China Accounting and Finance Review

CEO individualism and corporate innovation

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Received 18 December 2023
Revised 14 May 2024
Accepted 10 June 2024

Abstract

Purpose – This paper aims to study the impact of CEOs' cultural background on corporate innovation. The paper constructs a measure of CEOs' cultural individualism based on their birthplaces and investigates its relationship with firms' patents and citations. The study aims to shed light on the interaction of culture and corporate decisions and focuses on the role of top managers. The paper also investigates the mechanism of how top management can affect corporate innovation output.

Design/methodology/approach – The paper constructs the measure of individualism using the westward expansion in US history. To do so, the paper uses the US county-level duration of exposure of the frontier territory in the 19th century and links the counties to CEOs' birthplaces. The paper argues the cultural characteristics of birthplaces can affect a person's later management styles and decisions, hence affecting corporate innovation policies. Using regression and difference-in-differences estimations, the paper explores the relation and causality between cultural individualism and innovation output.

Findings – The paper finds that CEO cultural individualism is positively related with the number of patents produced by the firm and the citations received by the firm. Difference-in-differences tests using CEO turnovers support that the relation is causal. The paper also investigates the economic mechanism of how individualistic CEOs achieve such results. It finds that individualistic CEOs tend to hire more talented employees and improve the workplace environment to attract top inventors.

Originality/value – This paper provides firm-level evidence of culture and innovation. Prior studies in this area focus on cross-country evidence and suffer the limitation of confounding factors. Using a county-level measure of individualism and a sample of firms in USA, the paper alleviates the concern and provides evidence with better granularity. This paper also provides a novel mechanism for attracting top inventors, while existing literature tend to focus on risk-taking activities.

Keywords Innovation, Culture, CEO turnover, Inventors

Paper type Research paper

1. Introduction

Innovation plays a crucial role in fostering long-term economic growth (see, e.g. Hall, Jaffe, & Trajtenberg, 2005; Hirshleifer, Hsu, & Li, 2013; Kogan, Papanikolaou, Seru, & Stoffman, 2017). Corporations are particularly essential in driving innovation as they confront real-world problems during production. However, firm innovation is also costly and risky, often making decisions related to exploration challenging for corporate managers and firm employees. CEO personalities typically play a significant role in shaping corporate decisions and innovation policies (Kaplan & Sorensen, 2017). Therefore, understanding which CEO characteristics influence successful firm innovation is important for investors, corporate boards and academics.

One CEO characteristic that can affect corporate innovation is cultural individualism. It is defined as an individual's preference for pursuing personal interests and emphasizing self-reliance (Hofstede & Hofstede, 1984). Literature shows that individualism has a positive impact on innovation at the country level. For example, Gorodnichenko and Roland (2011,

China Accounting and Finance Review
Vol. 26 No. 3, 2024
pp. 385-412
Emerald Publishing Limited
e-ISSN: 2307-3055
p-ISSN: 1029-807X
DOI 10.1108/CAFR-12-2023-0149

2012, 2017) and Boubakri, Chkir, Saadi, and Zhu (2021) show a positive association between cultural individualism and innovation, suggesting that individualism is an important cultural factor for long-term economic growth. Individualistic managers inherently value radical innovation and groundbreaking explorations, which may motivate them to adopt corporate policies that promote innovation. According to this *individualist-drive* hypothesis, CEO cultural individualism may positively influence corporate innovation.

Conversely, cross-country study findings may not necessarily translate to firms, given the substantial differences in education, social norms, demographics, infrastructure and legal systems across countries. Individualist CEOs may prioritize their self-interests and not to delegate important tasks to other top talent at the firm, potentially hindering the firm ability to build networks, motivate employees or launch new initiatives. As a result, individualistic CEOs may be ineffective at promoting innovation at the firm level. Although individualists are more likely to become entrepreneurs (Barrios, Hochberg, & Macciocchi, 2021), their collaboration and teamwork deficiencies Bazzi, Fiszbein, and Gebresilasse (2020, 2021) and Bian, Li, Xu, and Foutz (2020) could limit their firms' growth. This view has some support in the literature, which emphasizes the importance of networks and cooperation for innovation Faleye, Kovacs, and Venkateswaran (2014) and Chen, Chen, Hsu, and Podolski (2016). Therefore, it is also possible to hypothesize that individualists are less effective at promoting corporate innovation.

This paper investigates the impact of CEOs' individualistic cultural backgrounds on corporate innovation and explores the underlying mechanism. Focusing on US firms, I find a positive relationship between CEO individualism and corporate innovation, consistent with the *individualist-drive* hypothesis. To proxy for cultural individualism, I use the measure developed by Bazzi *et al.* (2020), which is based on the frontier experience during the westward expansion in American history. The frontier refers to the boundary where the population density falls below two individuals per square mile. Historians argue that the frontier experience had a causal effect on the local culture of individualism (Turner, 1921). I link CEOs' birthplaces to their total frontier experience (TFE), defined as the duration of exposure to this line between 1790 and 1890.

I first establish a positive empirical relationship between CEO individualism measured by TFE and corporate innovation. Specifically, I find that a one standard deviation increase in CEO individualism corresponds to an approximate 6.0% increase in the number of patents and a 5.7% increase in adjusted citations relative to the sample mean. This result supports the hypothesis that individualistic CEOs enhance corporate innovation. Individualists inherently seek explorations and deviate from established technologies (Turner, 1921; Gorodnichenko & Roland, 2011, 2012, 2017), which may lead them to value and promote innovation. The positive association between CEO individualism and corporate innovation remains robust when using alternative measures of innovation and various fixed effects.

A potential concern in interpreting the positive relationship between CEO individualism and firm innovation is the possibility that TFE may serve as a proxy for previously studied determinants of innovation. To address this concern, I control for additional factors that may influence corporate innovation and find that the results remain robust. These factors include CEO education, overconfidence, founder status, managerial incentives through compensation, General Ability Index (GAI), uncertainty avoidance preference, management team quality and inventor experience. Moreover, in contrast to cross-country study findings, [1] individualism measured by TFE does not drive innovation through increased risk-taking. This finding implies that CEO individualism enhances corporate innovation via unique mechanisms.

Another concern is that the board of directors may select a CEO based on specific characteristics that increase corporate innovation. While firm-fixed effects account for time-invariant characteristics, time-varying firm attributes may still affect the firm-CEO match.

To alleviate this concern, I conduct a difference-in-differences (DID) analysis using a sample of CEO turnovers. Gentry, Harrison, Quigley, and Boivie (2021) provide an open-source dataset of S&P 1,500 firms' CEO departures from 2000 to 2018, including detailed reasons for turnover. I retain only those CEO turnovers where the given CEO departure reason is unrelated to firm performance, such as CEO death, health concerns or retirement.

The DID estimation shows that firms experiencing an increase in CEO individualism post-turnover tend to exhibit greater innovation than those with a decline. Specifically, firms that experience an increase in CEO individualism following the turnover improve their patents and adjusted citations by 6.57% and 7.91%, respectively, relative to the sample average, compared with firms with a decrease in CEO individualism. This result is robust on a matched sample based on firm and CEO characteristics. If firms disregard individualism when hiring replacement CEOs, the estimation supports the notion that individualism improves innovation. However, if boards intentionally select individualistic CEOs to boost innovation, the positive association between CEO individualism and innovation implies their expectations are well-founded. In this context, the findings still hold value as they indicate that individualistic CEOs can contribute to innovation, even if the selection process is not entirely independent of individualism.

In addition to increasing patent quantity, I demonstrate that individualistic CEOs enhance patent quality. Estimation results indicate that firms led by individualistic CEOs produce more top-tier patents, defined as those with citation counts ranking within the top 1%, 5% or 10% among patents in their respective classes. These highly cited patents typically have a better quality or broader impact. Kogan *et al.* (2017) assess patent market value by examining stock market reactions to patents. Using this measure, I further show that individualistic CEOs tend to file patents with higher economic value, as evidenced by favorable stock market responses.

Next, I explore the underlying mechanisms to explain the positive relationship between CEO individualism and firm innovation. A key factor in fostering corporate value and innovation is to acquire talented employees, specifically inventors (Edmans, 2011; Bloom, Kretschmer, & Van Reenen, 2011; Edmans, Li, & Zhang, 2014; Huang, Li, Meschke, & Guthrie, 2015; Ian Carlin & Gervais, 2009; Chen *et al.*, 2016). One strategy to achieve this goal is to create a positive work environment. Positive firm and CEO reviews on social media platforms can signal an appealing work environment and better opportunities for career growth, which can attract potential candidates. By analyzing employee ratings from Glassdoor.com, I observe that firms led by individualistic CEOs consistently attain higher ratings across various categories, such as overall satisfaction, CEO approval and employee compensation and benefits. Moreover, individualistic CEOs are associated with more tech-related job positions. The findings support that individualistic CEOs promote corporate innovation by improving their firms' image and attracting top talent.

I then demonstrate that individualistic CEOs effectively recruit and retain top inventors who receive the top 5% or 10% of citations to their firms. Following the definition of the net flow of top inventors in Chemmanur, Kong, Krishnan, and Yu (2019), I find that individualistic CEOs are positively associated with the net flow of top inventors. A one standard deviation increase in CEOs' TFE corresponds to a 13.76% increase in the net flow of top inventors compared to the sample mean. This finding supports the notion that individualism is conducive to forming a corporate culture that is "open to disruption" and an innovative environment to retaining top inventors and stimulating radical innovation (Acemoglu, Akcigit, & Celik, 2020).

Lastly, I investigate additional aspects of firm management and find that individualistic CEOs lower employee quality monitoring. Collectivist culture can mitigate information asymmetry and shirking issues, reducing the monitoring costs (Fan, Gu, & Yu, 2022). In contrast, individualism may struggle to reduce information asymmetry and face higher

monitoring costs due to the lack of collective activities and teamwork. Consistent with this notion, I find that individualistic CEOs are associated with lower monitoring scores. Manso (2011) argues that a flexible corporate environment promotes innovation, as managers and employees feel less pressured by failures when choosing risky and innovative projects. Although individualistic CEOs may not intentionally tolerate failure, their inherent nature of overlooking overall harmony and efficiency might inadvertently create a flexible environment that encourages innovation. Furthermore, consistent with the arguments of Bazzi *et al.* (2020, 2021) and Bian *et al.* (2020), Gorodnichenko and Roland (2017) argue that collectivism should have an advantage in coordinating production processes and public good provision. Consequently, firms led by individualistic CEOs do not exhibit significantly better performance even if the market value of patents is high.

This paper contributes to several strands of literature. First, it extends the research on individualism and innovation. Studies including Gorodnichenko and Roland (2011, 2012, 2017), Bukowski and Rudnicki (2019) and Boubakri *et al.* (2021) demonstrate that culture can impact economic growth and innovation at the national level. I add to this literature by providing firm-level evidence that CEO individualism fosters corporate innovation. This study emphasizes the role of CEOs' preferences and how cultural attributes affect corporate innovation.

Second, this paper contributes to the literature on individualism and frontier culture. Bazzi *et al.* (2020, 2021) and Bian *et al.* (2020) provide evidence that the culture of rugged individualism hinders collective action in response to COVID-19. Their findings demonstrate that locations with higher historical exposure to a frontier culture exhibit poor social distancing, reduced mask usage, weaker government efforts to control the virus and fewer charitable donations. In another study, Barrios *et al.* (2021) reveal that the formation of new businesses is primarily driven by the experience of geographic frontiers, arguing that an individualistic culture bolsters entrepreneurship. This study shows that early-life exposure to a frontier culture influences corporate managers' preferences, leading to higher firm innovation.

This paper also contributes to the literature exploring the connection between CEO characteristics and corporate innovation. For instance, Malmendier and Tate (2005a, b) Galasso and Simcoe (2011) and Hirshleifer, Low, and Teoh (2012) investigate the relationship between managerial overconfidence, firm investment and innovation. Sunder, Sunder, and Zhang (2017) examine how a CEO's hobby of flying airplanes correlates with their firm's innovation activities, while Custódio, Ferreira, and Matos (2019) study the association between general managerial skills and innovation. This paper identifies CEO cultural individualism as a crucial characteristic that affects innovation and explores the underlying mechanism driving this relationship.

Lastly, this paper contributes to the literature examining the impact of cultural factors on financial decision-making. For instance, Chui, Titman, and Wei (2010) and Eun, Wang, and Xiao (2015) explore the effects of culture on investors and equity markets. Li, Griffin, Yue, and Zhao (2013), Liu (2016) and Pan, Siegel, and Wang (2017, 2020) demonstrate that cultural factors influence corporate decisions. In a contemporaneous paper, Gao, Han, Pan, and Zhang (2023) study the relationship between CEO individualism and corporate innovation. This paper differs from Gao *et al.* (2023) in several aspects. First, while Gao *et al.* (2023) also use a historical frontier measure, this study focuses on CEOs' personal experiences with frontier experiences. Second, this study employs a difference-in-differences approach to isolate the impact of changes in CEO individualism due to CEO turnovers, supporting the causal link between CEO traits and innovation outcomes. Third, this study delves deeper into how individualistic CEOs attract and retain top inventive talents. This study explores online employee ratings and satisfaction, uncovering a detailed mechanism compared to the general discussion by Gao *et al.* (2023). Fourth, this study extends the analysis to the economic impact

and discusses the tradeoff of individualistic culture. While individualism may foster innovation, its lack of monitoring and efficiency does improve firm performance. It is beneficial for firms to balance the strength of both cultures in management practices.

The rest of the paper is organized as follows. Section 2 describes cultural individualism, the frontier experience and the potential impact of cultural individualism on social and economic decisions. Section 3 describes the sample construction and provides summary statistics. Section 4 presents the baseline estimation results. Section 5 describes the DID results using the sample CEO turnovers. Section 6 demonstrates that CEO individualism also positively affects innovation quality. Section 7 investigates the underlying mechanisms. Section 8 explores the relationship between CEO individualism and corporate monitoring. Section 9 concludes.

2. Background

2.1 Cultural individualism

Individualism (contrasted with collectivism) is a type of culture in which people perceive themselves as independent and self-reliant, acting based on self-interest (Hofstede & Hofstede, 1984). Individualists value personal achievements, such as making important discoveries and prefer to stand out rather than blend in. Individualism can hinder collective action because individuals pursue self-interest without internalizing group interests, avoid conformity and oppose regulations and interventions (Gorodnichenko & Roland, 2011, 2012, 2017; Bazzi *et al.*, 2020).

2.2 Frontier experience and rugged individualism

Rugged individualism is a culture associated with 19th-century westward expansion and frontier experience in American history. Turner (1921) characterized the frontier as a "meeting point between savagery and civilization," which fosters a pervasive individualistic culture in the region. Low population density and lack of public facilities on the frontier required people to rely on their efforts and skills to survive and improve their living conditions. Such individualists preferred taking responsibility for their living conditions to reliance on government services and interventions (Bazzi *et al.*, 2020).

Bazzi *et al.* (2020) construct a measure of individualism based on the duration of frontier exposure between 1790 and 1890, as this experience is positively associated with local individualistic culture. For instance, TFE correlates positively with the choice of unique names for children, reflecting a preference to stand out. As culture is sticky and persistent, historical exposure to frontier culture continues to shape people's preferences in the present day. Studies including Bazzi *et al.* (2020, 2021) and Bian *et al.* (2020) show that the frontier experience is associated with opposition to redistribution and government intervention even after westward expansion ceased.

Individualistic preferences can be passed down to those with early exposure to frontier culture. Frontier locations often attract individualistic families and cultural individualism can be transmitted to their children and future generations (Bisin & Verdier, 2000, 2001; Giuliano, 2007). Moreover, culture influenced by historical factors can shape the values and preferences of local individuals, even those whose parents originate from elsewhere. Consequently, CEOs born in frontier locations tend to exhibit individualistic traits.

2.1 Innovation, entrepreneurship and corporate management

Individualists value personal achievement and discovery, favoring exploration and deviation from existing technologies (Gorodnichenko & Roland, 2012; Acemoglu *et al.*, 2020). Similarly, Barrios *et al.* (2021) reveal that the geographic distribution of the frontier experience

contributes to the development of new businesses and entrepreneurship. Individualism is also characterized by opposition to regulation, promoting a laissez-faire approach to business and management. Individualists appreciate equal opportunities over equal outcomes (Alesina, Glaeser, & Sacerdote, 2001) and dislike hierarchies and elites (Bazzi *et al.*, 2020).

3. Data and summary statistics

3.1 Data and sample construction

I start from a sample of 8,531 CEOs from Execucomp, excluding financial firms (SIC codes 6000–6999) and utility firms (SIC codes 4900–4999). Next, I collect birthplace information for 2,065 US-born CEOs using public resources, such as Wikipedia and the Notable Names Database (NNDB) [2]. I then merge CEO birthplaces with the TFE measure presented in Bazzi *et al.* (2020), which assigns each US county a number representing its duration as part of the frontier.

Firm patents, citations, classifications and market value data are obtained from Kogan *et al.* (2017). Inventor information is collected from the US Patent and Trademark Office (USPTO). Firm-level variables are obtained from Compustat and CRSP, while CEO characteristics, such as age, tenure and compensation, are collected from Execucomp. M&A information is collected from SDC M&A. Information about Glassdoor ratings is obtained from Wang, Zhu, Avolio, Shen, and Waldman (2022). By combining CEO, patent and firm data, the final sample contains 10,336 observations for the 1992–2016 period [3].

3.2 Other CEO characteristics

CEO compensation data is calculated using Execucomp, following the methodologies of Core and Guay (2002) and Coles, Daniel, and Naveen (2006). Educational background and management team quality information are collected from BoardEx, while the GAI comes from Custódio *et al.* (2019). CEO founder status from 2008 to 2016 is obtained from Lee, Hwang, and Chen (2017). The CEO turnover information from Gentry *et al.* (2021). The employee monitoring score is collected from Refinitiv Asset4, and the number of tech-related job positions is obtained from Bloom, Hassan, Kalyani, Lerner, and Tahoun (2021). Additionally, I construct the individualism score using Hofstede's cultural dimensions, following Liu (2016) and Pan *et al.* (2017). Detailed definitions are provided in Appendix Table A1.

3.3 Summary statistics

Panel A of Figure 1 plots the distribution of TFE across US counties, with values ranging from 0 to 6.6 decades. High TFE areas include the west coast, Louisiana, Florida, Oklahoma and Georgia. Meanwhile, Panel B of Figure 1 plots the distribution of CEOs (adjusted by historical average population) based on their US county birthplace. CEOs of large firms are not necessarily more likely to originate from high TFE regions. A weak negative relationship exists between the number of S&P 1500 firm CEOs and TFE, demonstrated by a correlation of -0.04 and a p-value<0.05.

Table 1 presents the descriptive statistics for the final sample, containing 10,336 observations from 1992 to 2016. The table describes CEO characteristics, innovation variables, management team quality and firm characteristics. CEO individualism measured by TFE has a sample mean of 0.85 and a median of 0.5 (decade). Both the average and median CEO age stands at 57 years. The mean CEO tenure is 8 years, with a median of 6 years. On the 0–3 education scale [4], the average CEO education reaches 1.8. About 21.5% of the CEOs hold a degree from an Ivy League school, while 14.2% of CEOs are the founders of their firms. The Hofstede individualism score has an average of 76.8 and a median of 80. The mean and median of Hofstede uncertainty avoidance scores are 50 and 35, respectively. The CEO

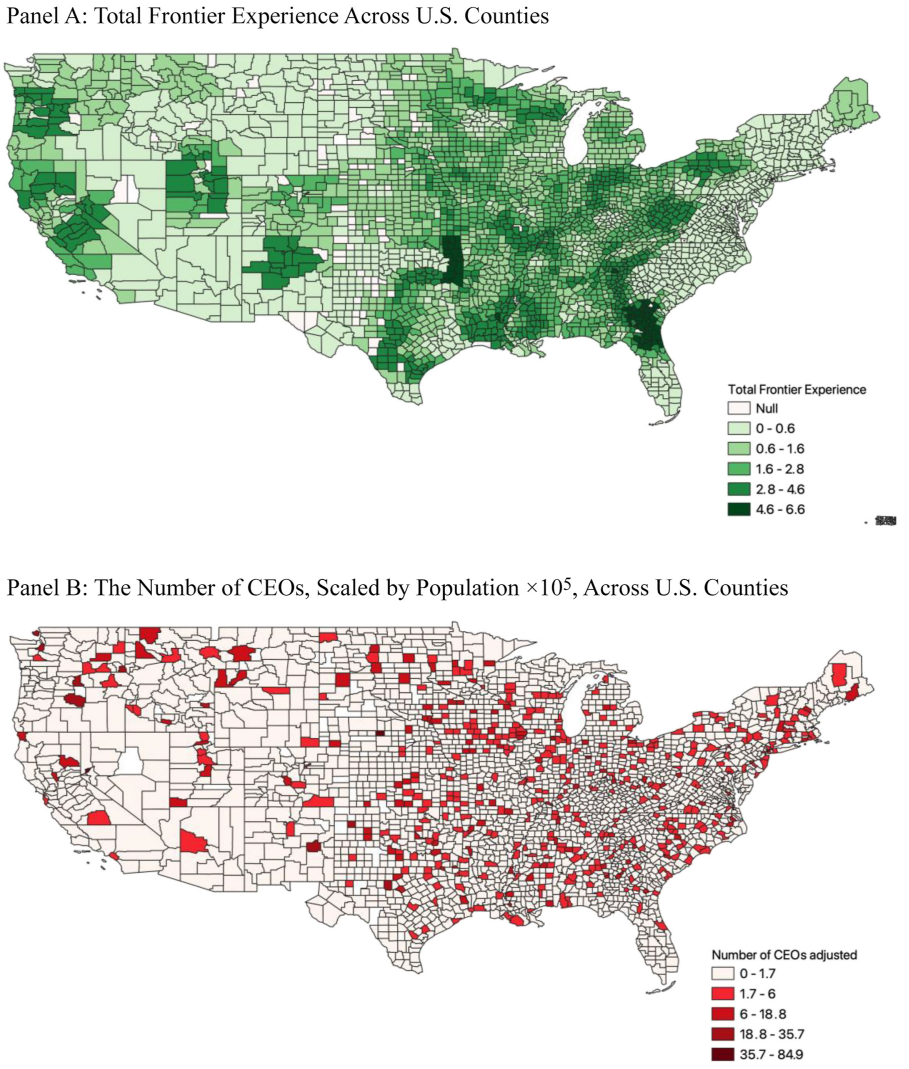


Figure 1. Spatial distribution of TFE and the number of CEOs

network size has a mean of 1,915 and a median of 1,406. Approximately 5.7% of CEOs are inventors themselves.

Table 2 compares the difference of means for variables analyzed in this study between high and low TFE CEOs. I divide the sample into high and low individualism subsamples using the median of TFE (0.5). I then compare the differences in the average CEO and firm characteristics between these two subsamples. The low TFE subsample generally exhibits lower Hofstede individualism scores and higher uncertainty avoidance, confirming the selection channel wherein individualistic families opt to relocate to frontier areas [5]. In line with the dislike for elites, the high TFE subsample has a significantly lower proportion of Ivy League degrees, although it has a slightly higher degree overall. Low TFE subsample CEOs tend to receive higher compensation. As the CEOs in the sample already have relatively low

	N	*Mean*	*STD*	*p5*	*p50*	*p95*
CEO characteristics						
Total frontier experience (TFE)	10,336	0.85	1.14	0	0.50	3.30
CEO age	10,336	58	8	45	57	71
CEO tenure	10,336	8	8	0	6	25
CEO education	10,336	1.2	1.1	0	1	3
Ivy league degree	10,336	0.215	0.411	0	0	1
CEO overconfidence	10,336	0.243	0.429	0	0	1
CEO compensation (TDC1)	10,273	7,161	12,569	526	4,017	22,238
Delta	9,690	1,978	16,232	16	335	4,909
Vega	9,663	218	433	0	76	886
Founder CEO	4,816	0.142	0.349	0	0	1
General ability index (GAI)	6,272	0.254	1.066	−1.268	0.111	2.203
Hofstede individualism	7,921	76.8	13.7	54	80	89
Hofstede uncertainty avoidance	6,901	50.4	19.5	35	35	86
CEO network	6,071	1,915	1,736	121	1,406	5,684
Inventor CEO	10,336	0.057	0.232	0	0	1
Patent variables						
Number of patents, *t+1*	10,336	64.4	287	0	0	309
Number of patents, *t+2*	10,336	65.4	296	0	0	311
Number of patents, *t+3*	10,336	65.3	301	0	0	310
Number of adjusted citations, *t+1*	10,336	68.8	295	0	0	315
Number of adjusted citations, *t+2*	10,336	69.3	298	0	0	321
Number of adjusted citations, *t+3*	10,336	68.5	298	0	0	321
Real market value of patents, *t+2*	10,336	1,124	3,607	0	0	6,845
Nominal market value of patents, *t+2*	10,336	2,352	7,518	0	0	14,379
Top 10% patents, *t+2*	10,336	8.7	39.6	0	0	41
Top 5% patents, *t+2*	10,336	4.1	17.6	0	0	20
Top 1% patents, *t+2*	10,336	0.9	4.0	0	0	4
Management team quality						
Team size	5,941	9.149	3.021	5	9	14
Team MBA	5,941	0.344	0.192	0	0.333	0.667
Team PhD	5,941	0.035	0.066	0	0	0.167
Team network size	5,939	2,165	1,339	488	1,891	4,597
Team experience	5,941	0.557	0.275	0	0.600	1
Team tenure	5,941	5.019	2.553	1	4.833	9.455
Firm characteristics						
Total assets	10,336	29,234	134,246	221	4,301	99,714
R&D expenditures	10,336	0.033	0.069	0	0	0.178
Capital expenditures	10,336	0.052	0.046	0.002	0.041	0.142
Firm age	10,336	24.9	10.9	7	26	42
Employees	10,336	35.87	80.58	0.666	11.52	146
Tobin's Q	10,258	1.640	2.421	0.381	1.150	4.228
Profitability	10,189	0.137	0.089	0.016	0.133	0.288
Overall firm rating	2,224	3.356	0.623	2.200	3.400	4.243
CEO approval rating	2,188	0.354	0.410	−0.400	0.399	1
Work-life-balance rating	2,224	3.300	0.656	2.220	3.313	4.333
Compensation and benefits rating	2,224	3.217	0.581	2.360	3.200	4.125
Career opportunity rating	2,224	2.980	0.593	2	3	4
Number of evaluations	2,224	113	264	1	24	495

Table 1.
Descriptive statistics

(*continued*)

	N	*Mean*	*STD*	*p5*	*p50*	*p95*
Total tech job positions	481	0.902	4.402	0	0	3
Employment quality monitoring score	3,371	0.451	0.183	0.328	0.423	0.995
Stock return volatility, *t+1*	9,980	0.021	0.014	0.008	0.018	0.046
Idiosyncratic volatility, *t+1*	9,980	0.020	0.013	0.008	0.017	0.042
Number of effective acquisitions, *t+1*	10,336	0.683	1.707	0	0	4
Number of announced acquisitions, *t+1*	10,336	0.948	2.064	0	0	4
Inventor variables						
Net inflow of top 10% inventors, *t+2*	10,336	0.174	0.459	0	0	1.253
Net inflow of top 5% inventors, *t+2*	10,336	0.140	0.425	0	0	1.099
Net inflow of top 10% inventors, *t+1*	10,336	0.173	0.453	0	0	1.235
Net inflow of top 5% inventors, *t+1*	10,336	0.139	0.421	0	0	1.099

Note(s): This table reports summary statistics for CEO characteristics, patent variables, management team quality, firm characteristics and inventor variables used in the sample

Table 1.

TFE scores (with the 95th percentile at 3.3 decades), there is no substantial difference in terms of overconfidence, founder status, GAI, network and inventor status.

It is worth noting that there are considerable differences in innovation variables between the two samples: the low TFE subsample generally exhibits lower patent quantity and quality. Additionally, there are significant disparities in firm characteristics between the two samples. CEOs with high TFE tend to work for smaller firms with better social media ratings. However, there is no substantial difference in the firms' investments and stability. In addition, high TFE CEOs tend to collaborate with management teams with smaller network sizes.

4. Empirical estimation

4.1 CEO individualism and innovation

The *individualist-drive* hypothesis is that cultural individualism benefits innovation (Hofstede & Hofstede, 1984; Gorodnichenko & Roland, 2011, 2012, 2017). Individualistic CEOs value explorations and long-term success and, hence are likely to promote corporate innovation and novel explorations. To investigate the relationship between CEO individualism measured by TFE and corporate innovation, I estimate the following model:

$$\text{Innovation}_{i,t+2} = \alpha_i + \beta \cdot TFE_{j,t} + \gamma \cdot X_{j,t} + \delta \cdot Z_{i,t} + \eta_i + \delta_t + \epsilon_{j,t}. \quad (1)$$

In the regression analysis, i represents the firm and j represents the CEO. The dependent variables are innovation measures, including the logarithm of one plus the number of patents and citations. Citations are adjusted by the class-year average to account for bias following Hall, Jaffe, and Trajtenberg (2001). The innovation variables are patents and citations from year $t+2$. $X_{j,t}$ denotes the set of CEO characteristics, including the logarithm of CEO age and tenure. $Z_{i,t}$ represents the set of firm controls, such as firm size, the logarithm of firm age, capital expenditure, R&D expenditure and the logarithm of employees. Columns (1) and (2) include industry and year (δ_t) fixed effects. Columns (3) and (4) include firm (η_i) and year (δ_t) fixed effects. Column (5) includes firm and industry-year fixed effects to control for industry-level time-varying unobservables. Column (6) consists of firm and state-year fixed effects to control for state-level time-varying unobservables. Industries are categorized using the four-digit SIC code. Standard errors are clustered at the CEO level.

	Low TFE $N = 5{,}364$		High TFE $N = 4{,}972$		Difference in means	
	Mean	Median	Mean	Median	Low–high	*p*-value
CEO characteristics						
CEO tenure	8.4	6.0	7.7	6.0	0.6***	0.000
CEO education	1.216	1	1.205	1	−0.048**	0.023
Ivy league degree	0.257	0	0.170	0	0.087***	0.000
CEO compensation	8,118	4,485	6,127	3,590	1,991***	0.000
Delta	2,779	378	1,119	289	1,660***	0.000
Vega	257	86	177	65	81***	0.000
CEO overconfidence	0.246	0	0.239	0	0.007	0.386
Founder CEO	0.143	0	0.141	0	0.002	0.846
General ability index (GAI)	0.250	0.063	0.258	0.155	−0.008	0.766
Hofstede individualism	75.7	76.0	77.9	80.0	−2.1***	0.000
Hofstede uncertainty avoidance	52.0	35.0	48.8	35.0	3.3***	0.000
CEO network	1,941	1,374	1,887	1,448	55	0.221
Inventor CEO	0.058	0	0.056	0	0.002	0.713
Patent variables						
Number of patents, *t+2*	57.7	0	73.7	0	−16.0***	0.006
Number of adjusted citations, *t+2*	59.9	0	79.3	0	−19.4***	0.001
Real market value of patents, *t+2*	1,066	0	1,187	0	−121*	0.091
Nominal market value of patents, *t+2*	2,219	0	2,496	0	−277*	0.063
Top 10% patents, *t+2*	7.1	0	10.4	0	−3.2***	0.000
Top 5% patents, *t+2*	3.5	0	4.9	0	−1.4***	0.000
Top 1% patents, *t+2*	0.7	0	1.0	0	−0.3***	0.000
Mangement team quality						
Team size	9.1	9	9.2	9	−0.1	0.145
Team MBA	0.349	0.333	0.337	0.333	0.012**	0.013
Team PhD	0.034	0	0.035	0	−0.001	0.465
Team network size	2,294	2,039	2,019	1,708	276***	0.000
Team experience	0.563	0.600	0.551	0.583	0.011	0.117
Team tenure	5.022	4.900	5.014	4.778	0.008	0.903
Firm characteristics						
Total assets	33,044	4,518	25,124	4,102	7,920	0.003
Capital expenditures	0.047	0.037	0.057	0.046	−0.010	0.000
R&D expenditures	0.034	0	0.031	0	0.003	0.012
Employees	35.011	12.100	36.794	10.870	−1.783	0.268
Firm age	24.8	26.0	25.0	26.0	−0.2	0.350
Tobin's Q	1.699	1.164	1.576	1.143	0.123	0.009
Profitability	0.135	0.132	0.140	0.134	−0.005	0.002
Overall firm rating	3.324	3.370	3.391	3.430	−0.067	0.012
CEO approval rating	0.336	0.376	0.373	0.408	−0.037	0.037
Work-life-balance rating	3.286	3.283	3.316	3.342	−0.029	0.293
Compensation and benefits rating	3.185	3.173	3.252	3.250	−0.067	0.007
Career opportunity rating	2.941	2.974	3.023	3.003	−0.082	0.001
Number of evaluations	125	26	100	21	25	0.023
Employment quality monitoring score	0.458	0.423	0.442	0.423	0.015	0.013
Total tech job positions	0.761	0	1.023	0	−0.262	0.510
Stock return volatility, *t+1*	0.021	0.018	0.021	0.018	0.000	0.945
Idiosyncratic volatility, *t+1*	0.020	0.017	0.020	0.016	0.000	0.703
Number of announced acquisitions, *t+1*	0.933	0	0.966	0	−0.033	0.416
Number of effective acquisitions, *t+1*	0.669	0	0.698	0	−0.029	0.386

Table 2. Descriptive statistics for low and high TFE subsamples

(*continued*)

	Low TFE $N = 5{,}364$		High TFE $N = 4{,}972$		Difference in means	
	Mean	Median	Mean	Median	Low–high	p-value
Inventor variables						
Net inflow of top 10% inventors, $t+2$	0.169	0.000	0.179	0.000	−0.010	0.269
Net inflow of top 5% inventors, $t+2$	0.141	0.000	0.139	0.000	0.002	0.788
Net inflow of top 10% inventors, $t+1$	0.167	0.000	0.179	0.000	−0.013	0.160
Net inflow of top 5% inventors, $t+1$	0.141	0.000	0.137	0.000	0.004	0.623

Note(s): The table reports the means and medians of firm characteristics for subsamples with low and high TFE. The sample is split at the sample median of TFE. The last column shows the p-values for the difference in means between the two subsamples

Table 2.

Table 3, Panel A presents the estimation results for equation (1), demonstrating a positive and significant relationship between TFE and corporate innovation. As shown in Column (3), a one standard deviation increase in TFE predicts a 6.0% increase in the (log) number of patents relative to the sample mean. Column (4) shows consistent findings, as a one standard deviation increase in TFE predicts a 5.7% increase in the (log) number of adjusted citations relative to the sample mean [6]. The results remain consistent in other columns using alternative fixed effects.

Moreover, the positive association between TFE and corporate innovation persists in various robustness tests. Panel A of Table A2 reveals that the relationship between TFE and innovation in years $t+1$ and $t+3$ is consistently positive. Panel B of Table A2 confirms the relationship when the dependent variables represent the number of patents and adjusted citations without taking the logarithm. In Panel B of Table A2, Columns (1) and (3) use the number of patents and adjusted citations as dependent variables, and Columns (2) and (4) use the number of innovations, excluding observations with zero innovation. Columns (5) and (6) present the regression results using Negative Binomial regression for the count variable [7]. Collectively, these results consistently demonstrate a positive relationship between CEO individualism, as captured by TFE and corporate innovation.

4.2 Alternative explanations

One potential concern regarding CEO individualism measured by TFE is that it may serve as a proxy for known determinants of innovation. To address alternative explanations, I estimate the relationship between TFE and innovation, including additional control variables. The results are presented in Table 3, Panel B. The dependent variable is the logarithm of one plus the number of patents in year $t+2$. CEO education background may influence innovation; for instance, He and Hirshleifer (2022) demonstrate that an exploratory mindset (proxied by a Ph.D. degree) can affect a firm's innovation. Therefore, I control for CEO education in Column (1), including the highest degree obtained by a CEO and an indicator for an Ivy League degree, following Islam and Zein (2020). CEO overconfidence is known to positively impact firm investment decisions (Malmendier & Tate, 2008; Galasso & Simcoe, 2011; Hirshleifer *et al.*, 2012), thus, Column (2) controls for an indicator of CEO overconfidence, defined as in Hirshleifer *et al.* (2012) and Islam and Zein (2020). CEO compensation may provide incentives affecting managers' decisions. For example, Mao and Zhang (2018) document that risk-taking incentives can affect corporate innovation. Column (3) accounts for CEO compensation measures, including total compensation (TDC), Delta and Vega. Column

Table 3. CEO individualism and firm innovation

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: CEO individualism and firm innovation (base set of controls)						
	Log(1+patents), *t+2*				Log(1+citations adj.), *t+2*	
TFE	*0.056**	*0.078****	*0.057**	*0.048**	*0.071****	*0.079***
	(1.94)	*(3.17)*	*(1.93)*	*(1.65)*	*(2.87)*	*(1.99)*
Log CEO age	−0.296	0.426**	0.172	−0.305	0.516**	0.307
	(−1.06)	(2.19)	(0.59)	(−1.06)	(2.49)	(1.48)
Log CEO tenure	0.009	−0.070***	−0.028	0.018	−0.072***	−0.066***
	(0.25)	(−3.07)	(−0.92)	(0.49)	(−2.98)	(−2.81)
Firm size	0.447***	0.125**	0.244***	0.461***	0.107**	0.129**
	(7.79)	(2.50)	(3.12)	(7.69)	(2.05)	(2.51)
R&D expenditures	4.464***	0.172	0.192	4.382***	−0.583	0.157
	(5.53)	(0.22)	(0.19)	(4.85)	(−0.70)	(0.23)
Capital expenditures	3.689***	0.539	0.481	3.657***	0.488	0.466
	(5.67)	(1.57)	(1.09)	(5.54)	(1.39)	(1.27)
Log firm age	0.089	−0.200*	−0.406**	0.056	−0.154	−0.124
	(1.27)	(−1.77)	(−2.06)	(0.78)	(−1.20)	(−1.17)
Log employees	0.296***	0.356***	0.327***	0.270***	0.331***	0.317***
	(3.82)	(4.60)	(2.60)	(3.33)	(4.13)	(4.18)
Observations	10,336	10,336	7,649	10,336	10,336	10,030
Adjusted R^2	0.681	0.903	0.923	0.654	0.884	0.907
Industry FE	Yes	No	No	Yes	No	No
Year FE	Yes	Yes	No	Yes	Yes	No
Firm FE	No	Yes	Yes	No	Yes	Yes
State-Year FE	No	No	No	No	No	Yes
Industry-Year FE	No	No	Yes	No	No	No

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel B: individualism and firm innovation (expanded set of controls)								
				Log(1+patents), *t+2*				
TFE	*0.079****	*0.078****	*0.068****	*0.103****	*0.051**	*0.053**	*0.078****	*0.098****
	(3.23)	*(3.17)*	*(2.75)*	*(3.07)*	*(1.66)*	*(1.78)*	*(3.19)*	*(2.86)*
CEO education	−0.030							
	(−1.06)							
Ivy League degree	0.095							
	(1.40)							

(*continued*)

Table 3.

Panel B: individualism and firm innovation (expanded set of controls)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	Log(1+patents), $t+2$							
CEO overconfidence		0.003						
		(0.11)						
Log CEO compensation			0.014					
			(0.91)					
Log Delta			0.009					
			(0.73)					
Log Vega			0.003					
			(0.26)					
Founder CEO				−0.097				
				(−0.83)				
General ability index (GAI)					0.021			
					(0.62)			
Uncertainty avoidance (UAI)						0.003**		
						(1.98)		
Inventor CEO							0.024	−0.446**
							(0.157)	(−2.35)
Log team size								−0.144
								(−1.55)
Team MBA								0.225
								(1.41)
Team PhD								−0.187
								(−0.48)
Log team network								0.122**
								(2.10)
Team experience								−0.206
								(−1.59)
Log team tenure								0.047
								(0.58)
Observations	10,336	10,336	9,605	4,816	6,272	6,901	10,336	5,939
Adjusted R^2	0.903	0.903	0.907	0.933	0.922	0.919	0.903	0.931
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note(s): The dependent variable in Columns (1), (3) and (5) of Panel A and in all columns of Panel B is the log of one plus the total number of patents filed by firm in year $t+2$; the dependent variable in Columns (2), (4) and (6) is the log of one plus the total number of citations adjusted by the year-patent class average in year $t+2$. Specifications in Panel A include the base set of controls and specifications in Panel B include a base set of controls and additional control variables (as shown) that address alternative explanations. Industries are classified using the four-digit SIC codes. The t-statistics based on the standard errors clustered at the CEO level are reported in parentheses.*, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively

(4) includes an indicator of whether the CEO is the founder to eliminate the possibility that innovation is driven by CEOs' founder status (Hellmann & Puri, 2002; Lee *et al.*, 2017). Column (5) controls for the GAI, which can positively affect firm innovation, calculated by Custódio *et al.* (2019). Column (6) includes the Hofstede uncertainty avoidance index (UAI) to address the potential impact of CEOs' risk preferences on innovation outcomes. Additional estimations in Appendix show that TFE does not drive innovation through risk-taking activities. Column (7) includes an indicator of whether the CEO is an inventor following Islam and Zein (2020), to exclude the possibility that CEO individualism may proxy for their hands-on experience as an inventor. Column (8) accounts for management team quality variables that can also affect innovation, following Chemmanur *et al.* (2019). Firm- and year-fixed effects are included in all columns, and standard errors are clustered at the CEO level.

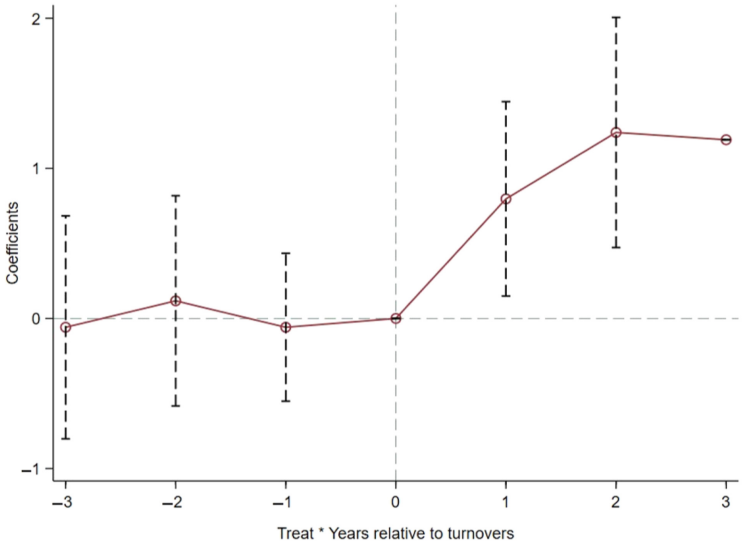
In Table 3, Panel B, the positive coefficients estimated for TFE remain consistent and significant across all specifications, suggesting that the relation between CEO individualism and corporate innovation is not driven by known determinants of innovation. Notably, risk-taking is a recognized driver of innovation and exhibits a positive correlation with individualism as measured by the Hofstede score (Chui *et al.*, 2010; Li *et al.*, 2013; Ashraf, Zheng, & Arshad, 2016). In addition to controlling for the uncertainty avoidance index (UAI), I further demonstrate that CEO individualism, as measured by TFE, does not increase corporate risk-taking outcomes such as stock return volatilities or activities such as merger and acquisition deals. The results are presented in Appendix Table A3. In conclusion, the positive association between CEO individualism measured by TFE and firm innovation cannot be explained by known determinants of innovation. Individualistic CEOs enhance corporate innovation through channels uniquely linked to their individualistic preferences.

5. Estimation using CEO turnover sample

One potential concern is that the CEO-firm matches may correlate with CEO and firm characteristics. While the firm-fixed effects account for time-invariant firm-level characteristics, the firm-CEO match can be affected by time-varying attributes. To mitigate this concern, in this section, I conduct a DID estimation using a sample of CEO turnovers that occur for reasons unrelated to firm performance. The CEO turnover events generate natural variation in CEO individualism. Gentry *et al.* (2021) provide a dataset of S&P 1500 firms' CEO dismissals from 2000 to 2018, featuring detailed reasons for departures. Starting with 4,183 CEO turnover events with reasons including illness, personal issues, retirement and career opportunities, which are uncorrelated with performance, I focus on 486 events where TFE information is available for both departing and replacement CEOs. Firms in the sample of CEO turnovers are classified as *Treated* (*Control*) if the incoming CEO has a higher (lower) TFE than the outgoing CEO. The sample contains 176 treated and 179 control firms [8]. The *Post* indicator variable is set to one if a given year is after the turnover year and is zero otherwise. The graphic analysis of the pre-trend is presented in Figure 2. I then estimate the following model on the turnover sample:

$$\text{Innovation}_{i,t+2} = \alpha_i + \beta \cdot \text{Treated} \cdot \text{Post} + \beta_1 \cdot \text{Post} + \gamma \cdot X_{j,t} + \delta \cdot Z_{i,t} + \lambda_k + \delta_t + \epsilon_{i,t}. \quad (2)$$

here i indexes firms and k indexes the turnover events. The dependent variables are various measures of firm innovation and control variables include CEO and firm characteristics. Columns (1) and (2) use a 3-year event window ([−3, −1] as pre and [1,3] as



Note(s): This figure displays the regression coefficients β_k and the corresponding 95% confidence intervals estimated for the sample of CEO turnover events using the following model: $Y_{i,t+2} = \alpha_i + \sum_{k=-3}^{k=3} \beta_k \cdot \text{Treated} \cdot \text{Year} + \gamma \cdot \text{Treated} + \sum_{k=-3}^{k=3} \delta_k \cdot \text{Year} + Z_{i,t} + \eta_i + \zeta_{t,ind\,i} + \epsilon_{j,t}$, where Y is the log of one plus the number of patents filed by the firm, Year is the year relative to the CEO turnover event, and Treated is an indicator variable equal to one if the replacement CEO is more individualistic than the departing CEO. $Z_{i,t}$ is the set of CEO and firm control variables. η_i is firm fixed effects. $\zeta_{t,ind\,i}$ is the year-industry fixed effects. Standard errors are clustered at the CEO level

Figure 2.
Firm innovation around CEO turnover events

post), whereas columns (3) and (4) employ a 4-year event window. All specifications incorporate event (λ_k) and year fixed effects. The coefficients on variables *Treated* are subsumed by the event-fixed effects. Standard errors are clustered at the firm level. Table 4 reports the DID results for the raw sample of 355 (=176 + 179) CEO turnover events in columns (1)-(4).

The coefficients estimated for the interaction terms "Treated" and Post" are positive and significant across all columns. Post turnovers, treated group firms experiencing an increase in CEO individualism exhibit a 6.6% increase in the (log) number of patents and a 7.9% increase in the (log) number of adjusted citations relative to the sample mean, compared to firms in the control group. This outcome is consistent with the baseline results, suggesting that CEO individualism positively impacts firm innovation.

While CEO departures are uncorrelated with performance, selecting a replacement CEO might still correlate with firm and CEO characteristics. To further alleviate this concern, I apply propensity score matching to create matched treated and control groups. The matching process is based on the replacement CEO's age, tenure, firm size, R&D expenditures, capital expenditures and firm employment. The matched sample consists of 128 in the treated group and 70 events in the control group. Table A4 in Appendix

Dependent variable	Log(1+patents), $t+2$			Log(1+citation adj.), $t+2$		
	(1)	(2)	(3)	(4)	(5)	(6)
Treated×Post	*0.228***	*0.256***	*0.797***	*0.267***	*0.298***	*1.023***
	(2.26)	*(2.56)*	*(2.33)*	*(2.07)*	*(2.32)*	*(2.36)*
Post	−0.053	−0.204	−0.800***	−0.016	−0.117	−1.049***
	(−0.30)	(−1.35)	(−2.37)	(−0.08)	(−0.69)	(−2.47)
Observations	916	1,162	436	916	1,162	436
Adjusted R^2	0.948	0.940	0.941	0.929	0.922	0.917
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Sample type	Raw	Raw	Matched	Raw	Raw	Matched
Sample window	[−3,+3]	[−4,+4]	[−3,+3]	[−3,+3]	[−4,+4]	[−3,+3]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Event FE	Yes	Yes	Yes	Yes	Yes	Yes

Note(s): The table presents the results of the OLS regressions for the sample of CEO turnovers, where the reason for CEO departure is unrelated to firm performance, such as CEO death, health issues or retirement (Gentry *et al.*, 2021). Columns (1)–(2) and (4)–(5) present the estimation results using the raw sample, whereas Columns (3) and (6) show the estimation results using the matched sample from propensity score matching. Columns (1), (3), (4) and (6) use a 3-year event window around the turnover, whereas Columns (3) and (4) use a 4-year event window. The control variables (not shown) include the logarithm of CEO age, the logarithm of CEO tenure, firm size, the logarithm of firm age, capital expenditure, R&D expenditures and the logarithm of the number of firm employees. Event- and year-fixed effects are included in all columns. Standard errors are clustered at the firm level, with t-statistics presented in parentheses.*, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively

Table 4.
Difference-in-differences estimation around CEO turnover events

shows that the main control variables exhibit little difference between the treated and control groups in the pre-turnover years. From years $t-3$ to $t-1$, treated and control groups are similar in CEOs' age, tenure, firm size, R&D expenditures, capital expenditures and employees.

Table 4, Columns (5) and (6), report the DID results for the matched sample using a 3-year event window, including event- and year-fixed effects in both columns. Standard errors are clustered at the firm level. In line with the estimation results on the raw sample, the coefficients on the interaction terms are positive and significant across all specifications. An increase in CEO individualism measured by TFE predicts 23.1% more patents and 30% more adjusted citations relative to the sample mean following CEO turnover. These estimation results collectively support that CEO individualism, as measured by TFE, positively impacts firm innovation.

6. CEO individualism and innovation quality

The baseline and DID estimation results demonstrate that CEO individualism measured by TFE can enhance a firm's innovation quantity. However, do firms merely increase the number of patents by producing lower-quality patents? To answer this question, I investigate whether CEO individualism also improves the quality of innovation in this section. I employ two measures to assess patent quality: the number of top-cited patents and the market value of patents.

A top patent receives citations within the top 10%, 5% and 1% percentiles. Top patents generally are ground-breaking innovations with significant impacts. The market value of patents is collected from Kogan *et al.* (2017), who use the stock market reaction of the patent filing. This measure reflects the market's perception of the patent and the economic value it creates. Individualistic CEOs, who value radical innovation and exploration, are more likely to choose innovative projects with more potential and explore novel knowledge and technologies, hence raising the likelihood of producing high-quality patents. To examine

the relationship between CEO individualism and patent quality, I estimate the following model:

$$\text{Patent quality}_{i,t+2} = \alpha_i + \beta \cdot \text{TFE}_{j,t} + \gamma \cdot X_{j,t} + \delta \cdot Z_{i,t} + \eta_i + \delta_t + \epsilon_{j,t}. \quad (3)$$

Table 5 Panel A presents the estimation results for top-cited patents. The dependent variables encompass the top 10%, 5% and 1% cited patents in years *t+2* and *t+1*. The control variables include the logarithm of CEO age, tenure, firm size, the logarithm of firm age, capital expenditure, R&D expenditure, and the logarithm of employees. All columns include firm and year-fixed effects, with standard errors clustered at the CEO level. The coefficients estimated for TFE are positive and significant across all columns. A standard

Panel A: top cited patents

	Top 10% patents		Top 5% patents		Top 1% patents	
	t+2	*t+1*	*t+2*	*t+1*	*t+2*	*t+1*
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
TFE	*3.166***	*2.226***	*1.045***	*1.188***	*0.212**	*0.207**
	(2.33)	*(2.26)*	*(2.12)*	*(2.32)*	*(1.91)*	*(1.94)*
Observations	10,336	10,336	10,336	10,336	10,336	10,336
Adjusted R^2	0.654	0.733	0.748	0.722	0.699	0.688
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: market value of patents

	Real market value of patents	Log real market value of patents	Nominal market value of patents	Log nominal market value of patents
Dependent variable	*t+2*	*t+2*	*t+2*	*t+2*
	(1)	(2)	(3)	(4)
TFE	*173.188**	*0.120***	*403.852***	*0.128***
	(1.74)	*(2.36)*	*(2.21)*	*(2.28)*
Observations	10,336	10,336	10,336	10,336
Adjusted R^2	0.814	0.873	0.828	0.865
Control variables	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes

Note(s): The dependent variables in Panel A are the number of top 10%, top 5% and top 1% cited patents. Control variables include the logarithm of CEO age, the logarithm of tenure, firm size, the logarithm of firm age, capital expenditure, R&D expenditure and the logarithm of employees. Firm- and year-fixed effects are included in all columns. Standard errors are clustered at the CEO level. The t-statistics are in parentheses.*, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. Panel B of Table 5 reports the regression of TFE on the market value of innovation. The dependent variables in Columns (1) and (2) are the real and the logarithm of the real value of patents. The dependent variables in Columns (3) and (4) are the nominal and the logarithm of the nominal value of patents. Control variables include the logarithm of CEO age, the logarithm of tenure, firm size, the logarithm of firm age, capital expenditure, R&D expenditure and the logarithm of employees. Firm and year-fixed effects are included in all columns. Standard errors are clustered at the CEO level. The t-statistics are in parentheses.*, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively

Table 5.
CEO individualism and firm innovation quality

deviation increase in TFE predicts 41.4%, 32.7% and 27.4% more top 10%, 5% and 1% patents relative to the mean.

Panel B of Table 5 displays the estimation results for patent market value. The dependent variables represent the real and nominal market value of patents generated by the firm in the year *t+2*. The estimation includes both the dollar value and the logarithm of the market value. A one standard deviation increase in TFE corresponds to a 17.6 and 19.6% increase in the real and nominal patent value, respectively. Overall, the estimation results indicate that individualistic CEOs enhance a firm's innovation quantity and quality.

7. Mechanism: hiring talented employees

In this section, I investigate the underlying mechanisms to explain the positive association between CEO individualism and corporate innovation. A key determinant of corporate innovation is the inventor and talented employees. Therefore, the ability to acquire top inventors is crucial in promoting innovation. Workplace environments with competitive compensation and promising career growth opportunities are appealing to skilled and talented candidates (Edmans, 2011; Bloom *et al.*, 2011; Edmans *et al.*, 2014; Huang *et al.*, 2015; Ian Carlin & Gervais, 2009; Chen *et al.*, 2016). One way to achieve this objective is to enhance a firm's reputation through improved social media ratings.

In order to investigate this hypothesis, I perform two tests. First, I obtain employee ratings from Glassdoor.com and investigate whether firms led by individualistic CEOs consistently display higher ratings. The rating system consists of five scores: overall rating, CEO rating, work-life balance, compensation and benefits and career opportunity. Each rating spans from 1 to 5, with 5 representing the highest score. Moreover, I collect data on the number of tech job positions from Bloom *et al.* (2021). The estimation results are presented in Table 6, Panel A.

Table 6, Panel A presents the estimation results for social media and tech-related job positions. The results reveal a positive and consistent association between CEO individualism and all five rating scores, suggesting that higher TFE is associated with more favorable social media evaluations of the firm [9]. Furthermore, increased CEO TFE corresponds to a higher number of tech job positions, though this relationship is not observed for total jobs created.

Next, I examine the relationship between CEO individualism, as measured by TFE, and the net inflow of top inventors. Following Chemmanur *et al.* (2019), I calculate the net inflow of top inventors as the logarithm of one plus the number of top inventors for the subsequent year, minus the logarithm of one plus the top inventors in the current year. Top inventors are defined as those who receive the top 10% or 5% of citations. Panel B of Table 6 reports the estimation results. The dependent variables are the net inflow of top inventors in years *t+2* and *t+1*. The estimated coefficients are positive and significant across all columns. A one standard deviation increase in CEOs' TFE predicts a 13.8% increase in the top 10% inventor inflow and a 16.3% increase in the top 5% inventor inflow. These findings suggest that firms led by individualistic CEOs successfully acquire and retain top inventors, which could contribute to the enhanced quality and quantity of innovation generated by the firm.

8. CEO individualism and monitoring

In this section, I explore additional aspects of firm management related to CEO individualism. While individualistic CEOs may enhance firms' innovation, their lack of collaboration and teamwork could make them less effective managers. A collectivist culture is associated with the benefit of reducing information asymmetry and shirking issues (Fan *et al.*, 2022). In contrast, an individualistic culture may suffer from higher information asymmetry and

Dependent variable	Overall firm rating (1)	CEO approval rating (2)	Work-life-balance rating (3)	Compensation and benefits rating (4)	Career opportunity rating (5)	Tech job positions (6)
	Panel A: employee work environment					
TFE	*0.074***	*0.037***	*0.101****	*0.056****	*0.076***	*2.321***
	(2.40)	*(2.01)*	*(2.68)*	*(2.86)*	*(2.53)*	*(2.35)*
Observations	2,224	2,188	2,224	2,224	2,224	481
Adjusted R^2	0.368	0.378	0.400	0.459	0.328	0.631
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Dependent Variable	Top 10% star inventor inflow *t+2* (1)	Top 5% star inventor inflow *t+2* (2)	Top 10% star inventor inflow *t+1* (3)	Top 5% star inventor inflow *t+1* (4)
	Panel B: top inventors joining the firm			
TFE	*0.021****	*0.020***	*0.020****	*0.016***
	(2.70)	*(2.38)*	*(2.70)*	*(2.17)*
Observations	10,336	10,336	10,336	10,336
Adjusted R^2	0.437	0.387	0.436	0.389
Control variables	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes

Note(s): The dependent variables in Panel A are the different categories of company ratings from Glassdoor.com and the total number of tech job positions. The dependent variables in Panel B are the net inflows of top inventors whose inventions rank among the top 10% or 5% cited patents. Control variables (not shown) include the logarithm of CEO age, the logarithm of CEO tenure, firm size, the logarithm of firm age, capital expenditure, R&D expenditures and the logarithm of the number of firm employees. The t-statistics based on the standard errors clustered at the CEO level are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively

Table 6.
Mechanisms: creating positive work environment and hiring top inventors

monitoring costs. To investigate this aspect, I collect employee quality monitoring scores from Refinitiv Asset4 and estimate the impact of individualism on these scores. The score, ranging from 0 to 1, represents the company's performance monitoring concerning employment quality. Table 7 presents the estimation results.

In Table 7, the dependent variable is the monitoring score. Columns (1) and (3) include year- and industry-fixed effects, while Columns (2) and (4) include year- and firm-fixed effects. Standard errors are clustered at the CEO level. Coefficients estimated are negative and consistent for all columns, indicating that individualistic CEOs are indeed associated with lower monitoring scores in corporate management. A flexible corporate environment may foster motivation among other managers and employees to undertake risky projects, experiment and learn from failures, as they face less pressure in case of failure Manso (2011). Although individualistic CEOs may not intentionally create a failure-tolerant environment, their tendency to overlook harmony and efficiency might contribute to a flexible corporate environment that encourages exploration.

Individualistic CEOs are not necessarily better managers, as they may not improve the overall production and firm performance. The potential benefits of individualism in promoting innovation come with trade-offs. While reduced monitoring can potentially lead to

Dependent variable	(1) Employee quality monitoring, t	(2) Employee quality monitoring, $t+1$	(3) Employee quality monitoring, t	(4) Employee quality monitoring, $t+1$
TFE	*−0.017***	*−0.019***	*−0.017**	*−0.020**
	(−2.76)	*(−2.93)*	*(−1.72)*	*(−1.74)*
Observations	3,298	3,099	3,298	3,099
Adjusted R^2	0.280	0.320	0.488	0.546
Control variables	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes
Firm FE	No	No	Yes	Yes

Note(s): The table examines the relations between CEO individualism, measured by TFE, and the intensity of employee monitoring. The dependent variable is the score assessing the company's performance monitoring regarding employment quality in year t and $t+1$. Industries are classified based on the four-digit SIC code. Control variables (data not shown) include the logarithm of CEO age, the logarithm of CEO tenure, firm size, the logarithm of firm age, capital expenditures, R&D expenditures, the logarithm of the number of firm employees, firm leverage, profitability and Tobin's Q. The t-statistics based on the standard errors clustered at the CEO level are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively

Table 7.
CEO individualism and intensity of employee monitoring

a flexible environment, it may also lead to inefficiencies. In addition to the drawbacks highlighted in Bazzi *et al.* (2020, 2021) and Bian *et al.* (2020), Gorodnichenko and Roland (2017) argue that individualism may not offer advantages in coordinating production processes. Despite the high market value of patents, I do not observe evidence that individualistic CEOs have significantly better performance. A lack of collective activities could result in individualistic CEOs facing difficulties converting this value into their firms' production.

9. Conclusion

In this paper, I investigate the impact of a CEO's cultural background on a firm's innovation. Extant literature (Gorodnichenko & Roland, 2011, 2012, 2017; Boubakri *et al.*, 2021) argues that individualism is the most important cultural factor for innovation. To provide firm-level evidence of this relation, I use a geographical-historical measure of individualism for CEOs in US firms and establish a positive relation between CEO individualism and innovation. To alleviate endogeneity concerns, I analyze a sample of CEO turnovers unrelated to firm performance and employ DID estimation. The results reveal that TFE is positively related to both the quantity and quality of innovation, suggesting that individualistic CEOs enhance a firm's innovative performance. These results cannot be explained by known determinants of innovation or risk-taking activities within the firm.

I then explore the underlying mechanism for this relationship and show that individualistic CEOs can acquire more talented employees and inventors for their organizations. I use social media ratings from Glassdoor to demonstrate that firms led by individualistic CEOs tend to have higher ratings and hence are more appealing to prospective employees. Furthermore, I find a positive association between CEO individualism, as measured by TFE, and the net inflow of top inventors. The estimation results suggest that individualistic CEOs promote corporate innovation by recruiting and retaining talented inventors. However, individualistic CEOs may exhibit reduced monitoring, potentially leading to inefficiencies. Despite high economic market value patents, these firms do not hold a production advantage or translate these gains into better performance.

In conclusion, this study emphasizes the influence of cultural background on a firm's innovation. It contributes to the literature on culture and firm performance and the literature on the impact of CEOs' characteristics on corporate innovation. The findings highlight the potential advantages of cultural individualism in fostering corporate innovation while suggesting potential trade-offs arising from a lack of collective activities. Although not the central focus of the study, the results may prompt further consideration of a more nuanced equilibrium between individualistic and collectivist cultures as a potentially plausible approach to fostering innovation while enhancing overall corporate performance.

Notes

1. Chui *et al.* (2010) find that country-level individualism is positively related to volatility and trading volume, Li *et al.* (2013) find that the standard deviation of ROA is higher in firms operating in countries with high individualism, and Ashraf *et al.* (2016) find that bank risk-taking is higher in countries with high individualism.
2. 1,508 CEOs' birthplaces for 1992–2012 are obtained from Bernile, Bhagwat, and Rau (2017).
3. Due to the truncation issue in the patent citation dataset, I removed the last few years of observation and retained the sample until 2016.
4. Ph.D. degree = 3, Master's degree = 2, Bachelor's degree = 1, other = 0.
5. Nevertheless, TFE captures not only the selection but also the treatment effect of cultural individualism. Furthermore, TFE provides two benefits compared to the Hofstede score. Firstly, the Hofstede score employs individuals' origins to gauge their cultural background, and many US-born CEOs have ancestors from the USA and the UK Consequently, approximately 40% of the CEOs in my sample display no variation in the Hofstede score, which is consistent with the summary statistics in Pan *et al.* (2017). Secondly, while it is common for US firms to have managers and employees with ancestors from the USA and the UK, it is unlikely that all of the CEOs' colleagues originate from the same county where they were born. Hence, TFE can more effectively emphasize the role of CEO management in fostering firm innovation.
6. The sample mean of the logarithm of one plus the number of patents and adjusted citations are 1.48 and 1.42, respectively.
7. The estimation result remains consistent if the dependent variable is an indicator, suggesting that the results are not driven by sample selection or distribution.
8. Additionally, for 131 firms there is no change in TFE around the CEO turnover event.
9. However, I do not find a significant relationship between CEO individualism and actual employee ratings.

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Appendix

Variable	Description
CEO characteristics	
TFE	Total frontier experience, defined as the duration of the frontier experience at the county of CEO birthplace. Source: Bazzi *et al.* (2020)
CEO age	Age of the CEO.
CEO tenure	Tenure of the CEO, calculated as the number of years as a firm CEO plus one. Source: Execucomp
CEO education	The highest degree earned by the CEO: 3 for Doctoral degree, 2 for Master's degree, 1 for Bachelor's degree and 0 otherwise. Source: BoardEx
Ivy League degree	An indicator variable equals to one if the CEO attended an Ivy League school. Source: BoardEx
CEO overconfidence	An indicator variable equal to one for all years when the CEO's options exceed 67% moneyness and zero otherwise, as defined in Hirshleifer *et al.* (2012) and Islam and Zein (2020). The total value per option of the in-the-money options is obtained by dividing the value of all unexercised exercisable options by the number of options in Execucomp. Next I divide this value per option by the price at the end of the fiscal years in Compustat
CEO compensation	Total annual CEO compensation (TDC1). Source: Execucomp
Delta	The dollar change in a CEO's stock and options portfolio with a 1% change in stock price following Coles *et al.* (2006). Source: Execucomp and CRSP.
Vega	The dollar change in a CEO's option holdings with a 1% change in stock return volatility following Coles *et al.* (2006). Source: Execucomp and CRSP.
Founder CEO	An indicator variable that equals 1 if the CEO is the founder of the firm. Source: Lee *et al.* (2017)
General ability index (GAI)	The GAI developed by Custódio *et al.* (2019)
Hofstede individualism	Hofstede individualism index constructed following Liu (2016) and Pan *et al.* (2017)
Hofstede uncertainty avoidance	Hofstede UAI, constructed following Liu (2016) and Pan *et al.* (2017)
CEO network	Network size of selected individual (number of overlaps through employment, other activities and education). Source: BoardEx
Inventor CEO	An indicator variable equal to one if the CEO is an inventor, defined following Islam and Zein (2020)
Inventor variables	
Net inflow of top inventors	Logarithm of one plus the number of top inventors minus the logarithm of the number of top 10% or 5% cited inventors in the previous year. Source: USPTO
Patent variables	
Number of patents	Total number of patents that a firm files in a year (Kogan *et al.*, 2017)
Number of citations	Total number of patent citations that a firm receives in a year (Kogan *et al.*, 2017)
Number of adjusted citations	Total number of patent citations that a firm receives in a year, scaled by year-class average (Kogan *et al.*, 2017)
Real (nominal) market value of patents	Real (nominal) market value of all patents a firm files in a year (Kogan *et al.*, 2017)
Top 1%, 5% or 10% innovation	The number of top 1%, 5% or 10% cited patents that a firm files in a year (Kogan *et al.*, 2017)
Management team quality	
Team size	The size of the firm's top management team. The team is defined as managers with the title of vice president or higher (BoardEx)
Team MBA	Fraction of the management team with an MBA degree (BoardEx)

(*continued*)

Table A1. Variable definitions

Variable	Description
Team PhD	Fraction of the management team with a PhD degree (BoardEx)
Team network size	The average number of connections of the management team (BoardEx)
Team experience	The fraction of the management team that served in top management prior to joining the current firm (BoardEx)
Team average tenure	The average tenure of the management team (BoardEx)
Firm characteristics	
Firm size	The logarithm of the book value of total assets (Compustat)
Firm age	The number years the firm exists in Compustat
R&D expenditures	The ratio of R&D expenses (XRD) to net sales (SALE); set to 0 when XRD items is missing (Compustat)
Capital expenditures	The ratio of capital expenditures to total assets (Compustat)
Log employees	Logarithm of the number of firm employees in thousands (Compustat)
Leverage	The ratio of debt (DLTT + DLC) to total assets (AT) (Compustat)
Profitability	Return on assets (OIBDP/AT) (Compustat)
Overall firm rating	Overall firm rating from Glassdoor.com
CEO approval rating	Rating of CEO from Glassdoor.com
Work-life-balance rating	Rating for work-life-balance from Glassdoor.com
Compensation and benefits rating	Rating for compensation and benefits from Glassdoor.com
Career opportunity rating	Rating for career opportunity from Glassdoor.com
Tech job positions	Number of tech jobs (Bloom *et al.*, 2021)
Stock return volatility	Daily stock return volatility in a year (CRSP)
Idiosyncratic volatility	Daily idiosyncratic stock return volatility in a year estimated using Fama-French-Carhart factors (CRSP)
Number of announced M&A deals	Number of announced M&A deals (SDC M&As)
Number of completed M&A deals	Number of completed M&A deals (SDC M&As)
Employee quality monitoring	A score between 0 and 1, which measures whether the company monitors the performance on employment quality. Source: Refinitiv Asset4

Table A1.

Panel A: alternative horizon for patents filed and cited

Dep. Variable	(1) Log(1+patents) *t+1*	(2) Log(1+citations adj.) *t+1*	(3) Log(1+patents) *t+3*	(4) Log(1+citations adj.) *t+3*
TFE	*0.071***	*0.066***	*0.079***	*0.066***
	(2.94)	*(2.75)*	*(3.31)*	*(2.77)*
Observations	10,336	10,336	10,336	10,336
Adjusted R^2	0.908	0.891	0.897	0.872
Control variables	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes

Panel B: number of patents and citations without taking the logarithm or excluding zero patents

Dep. Variable	(1) Numb. of patents *t+2*	(2) Numb. of patents, excluding zero-patent firms *t+2*	(3) Numb. of adjusted citations *t+2*	(4) Numb. of adjusted citations, excluding zero-patent firms *t+2*	(5) Numb. of patents, excluding zero-patent firms *t+2*	(6) Numb. of adjusted citations, excluding zero-patent firms *t+2*
TFE	*15.123***	*30.961***	*14.286***	*27.647***	*0.082***	*0.077**
	(3.09)	*(2.99)*	*(2.29)*	*(1.99)*	*(2.63)*	*(1.84)*
Observations	10,336	4,727	10,336	4,723	4,727	4,723
Adjusted R^2	0.833	0.826	0.791	0.781		
Estimation method	OLS	OLS	OLS	OLS	NB	NB
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Note(s): Panel A reports the OLS regressions using patent variables over alternative horizons than ones examined in Table 3: *t+1* and *t+3*. Panel B presents the robustness tests for Table 3 for the number of patents and adjusted citations at *t+2*, but without taking the logarithm and/or excluding zero-patent firms. Specifications (1)–(4) in Panel B show the results from the OLS regressions, while specifications (5) and (6) in Panel B present the results of the negative binomial regressions. Control variables (not shown) include the logarithm of CEO age, the logarithm of CEO tenure, firm size, the logarithm of firm age, capital expenditures, R&D expenditures and the logarithm of the number of employees. Standard errors are clustered at the CEO level. The t-statistics are in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. Standard errors are clustered at the CEO level. The t-statistics are in parentheses.*, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively

Table A2. Robustness tests: alternative measures of firm innovation

Dependent variable	(1) Stock return volatility, *t+1*	(2) Idiosyncratic volatility, *t+1*	(3) Numb. announced M&A deals, *t+1*	(4) Numb. completed M&A deals, *t+1*	(5) R&D exp., *t+1*
TFE	*0.000*	*0.000*	*0.058*	*0.037*	*0.032*
	(0.34)	*(0.35)*	*(1.22)*	*(0.96)*	*(0.98)*
Observations	9,980	9,980	10,336	10,336	10,091
Adjusted R^2	0.599	0.595	0.444	0.430	0.185
Control variables	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes

Note(s): The table examines the relation between CEO individualism and several measures of CEO risk-taking. The dependent variables are stock return volatility in Column (1), idiosyncratic volatility in Column (2), the number of announced M&A deals in Column (3), the number of completed M&A deals in Column (4) and R&D expenditures in Column (5). Control variables (not shown) include the logarithm of CEO age, the logarithm of CEO tenure, firm size, the logarithm of firm age, capital expenditures, R&D expenditures and the logarithm of the number of employees. Standard errors are clustered at the CEO level. The t-statistics are in parentheses.*, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively

Table A3.
Ruling out alternative explanation related to CEO risk-taking

		Mean		Difference in means	
	Year	Control	Treated	Control–treated	*p*-value
Log CEO age	t−3	4.051	4.047	0.004	0.822
	t−2	4.058	4.070	−0.012	0.492
	t−1	4.067	4.085	−0.018	0.274
Log CEO tenure	t−3	1.800	1.850	−0.050	0.573
	t−2	1.867	1.930	−0.063	0.494
	t−1	1.934	2.033	−0.099	0.252
Firm size	t−3	8.708	8.746	−0.038	0.861
	t−2	8.697	8.668	0.029	0.887
	t−1	8.767	8.739	0.028	0.883
R&D expenditures	t−3	0.026	0.030	−0.004	0.606
	t−2	0.023	0.030	−0.007	0.331
	t−1	0.021	0.032	−0.011	0.123
Capital expenditures	t−3	0.07	0.063	0.007	0.335
	t−2	0.064	0.062	0.002	0.736
	t−1	0.062	0.062	0.000	0.975
Log employees	t−3	3.196	3.158	0.038	0.813
	t−2	3.189	3.077	0.112	0.45
	t−1	3.153	3.061	0.092	0.525

Note(s): The table reports the mean values of CEO and firm characteristics for treated and control firms for three years prior to the CEO turnover. The last column reports *p*-value for the test for the difference in means between the two samples

Table A4.
Examining parallel trends assumption around CEO turnover events