations