Routledge
Taylor & Francis Group

Economic Research-Ekonomska Istraživanja

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rero20

Does culture diversity affect innovation? Evidence from Chinese business group affiliated firms

Hui Xu, Bo Cheng & Qiaoling Fang

To cite this article: Hui Xu, Bo Cheng & Qiaoling Fang (2023) Does culture diversity affect innovation? Evidence from Chinese business group affiliated firms, Economic Research-Ekonomska Istraživanja, 36:1, 2180415, DOI: 10.1080/1331677X.2023.2180415

To link to this article: https://doi.org/10.1080/1331677X.2023.2180415

Published online: 09 Mar 2023.

ECONOMIC RESEARCH-EKONOMSKA ISTRAŽIVANJA
2023, VOL. 36, NO. 1, 2180415
https://doi.org/10.1080/1331677X.2023.2180415

Does culture diversity affect innovation? Evidence from Chinese business group affiliated firms

Hui Xu[a], Bo Cheng[b] and Qiaoling Fang[c]

[a]School of Accounting, Yunnan University of Finance and Economics, Kunming, China; [b]School of Accountancy, Nanjing Audit University, Nanjing, China; [c]School of Economics and Management, Fuzhou University, Fuzhou, China

ABSTRACT

We analyze how intra-group culture diversity affect group affiliated firm's innovation. Our findings suggest that the more inconsistency on risk preference among affiliated firms in one group, the less impact of affiliated firm's own risk culture on innovation. Specifically, we document that intra-group culture diversity impedes individual affiliated firm's innovation through managerial and controlling agency problems. The heterogeneity test shows that size, executives, headquarter connected, location, state ownership and information quality of affiliated firms can affect intra-group culture diversity on innovation. We prove that intra-group culture diversity impedes innovation on group affiliated firms, which means a dark side of business group affiliation.

ARTICLE HISTORY
Received 29 October 2022
Accepted 8 February 2023

KEYWORDS
Culture diversity; business group; innovation; collectivism; individualism

JEL CLASSIFICATION
G31; M14

1. Introduction

Culture has economic consequence (Guiso et al., 2015). With the development of culture and finance, the study of culture on corporate decision gets much attention in the last decade (Zingales, 2015), including culture increasing accounting conservatism (Kanagaretnam et al., 2014), earnings discretion (Chen et al., 2018), or board gender diversity (Lewellyn & Muller-Kahle, 2020), corporate risk taken (Li et al., 2013), as well as different kind of corporate investment (Adhikari & Agrawal, 2016; Hilary & Hui, 2009; Kayalvizhi & Thenmozhi, 2018; Lim et al., 2016). Whether related studies measuring culture by cultural elements (Hilary & Hui, 2009) or a specific type of culture (Cheng et al., 2020), there is a particular need to focus on how culture diversity affect culture consequence on corporate decisions. Since cultural diversity is hard to measure directly, existing studies have only been able to use country-specific cultural indices to measuring culture diversity on foreign joint ventures (Li et al., 2013), or on companies with foreign operations (Braguinsky & Mityakov, 2015), etc. There is still a significant lack of research on how cultural diversity within organization affects its

CONTACT Qiaoling Fang qiaolingfang@fzu.edu.cn

decisions. Actually, some firms are affiliated with business groups. Affiliated firms under one business group share the same share controller, while they have different cultures. Using the specific research design on business group's affiliated firm samples, we measuring intra group culture diversity from individualism and collectivism, then argue and testify how intra group culture diversity affect and impede corporate risk decision, such as innovation.

We conduct our investigation in China for three reasons. First, China is a country that are deeply affected by informal regulations, such as culture of collectivism. As an eastern country, Chinese society always consider more on collectivism rather than individualism through its long history. Meanwhile, China has been increasingly opened up to the West after the Opium War in 1840, amidst these opening-up endeavors, western values, such as individualism, independence, gradually gained popularity, strongly battering the Chinese traditional culture (Chen et al., 2019). Till today, culture diversity from collectivism to individualism may still have clearly effect on corporate decision. Second, business group are widely existed in emerging countries, including Korea, India, Mexcio, and especially in China. Most group affiliated firms are listed in Chinese capital market that facilitate us to acquire culture elements from their disclosed textual information, then provide us a chance to see the intra group culture diversities through different group affiliated firms. Third, Chinese innovation inputs and outputs have maintained rapid growth in the last decade (Cumming et al., 2021), Chinese total investment in R&D has increased to 2.4 trillion, the ranking of the Global Innovation Index has risen rapidly to 14th. In the next five years, Chinese government plans to maintain an average annual growth rate of "more than 7%" in the scientific and technological resources of the whole society. Related literatures such as Cheng et al. (2016) indicated that high individualism countries are more innovative. Under Chinese strongly policy incentives on innovation, we use group affiliated firms' data to analyze and testify how culture diversity affect and impede innovation.

We document several findings. First, we report that more risk preference brings more patents to group affiliated firms, which is consistently with relevant literature that risk promotes innovation. Then, after considering collective culture from the whole group, it shows that the higher degree of inconsistency in risk preference among different individualism of affiliated firms in group, the weaker impact of affiliated firm's own risk culture on patent. In other words, the difference between intra group collective culture and affiliated firm's individual culture impedes innovation. The findings are robust to a battery of alternative tests and after accounting for endogeneity.

Second, we document that intra group culture diversity will impede individual affiliated firm's innovation through aggravate agency problems. On one hand, when affiliated firm has more severe managerial problem, it's manager will be more self-interested, thus risk culture diversity from whole group to individual will impede more on affiliated firm's innovation. On the other hand, when existing more conflicts between controlling and minority shareholders, there might be more dissension from group headquarter to affiliated firms, thus risk culture diversity from whole group to individual will impede more on affiliated firm's innovation.

Third, we test the heterogeneity respectively from the whole group level and affiliated firm's level. From group level, we find that when size of affiliated firm is small,

it's more susceptible to risk culture diversity of intra group, which brings a more negative impact on affiliated firm's innovation. Following the same logic, when affiliated firm's executives have no concurrent position in headquarter, affiliated firms located not very far from each other, or affiliated firm's executives are most powerful compared with other affiliated firms, there brings more negative impact on affiliated firm's innovation.

From affiliated firm's level, we testify in two points. For one hand, in state-owned group, executives from affiliated firms are mostly assigned from government, constrained by strictly regulations. On the contrary, in non-state group, corporate governance is not very complete, most of them are family groups, that informal regulation is more prevalent, thus are more easily affected by culture. For another hand, when affiliated firm has better financial information quality, there will be a better communication between headquarter and affiliated firms, thus are less affected by culture. We find that in non-state affiliated firms, as well as in low information quality firms, there bring more negative impact on affiliated firm's innovation.

We make several contributions to the literature. First, we expand the literature on Culture and Finance. Although related research widely discusses how different kind of culture affect corporate risky decisions (Adhikari & Agrawal, 2016; Hilary & Hui, 2009; Li et al., 2013), the evidence is based mainly on single firms (Hilary & Hui, 2009). In some papers such as Li et al. (2013) and Shi and Tang (2015), authors use joint venture companies or associated companies to capture and research on how culture similarity or culture diversity affect corporate risky decisions. However, it's still very hard to capture organization's internal culture diversity. We use the specific setting by measuring group affiliated firms' culture diversity, provide the full evidence chain from Tables 1–3, to document that the difference between intra group collective culture and affiliated firm's individual culture impedes corporate innovation. Our findings complement the literature on economic consequence of culture diversity from the view of intra business group and group affiliated firms.

Second, we advance the literature on business groups in emerging markets. The business group literature focuses more on the internal capital market at firms in East Asia (Claessens et al., 2006), Korea (Shin & Park, 1999), China (He et al., 2013), India (Khanna & Palepu, 2000), among others. In recently years, some paper also focus on corporate governance of business groups, indicates that group affiliated firms tend to hire top 10 auditors to improve financial quality (Fang et al., 2017). We show that, the higher degree of inconsistency in risk preference among different individualism of affiliated firms in group, the weaker impact of affiliated firm's own risk culture on patent. Our finds expand the group literature by proposing that not only the internal group resource allocation (He et al., 2013), or corporate governance (Fang et al., 2017), but also the intra group cultural interaction affect group affiliated firm's decision. Moreover, we discuss on the intrinsic mechanism of our story from the view of agency problems, and provide more evidence from the Table 4, support the existed business group literature that the firstly and secondly agency problems are very important to group affiliated firm's risky decisions. There exists a famous conclusion that emerging market's business groups may bring the Bright Side or Dark

Table 1. The cultural differences in risk preference and innovation capability.

	(1) *Patents*	(2) $Patents_{[t+1]}$
RiskPreferDiff G5	**-0.055*****	**-0.059*****
	(−3.633)	**(−3.724)**
RD	9.184***	7.522***
	(7.993)	(6.223)
MissRD	0.830***	0.768***
	(9.694)	(8.538)
Size	0.529***	0.530***
	(15.105)	(14.257)
Lev	−0.081	−0.144
	(−0.445)	(−0.758)
EstAge	−0.163	−0.242**
	(−1.579)	(−2.339)
Roa	2.240***	2.219***
	(4.090)	(4.079)
CF	0.064	0.069
	(0.201)	(0.202)
Growth	−0.048	−0.029
	(−1.321)	(−0.784)
Capex	−1.409***	−1.398**
	(−2.599)	(−2.441)
Intaratio	−0.171	−0.123
	(−0.874)	(−0.490)
Top1	−0.402	−0.348
	(−1.616)	(−1.340)
Mshare	−0.820*	−0.433
	(−1.705)	(−0.832)
Instshare	0.093	0.098
	(0.562)	(0.561)
Boardsize	−0.012	−0.004
	(−0.559)	(−0.194)
Ind	0.770	0.897
	(1.186)	(1.322)
Big4	0.127	0.130
	(0.925)	(0.929)
Loss	−0.203***	−0.203***
	(−3.078)	(−2.824)
Sustainable	−0.201	0.030
	(−0.961)	(0.142)
EI	−0.003	0.001
	(−0.256)	(0.067)
GDP	0.258***	0.252***
	(5.057)	(4.653)
_cons	−13.279***	−12.352***
	(−14.038)	(−13.549)
Industry	Yes	Yes
Year	Yes	Yes
N	7206	6556
adj. R^2	0.539	0.526

Note: ***, **, and S indicate significant at the level of 1%, 5% and 10% respectively.
Source: The authors.

Side (Khanna & Palepu, 2000), we provide the Dark Side evidence from intra group culture diversity, which have not mentioned in the group literature yet.

Third, we show that culture diversity affect innovation. Specifically, we provide evidence to prove that the difference between business group's collective and individual culture can impede affiliated firm's innovation. Compared with the existing literatures, Adhikari and Agrawal (2016) already proved that regional culture can affect

Table 2. The risk preference, the cultural differences in risk preference and innovation capability.

	(1) *Patents*	(2) $Patents_{[t+1]}$
RiskPreferDiff G5	0.168***	0.164***
	(4.596)	(4.312)
RiskPreferG5	0.028	0.019
	(0.856)	(0.534)
RiskPreferDiffG5 × RiskPreferG5	**-0.024****	**-0.022****
	(−2.352)	**(−2.066)**
RD	8.740***	7.048***
	(7.636)	(5.852)
MissRD	0.820***	0.758***
	(9.636)	(8.496)
Size	0.529***	0.530***
	(15.276)	(14.411)
Lev	−0.067	−0.133
	(−0.374)	(−0.711)
EstAge	−0.155	−0.233**
	(−1.513)	(−2.275)
Roa	2.175***	2.138***
	(3.977)	(3.921)
CF	0.052	0.049
	(0.165)	(0.145)
Growth	−0.052	−0.033
	(−1.444)	(−0.880)
Capex	−1.346**	−1.332**
	(−2.488)	(−2.326)
Intaratio	−0.206	−0.147
	(−1.057)	(−0.593)
Top1	−0.381	−0.327
	(−1.551)	(−1.274)
Mshare	−0.868*	−0.498
	(−1.848)	(−0.979)
Instshare	0.111	0.117
	(0.680)	(0.675)
Boardsize	−0.011	−0.003
	(−0.523)	(−0.137)
Ind	0.748	0.874
	(1.169)	(1.304)
Big4	0.139	0.145
	(1.019)	(1.036)
Loss	−0.190***	−0.194***
	(−2.925)	(−2.741)
Sustainable	−0.180	0.056
	(−0.874)	(0.267)
EI	−0.004	−0.001
	(−0.398)	(−0.071)
GDP	0.247***	0.241***
	(4.972)	(4.551)
_cons	−13.699***	−12.808***
	(−14.650)	(−14.162)
Industry	Yes	Yes
Year	Yes	Yes
N	7206	6556
adj. R^2	0.544	0.531

*Note:****, **, and * indicate significant at the level of 1%, 5% and 10% respectively.
Source: The authors.

innovation, but we proved that in emerging countries, when business groups are widely existed, group affiliated firm's innovative policy depends on not only its own culture, but also intra group cultural diversity.

Table 3. The subgroup test: the risk preference, the cultural differences in risk preference and innovation capability.

	(1) First subgroup *Patents*	(2) Second subgroup *Patents*	(3) Third subgroup *Patents*
RiskPrefer	1.772***	0.636***	0.386
	(2.864)	(3.696)	(1.350)
RD	4.921*	9.243***	11.514***
	(1.862)	(7.618)	(4.898)
MissRD	0.916***	0.774***	0.804***
	(5.510)	(8.544)	(4.885)
Size	0.514***	0.525***	0.556***
	(7.301)	(14.588)	(9.542)
Lev	0.201	0.006	−0.399
	(0.516)	(0.030)	(−1.280)
EstAge	−0.016	−0.183*	−0.169
	(−0.076)	(−1.720)	(−0.882)
Roa	3.714**	2.358***	0.969
	(2.229)	(3.984)	(0.948)
CF	−0.315	0.029	0.534
	(−0.435)	(0.079)	(0.883)
Growth	−0.173**	−0.049	0.022
	(−2.165)	(−1.094)	(0.285)
Capex	−1.147	−1.193**	−2.538**
	(−1.066)	(−2.155)	(−2.181)
Intaratio	−0.052	−0.236	−0.027
	(−0.118)	(−1.159)	(−0.058)
Top1	−0.180	−0.575**	−0.173
	(−0.433)	(−2.120)	(−0.400)
Mshare	−0.408	−2.019***	0.428
	(−0.533)	(−3.493)	(0.659)
Instshare	−0.161	0.119	0.196
	(−0.483)	(0.666)	(0.690)
Boardsize	−0.098***	0.005	0.000
	(−2.665)	(0.215)	(0.005)
Ind	−0.206	1.058	−0.531
	(−0.186)	(1.522)	(−0.487)
Big4	−0.212	0.105	0.576**
	(−0.768)	(0.732)	(2.000)
Loss	−0.097	−0.170**	−0.323**
	(−0.629)	(−2.533)	(−2.267)
Sustainable	−0.314	−0.284	−0.001
	(−0.418)	(−1.427)	(−0.003)
EI	−0.009	−0.001	−0.017
	(−0.354)	(−0.126)	(−0.744)
GDP	0.140	0.248***	0.305***
	(1.493)	(4.509)	(3.783)
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
chi2(1)	(1)VS(2)4.40**		(1)VS(3)5.75***
Prob > chi2	(1)VS(2)0.036		(1)VS(3)0.017
N	1199	4839	1168
adj. R^2	0.522	0.555	0.532

Note: ***, **, and * indicate significant at the level of 1%, 5% and 10% respectively.
Source: The authors.

Last, business groups are common not only in China but also in other emerging countries, which are very familiar with cultural diversity. Our findings show that risky decisions of group affiliated firm depending both on collective and individual cultures. Hence, cultural diversity on business group decisions in China offer valuable lessons on many economic decisions in other emerging markets.

Table 4. Intrinsic mechanism: the agency problem.

	The principal-agent problem of shareholder and manager				*The principal-agent problem of majority shareholder and minority shareholders*			
	(1) management expense ratio High	(2) management expense ratio Low	(3) investment efficiency Low	(4) investment efficiency High	(5) major shareholders' shareholding High	(6) major shareholders' shareholding Low	(7) capital appropriation High	(8) capital appropriation Low
RiskPreferDiff G5	0.163***	0.146***	0.170***	0.162***	0.181***	0.146***	0.146***	0.181***
	(3.320)	(2.870)	(3.852)	(3.310)	(3.641)	(3.004)	(3.080)	(3.583)
RiskPreferG5	0.057	−0.005	0.061	−0.009	0.061	−0.008	0.012	0.043
	(1.294)	(−0.107)	(1.551)	(−0.191)	(1.370)	(−0.184)	(0.274)	(0.928)
RiskPreferDiffG5* × *RiskPreferG5	**-0.032****	**-0.014**	**-0.029****	**-0.017**	**-0.032****	**-0.013**	**-0.026****	**-0.021**
	(−2.454)	**(−0.929)**	**(−2.309)**	**(−1.283)**	**(−2.247)**	**(−1.006)**	**(−2.026)**	**(−1.438)**
RD	8.587***	7.801***	8.538***	8.444***	9.245***	7.930***	7.231***	10.482***
	(5.799)	(4.340)	(6.178)	(6.002)	(5.979)	(5.137)	(4.694)	(7.325)
MissRD	0.680***	0.826***	0.840***	0.772***	0.640***	1.018***	0.947***	0.670***
	(5.999)	(7.619)	(8.743)	(7.573)	(5.848)	(8.833)	(8.772)	(6.340)
Size	0.597***	0.582***	0.532***	0.519***	0.503***	0.543***	0.534***	0.516***
	(12.604)	(12.436)	(15.064)	(11.705)	(10.276)	(11.687)	(12.881)	(11.392)
Lev	−0.062	0.011	−0.213	0.084	−0.102	−0.029	−0.243	−0.038
	(−0.274)	(0.045)	(−1.058)	(0.382)	(−0.373)	(−0.130)	(−1.088)	(−0.161)
EstAge	−0.146	−0.175	−0.135	−0.287**	−0.317**	0.161	−0.231*	−0.083
	(−1.215)	(−1.333)	(−1.402)	(−1.963)	(−2.554)	(1.079)	(−1.708)	(−0.726)
Roa	1.505**	2.941***	2.323***	2.416***	2.730***	1.667***	2.236***	1.780**
	(2.407)	(3.376)	(3.814)	(2.923)	(2.592)	(2.720)	(3.314)	(2.442)
CF	−0.037	−0.268	−0.188	0.212	−0.124	0.150	0.480	−0.111
	(−0.078)	(−0.694)	(−0.462)	(0.564)	(−0.281)	(0.377)	(1.287)	(−0.259)
Growth	0.042	−0.090*	−0.017	−0.097	−0.050	−0.033	−0.076	−0.035
	(0.795)	(−1.956)	(−0.413)	(−1.310)	(−1.044)	(−0.653)	(−1.618)	(−0.648)
Capex	−0.650	−1.360*	−1.069*	−0.973	−0.722	−2.048***	−1.047	−1.046
	(−0.877)	(−1.902)	(−1.909)	(−1.003)	(−0.966)	(−2.870)	(−1.542)	(−1.562)
Intaratio	−0.029	−0.301	−0.111	−0.310	−0.211	−0.234	−0.230	−0.279
	(−0.096)	(−1.229)	(−0.498)	(−1.179)	(−0.834)	(−0.825)	(−0.875)	(−1.067)
Top1	−0.650*	−0.242	−0.360	−0.430			−0.615**	−0.036
	(−1.954)	(−0.788)	(−1.422)	(−1.423)			(−2.131)	(−0.118)
Mshare	−0.812*	−0.555	−1.104**	0.121	−1.381**	−0.113	−0.863	−0.926*
	(−1.699)	(−0.752)	(−2.570)	(0.138)	(−2.006)	(−0.209)	(−1.344)	(−1.657)
Instshare	−0.035	0.098	−0.072	0.346*	0.113	0.031	0.272	−0.071
	(−0.153)	(0.446)	(−0.417)	(1.701)	(0.502)	(0.136)	(1.382)	(−0.326)

(*continued*)

Table 4. Continued.

	The principal-agent problem of shareholder and manager				*The principal-agent problem of majority shareholder and minority shareholders*			
	(1) management expense ratio High	(2) management expense ratio Low	(3) investment efficiency Low	(4) investment efficiency High	(5) major shareholders' shareholding High	(6) major shareholders' shareholding Low	(7) capital appropriation High	(8) capital appropriation Low
Boardsize	−0.059**	0.026	−0.019	−0.004	0.002	−0.009	−0.037	0.017
	(−2.164)	(0.965)	(−0.830)	(−0.186)	(0.074)	(−0.345)	(−1.472)	(0.600)
Ind	0.137	0.994	0.423	1.213	0.868	0.258	0.589	0.368
	(0.187)	(1.084)	(0.618)	(1.584)	(1.022)	(0.302)	(0.720)	(0.458)
Big4	0.144	−0.016	0.268*	0.023	0.254	−0.082	0.152	0.109
	(0.826)	(−0.092)	(1.857)	(0.149)	(1.482)	(−0.409)	(1.107)	(0.566)
Loss	−0.173*	−0.232***	−0.199**	−0.177**	−0.266**	−0.117	−0.294***	−0.049
	(−1.904)	(−2.805)	(−2.309)	(−2.259)	(−2.533)	(−1.429)	(−3.729)	(−0.509)
Sustainable	0.004	−0.376	−0.440*	0.031	−0.089	−0.256	−0.318	0.139
	(0.016)	(−1.257)	(−1.861)	(0.097)	(−0.222)	(−1.090)	(−1.283)	(0.488)
EI	−0.002	−0.001	−0.000	−0.005	−0.006	0.001	0.000	−0.015
	(−0.118)	(−0.059)	(−0.036)	(−0.383)	(−0.428)	(0.066)	(0.029)	(−1.003)
GDP	0.173**	0.255***	0.256***	0.237***	0.284***	0.236***	0.228***	0.274***
	(2.494)	(4.319)	(4.991)	(3.899)	(4.051)	(3.949)	(3.733)	(4.478)
_cons	−13.450***	−15.348***	−13.758***	−12.631***	−12.995***	−14.719***	−12.411***	−13.280***
	(−11.845)	(−12.556)	(−14.322)	(−11.285)	(−11.590)	(−11.158)	(−11.141)	(−12.104)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3526	3680	3678	3528	3937	3269	3688	3518
adj. R^2	0.572	0.547	0.541	0.551	0.546	0.551	0.565	0.528

Note: ***, **, and * indicate significant at the level of 1%, 5% and 10% respectively.
Source: The authors.

2. Literature and hypothesis

2.1. Culture and corporate decision making

Informal institutions have important influences on corporate decision making. Almost all of the existing studies on informal institutions such as social networks, political connections, and religious beliefs can be attributed to cultural factors (Zingales, 2015). Culture means the process of intergenerational transmission among actors by teaching or imitating knowledge, values, and other factors that may affect behavior (Boyd & Richerson, 1988). Evidence shows that culture will increase accounting conservatism (Kanagaretnam et al., 2014), or affecting corporate risk taken (Li et al., 2013), corporate governance (Du, 2015, 2016), etc.

The mostly concerned topic is how culture affect various types of corporate investment decision. Hilary and Hui (2009) suggest that risk-averse culture helps firms to operate with low-risk investments, including innovation and M&A. Chen et al. (2019) find that traditional Chinese Confucian culture can improve firm's investment efficiency. Shi and Tang (2015) found that if two sides of corporate alliance have more similar cultural backgrounds, they will be more conducive to cooperation and investment during this reliance. Lim et al. (2016) found that cultural characteristics of the main merging parties significantly affect the number of cross-border M&A and synergy effects.

2.2. Individual culture and corporate innovation

Although institutional factors can influence innovation (Li et al., 2022), there is much more evidence on how culture affects firm innovation. Among them, Adhikari and Agrawal (2016) argue that when located in areas with speculative culture, firms increase their innovation inputs in order to obtain more output. Good faith culture (Cheng et al., 2020) can be driver of firm innovation.

Culture can be broken down into different elements or dimensions (Hofstede, 1991). Among which uncertainty avoidance is most closely related to innovation. Uncertainty avoidance refers to the degree that people tolerate uncertainty or unclear, unconventional situations. When the degree of uncertainty avoidance is low, higher risk appetite is exhibited, social organizations or members face and deal with high uncertainty and risk without the constraints of strict rules and institutions (Hofstede, 1991). For all types of corporate investment decisions, innovation undoubtedly have the highest level of uncertainty. Not only do they face the possibility that the product or technology developed may not be successfully completed, but also that the sales or market acceptance of the newly developed product or technology may be much lower than expected due to constraints such as R&D cycles, technological advances, or external competition. Therefore, when firm have its own risk preference culture, they are more likely to engage in high-risk innovation activities (Hilary & Hui, 2009). This leads to hypothesis1.

Hypothesis 1 The more risk preference culture a group affiliated firm has, the more innovative it gets.

2.3. Collective culture and corporate innovation

When there are situations such as cultural intermingling, cultural distance and cultural diversity, the effect of a certain type of culture itself on corporate decision making is affected. Cultural diversity usually refers to the degree of inconsistency in the culture or values of different actors between or within organizations, thus there exists cultural intermingling refers to the interaction of different cultures. Cultural inconsistency is widely present between and within organizations. Inter-organizational cultural diversities are relatively easy to measure, related studies have been conducted from the perspective of country-specific cultural elements (Eun et al., 2015; Holderness, 2017; Li et al., 2013), using companies in cross-border mergers and acquisitions (Lim et al., 2016), strategic alliances (Shi & Tang, 2015), and joint ventures (Li et al., 2013). However, intra- organizational cultural diversities are hardly to measure. We try to overcome limitations of such studies on the disclosure of intra-organizational cultural characteristics by using a unique organizational structure, business group, to discuss how intra-group cultural diversity affect group affiliated firm's innovative decisions.

Business groups are prevalent worldwide (Almeida & Wolfenzon, 2006), especially play important role in emerging countries where external markets are incomplete. After forming into a business group, headquarter is able to centralize or indirectly control the strategic, financial, and personnel aspects of all affiliated firms, reducing information asymmetries and transaction costs (Khanna & Yafeh, 2007). Business groups have been described as both "paradigms" and "parasites" (Khanna & Yafeh, 2007). In other words, business group first brings the "Bright Side" (Khanna & Tice, 2001), which is reflected in the fact that group internal market provides more funds for the group (Billett & Mauer, 2003; Claessens et al., 2006; He et al., 2013; Shin & Park, 1999), improved financing decisions (Cline et al., 2014), more efficient resource allocation within the group as a whole (Scharfstein & Stein, 2000), etc. However, business group can also lead to a "dark side", including inefficient allocation of internal resources and even related transactions to transfer benefits due to the two-tier agency structure within the groups (Rajan et al., 2000; Scharfstein & Stein, 2000; Wulf, 2009).

In China, group headquarters mostly control several listed firms with a pyramidal shareholding structure. On the one hand, group headquarter has a controlling interest to affiliated firms and can directly influence their decisions. On the other hand, group headquarter can also affect affiliated firms' decisions through informal ways. For example, the core values of the group as a whole will be directly transmitted to affiliated firms, while the cross-flow of executives or employees within the group will also form an informal network of relationships between headquarters and affiliated firms, thus achieving an indirect cultural export to affiliated firms, including risky culture. Na et al. (2017) provide evidence that cross-employment within business group exacerbates the contagion of risk among affiliated firms, making them more inclined to risky decisions. The so-called spillover effect or contagion effect of business group means that decision made by an intra-group affiliated firm may also affect other affiliated firms in the same group. Cai and Zheng (2016) once approve that

compensation of any affiliated firm not only depend on the firm's own performance, but also closely related to the performance of other firms within the group.

According to previous analysis, when any affiliated firm has a significant risk appetite, its innovation capacity is higher. However, if the collective culture within the group is inconsistent, that is, there are great diversity in culture among affiliated firms, any firm will have a lower cultural identification with the group's overall culture and system, and affiliated firms are prone to present cognitive bias, communication barriers, and trust deficit among themselves. Affiliated firms are only willing to follow the group's institutional arrangements and work processes to accomplish their tasks, rather than seeking innovative ideas and methods of work, and do not take the initiative to explore new ways to update their products or services, which hinders the positive impact of individual risk culture preferences on innovation ability. Thus culture diversity through a business group's collective and individual culture will bring "Dark Side" to any affiliated firm. Accordingly, this leads to hypothesized 2.

Hypothesis 2 The more diversity between a business group's collective and individual culture, the less impact of any affiliated firm's risky culture on its innovation.

3. Sample, research design, and Descriptive statistics

3.1. Data sources and sample selection

We obtain financial and governance data from the China Securities Market and Accounting Research and Chinese Research Data Services database. We select listed companies affiliated with business groups from 2008 to 2019 as the initial sample. Then we exclude observations that are in the financial industry or asset-liability ratio greater than 1. The final sample has 7,206 firm-years.

Following He et al. (2013), we manually collected business group-affiliated data. When two or more A-share firms belong to the same final control shareholder, these firms are considered as business group-affiliated firms. The data of risk preferences or cultural differences between business group-affiliated firms were obtained by extracting risk-related information from the annual reports of business group affiliated firms by PYTHON.

3.2. Variable design

3.2.1. Culture of risk preferences

Despite the rich researches on "Culture and Finance", there are different measurements of culture due to the abstractness of the culture. There are two main types of culture measurements: first, the measurement using Hofstede or Schwartz country culture index, such as Li et al. (2013) and Eun et al. (2015); second, the measurement using individual or regional religious beliefs, such as Hilary and Hui (2009), Aggarwal et al. (2012). Researches based on Chinese context mainly refer to Aggarwal et al. (2012) using the geographic location and distance. Du (2015) uses religious sites or Confucian cultural sites within a certain distance from the company as a proxy variable for religion or culture.

We need to consider the rationality and availability of the cultural measurements used in the existing literature. First, among existing researches, the Hofstede or Schwartz country cultural index have far-reaching effects in social disciplines field and are more widely used and authoritative, but the index are based on the national level and are difficult to apply in studies for the same country. Second, from the perspective of data availability, data on individual and regional religious belief levels are relatively easy to obtain in the western nations and religious beliefs can better reflect the cultural characteristics of the western nations; however, data on individual and regional religious belief levels in China are not only difficult to obtain, but also cannot well explain individual or regional cultural characteristics; even in Chinese studies, some scholars have used personal belief survey data for research (Jiang et al., 2015), yet the data limitations make it not universally applicable. Finally, the more commonly used indicators of geographic distance and location culture in Chinese researches are difficult to distinguish cultural influences from the other underlying factors, leading to controversial in researches.

In this paper, we refer to Baker et al. (2016) and Loughran and McDonald (2013) to extract culture-related words of risk preferences from annual reports of group affiliated firms by using text analysis to determine keyword word frequencies. Since the annual reports contain both risk preferences and risk aversion words, we refer to Li et al. (2021): firstly, we divide persons into several groups; secondly, each group repeatedly reads the annual report three times; then we cross-check and complement each other; finally, we form a list of word roots for the two cultural dimensions of risk preference and risk aversion, as shown in Table 5. Based on this, Python is used to divide and extract the words, and finally collate the data of risk preference culture of group affiliated firms. Since each annual report sample may have both risk preference and risk aversion words, we define risk preference culture (*RiskPrefer*) as risk preference words minus risk aversion words, then divide it by the total number of words in the annual report and multiply by 100. Risk preference culture level (*RiskPreferG5)* divides *RiskPrefer* into 1, 2, 3, 4 and 5 levels according to the risk preference culture level of the industry in which the group affiliated firm is located every year. The larger the number, the stronger the risk preference.

3.2.2. Cultural differences between business group and its affiliated firms

We determine whether a listed company belongs to a business group based on the mainstream business group research literatures (He et al., 2013). Specifically, according to the chain diagram of actual controllers disclosed in the annual report of listed companies, when at least two or more companies belong to the same actual controller (business group) in the same year, the company is an affiliated firm of the business group. It should be noted that the actual controller of a state-owned business group is determined based on the company at the lower level of SASAC in the control chain diagram.

On this basis, the cultural differences (*RiskPreferDiffG5*) between business group (collective) and its affiliated firms (individuals) are measured by the degree of difference in risk preference culture *(RiskPrefer*) between different affiliated firms belonging to the same business group. The calculation steps are: first, calculate the difference in

Table 5. Word roots of risk preference culture.

Cultural Dimension	Root Words	Chinese Root Words
Risk Preference	Burst, change, try, undertake, bear, impact, innovation, substantial, substantial increase, risk preference, high risk, intense, competition, huge adjustment, upheaval, pioneering, expansion, opportunity, seize, challenge, surge, breakthrough, rapid, pressure, cope with risk, meet risk, survival of the fittest, major change, transformation	爆发、变革、尝试、承担、承受、冲击、创新、大幅度、大幅增加、风险偏好、高风险、激烈、竞争、巨大调整、剧变、开拓、扩张、契机、抢占、挑战、突飞猛进、突破、迅猛、压力、应对风险、迎接风险、优胜劣汰、重大改变、转型
Risk Aversion	safe, secure, protect, conservative, safeguard, guarantee, avoid, hedge, conventional, sustain prosperity, resist risk, contain, prevent, slow down, diversify risk, risk control, risk management, risk control, risk awareness, risk response, control, circumvent, tamp, supervise, healthy, reduce risk, reduce leverage, footloose, caution, warning, vigilance, reliable, controllable, control risk, control leverage, solid, smooth, practical, deleveraging, prudent, cautious, prudent, conform, improve risk resistance, maintain, save against a rainy day, steady production, steady leverage, steady, steady strategy, limit, tight control, warning, meticulous	安全、安稳、保驾护航、保守、保障、保证、避免、避险、常规、持续繁荣、抵抗风险、抵御风险、遏制、防范、放缓、分散风险、风控、风险管理、风险控制、风险意识、风险应对、管控、规避、夯实、监督、健康、降低风险、降杠杆、脚踏实地、谨慎、警示、警惕、可靠、可控、控制风险、控制杠杆、牢固、内部控制建设、平稳、切实可行、去杠杆、审慎、慎重、顺势、顺应、提高抗风险、维持、未雨绸缪、稳产、稳杠杆、稳妥、稳扎稳打、稳战略、限制、严控、预警、缜密

Source: The authors.

risk preference culture *(RiskPrefer)* between different two affiliated firms within the same business group each year, and then calculate the absolute value; second, calculate the average value within a business group (*RiskPreferDiffD*) which represents the degree of business groups' cultural differences; finally, divide the value of business groups' cultural differences each year into 1, 2, 3, 4 and 5 levels (*RiskPreferDiffG5*); The larger the value, the greater the cultural difference between business group (collective) and its affiliated firms (individuals).

3.2.3. Innovation capability

We measure the innovation capacity of company is the total number of patent applications at home and abroad, then add 1, and then take the natural logarithm following Dosi et al. (2006), Hall and Harhoff (2012) and others. In addition, in order to ensure the robustness of the results, we consider different types of patent applications, including invention patent, utility model patent and design patent applications. The reason for using patent applications to measure innovation of company is that, on the one hand, the number of patent applications is a more reasonable proxy for the innovation capability of a company, since patent applications are the final output of the resources invested in technological innovation. On the other hand, compared with the number of patents granted, the number of patent applications is a more reasonable measure of corporate innovation. Patent technology is often applied to production or operation during the application process, which in turn affects corporate performance. However, after the patent is granted, it needs to be tested according to the regulations and pay an annual fee. At the same time, it is also vulnerable to factors such as government rent-seeking. Therefore, the number of patent applications is more stable, reliable and timely than the number of grants. Appendix presents the variable definitions.

3.3. Research design

3.3.1. Hypothesis 1: the risk preference and innovation capability

Referring to Cornaggia et al. (2015), the following basic model is designed to test the effect of risk-preference culture on the innovation capacity of business group affiliated firms.

$$\text{Patents} = \beta_0 + \beta_1 \text{RiskPrefer}(\text{RiskPreferG5}) + \beta \text{Control} + \varepsilon \quad (1)$$

where *Patents* is the total number of patent applications at home and abroad, then add 1, and then take the natural logarithm; *RiskPrefer* and *RiskPreferG5* are the main explanatory variables, which represent the degree of corporate culture on risk preference, and the larger their values, the higher the degree of risk prefer*ence*. We expect the coefficients of *RiskPrefer* and *RiskPreferG5* should be significantly positive, that is, the more risk preference of a business group affiliated firm is, the stronger innovation ability is.

Referring to Chemmanur et al. (2014), etc, we use a set of control variables including R&D expenditure (*RD*), the missing value variable of R&D expenditures *(MissRD)*, the size of firm(*Size*), asset-liability ratio (*Lev*), the age of firm (*EstAge*), firm's growth

capacity (*Growth*), return on assets (*Roa*), the cash flow (*CF*), cash paid for the purchase and construction of fixed assets as a percentage of total assets (*Capex*), the proportion of intangible assets (*Intaratio*), the impact of prior year operating losses (*Loss*), the percentage of first shareholder ownership (*Top1*), the shareholding ratio of senior executives (*Mshare*), the shareholding ratio of institutions(*Instshare*), the percentage of independent directors (*Ind*), the board size (*Boardsize*), the audit of the four major accounting firms (*Big4*), and sustainable growth rate (*Sustainable*), and share of non-recurring gains and losses (*EI*), the provincial gross national product (*GDP*), and the year and industry fixed effects. Appendix presents the variable definitions. Because there may be a lag in the role of risk-preference culture on corporate innovation, and in order to further attenuate the effect of endogenous issues, this paper tests both explanatory and control variables with a one-period lag.

3.3.2. Hypothesis 2: the cultural differences in risk preference and innovation capability

To test the hypothesis2 that cultural difference in risk preferences of business groups affect corporate innovation, the following model is designed.

$$Patents = \beta_0 + \beta_1 RiskPreferDiffG5 + \beta Control + \varepsilon \tag{2}$$

Where *RiskPreferDiffG5* is the difference in the degree of risk preference among affiliated firms within a business group, and the higher its value, the higher the degree of difference in risk preference. Similarly, the explanatory and control variables of the model here are tested with a one-period lag in this paper. Unlike the expected coefficients of *RiskPrefer* and *RiskPreferG5*, we expect that the coefficient of *RiskPreferDiffG5* should be significantly negative, that is, the greater the degree of difference in risk preference culture among affiliated firms within a business group, the weaker the firm's ability of innovation.

To test that the more inconsistent the risk preference culture of affiliated firms within a business group, the more it will weaken the impact of the corporate risk preference culture on the firm's innovation capability, the following model is designed.

$$\begin{aligned} \text{Patents} = {} & \beta_0 + \beta_1 \text{RiskPreferG5} + \beta_2 \text{RiskPreferDiffG5} + \beta_3 \text{RiskPreferG5} \\ & \times \text{RiskPreferDiffG5} + \beta \text{Control} + \varepsilon \end{aligned} \tag{3}$$

where *RiskPreferG5* × *RiskPreferDiffG5* is the value of the main observed coefficient in the Eq. (3). We expect the value of this coefficient to be negative, that is, the greater the cultural differences in risk preferences among affiliated firms within a business group, the more likely it is that the positive effect of that firm's risk preferences on innovation capacity is diminished.

3.4. Descriptive statistics and univariate analysis

We report the descriptive statistics of the variables in Table 6. The mean value of risk preference culture (*RiskPrefer*) is -0.167 and the median value is -0.138, indicating

Table 6. Descriptive statistics.

Variable	N	Mean	SD	Min	25%	Median	75%	Max
Main explanatory variables								
RiskPrefer	7206	−0.167	0.178	−0.920	−0.238	−0.138	−0.056	0.160
RiskPreferG5	7206	2.947	1.415	1.000	2.000	3.000	4.000	5.000
RiskPreferDiffG5	7206	2.985	1.413	1.000	2.000	3.000	4.000	5.000
Patents	7206	2.296	1.878	0.000	0.000	2.398	3.761	5.956
P_Substantive	7206	1.661	1.611	0.000	0.000	1.386	2.833	5.112
P_Strategic	7206	1.803	1.724	0.000	0.000	1.609	3.178	5.438
Granted_Patents	7206	1.160	1.333	0.000	0.000	0.693	2.079	4.500
Patents_Cited	7206	2.643	2.213	0.000	0.000	2.773	4.394	6.733
Control variables								
RD	7206	0.021	0.031	0.000	0.000	0.007	0.033	0.182
MissRD	7206	0.686	0.464	0.000	0.000	1.000	1.000	1.000
Size	7206	22.561	1.418	18.948	21.589	22.44	23.467	25.707
Lev	7206	0.511	0.206	0.053	0.356	0.522	0.668	0.999
EstAge	7206	2.780	0.398	0.000	2.564	2.833	3.045	3.332
Growth	7206	0.168	0.483	−0.721	−0.040	0.092	0.247	3.142
Roa	7206	0.031	0.063	−0.348	0.009	0.030	0.058	0.223
CF	7206	0.042	0.073	−0.203	0.003	0.041	0.083	0.261
Loss	7206	0.114	0.317	0.000	0.000	0.000	0.000	1.000
Capex	7206	0.046	0.047	0.000	0.012	0.032	0.063	0.258
Intaratio	7206	0.140	0.218	0.000	0.017	0.043	0.121	0.867
Top1	7206	0.375	0.152	0.090	0.254	0.360	0.490	0.758
Mshare	7206	0.018	0.072	0.000	0.000	0.000	0.001	0.670
Instshare	7206	0.225	0.241	0.000	0.024	0.122	0.388	0.889
Ind	7206	0.368	0.052	0.222	0.333	0.333	0.385	0.571
Boardsize	7206	9.155	1.865	5.000	8.000	9.000	9.000	15.000
Big4	7206	0.097	0.296	0.000	0.000	0.000	0.000	1.000
Sustainable	7206	0.043	0.141	−0.817	0.014	0.050	0.096	0.449
EI	7206	0.628	1.845	−1.409	0.017	0.111	0.413	11.202
GDP	7206	10.108	0.786	6.926	9.650	10.13	10.601	11.587
Other variables								
Mfee	7206	0.094	0.108	0.009	0.042	0.073	0.111	1.132
Invest	7206	0.052	0.064	0.001	0.014	0.032	0.062	0.363
Other	7206	0.017	0.030	0.000	0.003	0.008	0.019	0.393
SizeMax	7206	0.358	0.479	0.000	0.000	0.000	1.000	1.000
Iscocurp	7206	0.679	0.467	0.000	0.000	1.000	1.000	1.000
Distrank	7206	680.617	628.36	0.214	26.144	722.2	1141.4	2490.879
DA	7206	0.057	0.061	0.001	0.017	0.039	0.075	0.342
SOE	7206	0.776	0.417	0.000	1.000	1.000	1.000	1.000

Note: Continuous variables are winsorized at the top and bottom 1% percentiles.
Source: The authors.

that the number of words attributed to risk preference in the annual reports of the affiliated firms of a business group is smaller than risk avoidance, implying that most affiliated firms are still more conservative. The mean value of the innovation of affiliated firms (*Patents*) is 2.296, the median value is 2.398, the maximum value is 5.956, and the minimum value is 0, which shows that business group affiliated firms have a large difference in patent applications.

We report the univariate analysis for the mainly variables in Table 7. As shown in Panel A, there is a significant difference in the total number of patent applications between the risk preference and risk-aversion groups of the business group affiliated firms. In particular, the total number of patent applications in the risk aversion group is significantly lower than that in the risk preference group, with a difference of mean value −0.318 and significant at the 1% significance level. This provides preliminary evidence for the hypothesis1 that the more risk preference the business group

Table 7. Univariate comparison.

Panel A: Subgroup of risk preference(*RiskPrefer*)					
Variable	Risk Aversion	Mean	Risk Preference	Mean	Difference in Mean
Patents	3547	2.134	3659	2.452	−0.318***
P_Substantive	3547	1.540	3659	1.778	−0.238***
P_Strategic	3547	1.661	3659	1.942	−0.281***
Panel B: Subgroup test for cultural differences in group risk preferences					
Variable	Small Culture Difference	Mean	Large Culture Difference	Mean	Difference in Mean
Patents	3488	2.372	3718	2.224	0.149***
P_Substantive	3488	1.718	3718	1.607	0.110***
P_Strategic	3488	1.870	3718	1.740	0.130***

Note: ***, **, and * indicate significant at the level of 1%, 5% and 10% respectively.
Source: The authors.

affiliated firms are, the stronger their ability of innovation is. As shown in Panel B, there is a significant difference in the total number of patent applications between the large cultural difference group and the small risk cultural difference group. The total number of patent applications is significantly lower in the large cultural difference group than in the large cultural difference group, with a difference of mean value 0.149 and significant at the 1% significance level. This is also consistent with the hypothesis 2 which is a preliminary confirmation that the greater the cultural difference, the weaker the innovation ability.

4. Empirical results

4.1. The risk preference and innovation capability

We report the multivariable regression results of Eq. (1) in Table 8. First, column (1) is the regression result considering the control variables and the *RiskPrefer* coefficient is significantly positive. This indicates that the more risk preference culture of the business group affiliated firms(individuals), the stronger the innovation capacity. Also, considering the endogenous issue, the results remain significant in the lagged one-period regression of column (2). Further, to circumvent the problem of sample error due to text processing, we design the levels variable *RiskPreferG5* for risk preference culture, and the regression results from columns (3) to (4) show that the coefficients of *RiskPreferG5* are all significantly positive with a value of about 9.5%, indicating that each increase in risk-preference tendency increases innovation capability by 9.5%. All of the above results verify the hypotheses1 of this paper.

4.2. The cultural differences in risk preference and innovation capability

First, we test how the cultural differences that between the business group (collective) and affiliated firms(individuals) affect the innovation capability of the affiliated firms. We report the multivariable regression results of Eq. (2) in Table 1. The column (1) shows that the coefficient of *RiskPreferDiffG5* is significantly negative at the 1% significance level with a value of −0.055, indicating that the degree of cultural

Table 8. The risk preference and innovation capability.

	(1) *Patents*	(2) $Patents_{[t+1]}$	(3) *Patents*	(4) $Patents_{[t+1]}$
RiskPrefer	**0.718*****	**0.771*****		
	(4.830)	**(5.042)**		
RiskPreferG5			**0.095*****	**0.098*****
			(5.562)	**(5.523)**
RD	8.879***	7.192***	8.633***	6.961***
	(7.626)	(5.881)	(7.437)	(5.710)
MissRD	0.824***	0.762***	0.817***	0.755***
	(9.681)	(8.522)	(9.591)	(8.437)
Size	0.531***	0.532***	0.530***	0.531***
	(15.255)	(14.421)	(15.259)	(14.421)
Lev	−0.078	−0.140	−0.079	−0.147
	(−0.435)	(−0.743)	(−0.440)	(−0.781)
EstAge	−0.153	−0.231**	−0.152	−0.230**
	(−1.480)	(−2.238)	(−1.472)	(−2.235)
Roa	2.141***	2.118***	2.147***	2.111***
	(3.843)	(3.864)	(3.909)	(3.858)
CF	0.107	0.105	0.081	0.072
	(0.336)	(0.310)	(0.254)	(0.214)
Growth	−0.054	−0.036	−0.054	−0.035
	(−1.487)	(−0.958)	(−1.492)	(−0.942)
Capex	−1.348**	−1.333**	−1.371**	−1.363**
	(−2.485)	(−2.328)	(−2.528)	(−2.381)
Intaratio	−0.186	−0.141	−0.195	−0.129
	(−0.957)	(−0.572)	(−1.003)	(−0.523)
Top1	−0.390	−0.337	−0.386	−0.334
	(−1.574)	(−1.306)	(−1.562)	(−1.296)
Mshare	−0.847*	−0.476	−0.849*	−0.486
	(−1.719)	(−0.896)	(−1.744)	(−0.921)
Instshare	0.110	0.116	0.116	0.122
	(0.672)	(0.670)	(0.713)	(0.707)
Boardsize	−0.012	−0.004	−0.012	−0.004
	(−0.575)	(−0.196)	(−0.579)	(−0.201)
Ind	0.719	0.854	0.745	0.879
	(1.117)	(1.272)	(1.160)	(1.313)
Big4	0.126	0.131	0.131	0.137
	(0.920)	(0.938)	(0.958)	(0.979)
Loss	−0.188***	−0.190***	−0.187***	−0.190***
	(−2.890)	(−2.678)	(−2.880)	(−2.695)
Sustainable	−0.182	0.055	−0.171	0.067
	(−0.869)	(0.258)	(−0.823)	(0.319)
EI	−0.003	0.000	−0.003	−0.000
	(−0.280)	(0.007)	(−0.352)	(−0.039)
GDP	0.248***	0.241***	0.246***	0.239***
	(4.915)	(4.495)	(4.913)	(4.490)
_cons	−13.247***	−12.244***	−13.576***	−12.713***
	(−14.133)	(−13.575)	(−14.497)	(−14.106)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	7206	6556	7206	6556
adj. R^2	0.541	0.528	0.542	0.530

Note: ***, **, and * indicate significant at the level of 1%, 5% and 10% respectively.
Source: The authors.

differences between the collective and individual firms within the business group decreases by approximately 5.5% for each level of innovation capacity. Also, considering the endogenous issue, the results remain significant in the lagged one-period regression of column (2).

Then, we test whether the cultural differences in the business group (collective) weaken the effect of its affiliated firms'(individuals) own risk preferences on innovation capacity? We show the multivariable regression results of Eq. (3) in Table 2, where we mainly observe the coefficient values of *RiskPreferDiffG5* × *RiskPreferG5*. After considering the control variables in column (1), the coefficient of *RiskPreferDiffG5* × *RiskPreferG5* remains significantly negative with a value of −0.024, indicating that the greater the difference in the culture of the business group (collective), the more it weakens the positive effect of the culture of risk preferences on the innovative capacity of its affiliated firms. In other words, even if the affiliated firms of business group itself prefers risk, however, due to its affiliated to a group, it is influenced by the inconsistent risk preferences of its other affiliated firms, which suppresses the positive effect of its risk preferences on innovation capacity. Also considering the endogenous issue, the results remain significant in the lagged one-period regression of column (2).

We further divide the sample into three subgroups. The first subgroup is that the value of *RiskPreferD* of the affiliated firms in a business group all are 1, meaning that all of the affiliated firm's risk preferences are larger than the industry annual median; the second subgroup is that the value of *RiskPreferD* of the affiliated firms in a business group a partly are 1 and partly are 0, meaning that not all of the affiliated firms in a business group's risk preference are larger than the industry annual median and not all of them are less than the industry annual median; the third subgroup of the affiliated firms in a business group all have *RiskPreferD* values 0, meaning that all of the affiliated firms in a business group's risk preference are all less than the industry annual median. Our main observation is the test for differences between *RiskPrefer* coefficient value. In the first subgroup of columns (1), the *RiskPrefer* coefficient is 1.772 and is significant at the 1% level; in the second subgroup of columns (2), the *RiskPrefer* coefficient is 0.636 and is significant at the 1% level; however, in the third group of columns (3), the *RiskPrefer* coefficient is not significant. At the same time, the results of the two-group difference test of the three subgroups of *RiskPrefer* coefficients show that the impact of risk preference culture on innovation capacity is significantly higher in the affiliated firms that are all risk-preferring, than incompletely all risk-preferring ($1.772 > 0.636/0.386$). In other words, the own risk preferences of the affiliated firms in a same group that are not exactly all risk preference still have a positive contribution effect on innovation capacity, however, their values are significantly lower than those of the first subgroup, supporting our view that collective group cultural differences weaken the effect of individual culture on innovation capacity.

From Tables 1–3, we get the full evidence chain that no matter how much group affiliated firm's individual culture affect its innovation capacity, firm's innovation capacity is still affected more by the whole group's collective culture, as we provided in hypothesis 2, the more diversity between a business group's collective and individual culture, the less impact of any affiliated firm's risky culture on its innovation.

4.3. Robustness test

4.3.1. Refine the indicators of patents application

Li and Zheng (2016) distinguish innovation from substantive and strategic innovation behaviors in terms of innovation effects. Substantial innovation, which is high-tech innovation, can promote the technological development of society; while strategic innovation, which is less innovative, is only to meet government policies. Therefore, patent applications for inventions can measure substantive innovation, while patent applications for utility models and designs can measure strategic innovation. So, we further distinguish substantive innovation from strategic innovation by using the number of invention patent applications (*P_Substantive)* to measure substantive innovation, and the number of utility model patent applications and design patent applications (*P_Design*) to measure strategic innovation, and the regression results are reported in the Table 9 Panel A. As seen in columns (1) and (4), the coefficients of *RiskPreferG5* are both significantly positive, indicating that the risk preference culture of the affiliated firm of the business group has a significant contribution to both substantive and strategic innovation. From columns (2), (5), the *RiskPreferDiffG5* coefficients are significantly negative, indicating that cultural differences in a business group have a negative effect on both substantive and strategic innovation. As seen in columns (3) and (6), the *RiskPreferDiffG5* × *RiskPreferG5* coefficients are both significantly negative, indicating that cultural differences reduce the promotion effect of risk preference culture on substantive and strategic innovation. The results are largely consistent with the previous paper and ensure the robustness of the results in this paper.

4.3.2. Replace the indicators of patents

In addition to using patents application as an indicator to measure innovation, existing research also adopt patents granted, patent cited (Chemmanur et al., 2014), innovation survey data (Hashi & Stojcic, 2013), or R&D expenditure (Lichtenberg & Siegel, 1991) to measures enterprise innovation. At present, there is no authoritative innovation survey data in China. In another hand, R&D expenditure can only represent the level of R&D input, but can hardly represent R&D output, which means innovation. For the robustness of our paper, referring to the practice of Chemmanur et al. (2014), we supplemented variables of patent granted (*Granted_Patents*) and patent cited (*Patents_Cited*) as robustness tests, the results are reported in Panel A columns (7) to (12) of Table 9, illustrate the robustness of the paper's findings.

4.3.3. Instrumental variables (IV)

Considering the possible endogenous between risk preference and innovation capacity, we use the risk preferences of an industry in a year as instrumental variables for affiliated firms' risk preferences, and then further estimate the culture differences as instrumental variables for cultural differences of the business group. The regression results, reported in Panel B columns (1) to (4) of Table 9, illustrate the robustness of the paper's findings.

Table 9. Robustness tests.

Panel A: Replace innovation indicators

	Refine patents application indicators						Replace patents indicators					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	P_Substantive			*P_Strategic*			*Granted_Patents*			*Patents_Cited*		
RiskPreferG5	**0.067*****		**0.133*****	**0.094*****		**0.152*****	**0.053*****		0.120***	**0.091*****		0.174***
	(4.245)		**(4.117)**	**(5.641)**		**(4.263)**	**(3.923)**		(4.516)	**(4.343)**		(3.909)
RiskPreferDiffG5		**-0.043*****	**0.031**		**-0.046*****	**0.023**		**-0.027*****	0.044*		**-0.036*****	0.055
		(−3.096)	**(1.060)**		**(−3.126)**	**(0.701)**		**(−3.272)**	(1.857)		**(−2.677)**	(1.394)
RiskPreferDiffG5 ×RiskPreferG5			**-0.022****			**-0.019***			**-0.021*****			**-0.027****
			(−2.410)			**(−1.942)**			**(−2.867)**			**(−2.178)**
RD	10.650***	11.046***	10.733***	4.114***	4.637***	4.200***	10.099***	10.394***	10.137***	12.765***	13.247***	12.811***
	(9.335)	(9.790)	(9.523)	(3.921)	(4.412)	(4.026)	(9.360)	(17.175)	(9.494)	(8.547)	(15.346)	(8.630)
MissRD	0.480***	0.489***	0.482***	0.627***	0.638***	0.629***	0.278***	0.285***	0.279***	0.771***	0.782***	0.772***
	(6.759)	(6.872)	(6.803)	(8.055)	(8.159)	(8.088)	(4.942)	(8.853)	(4.962)	(7.874)	(13.367)	(7.908)
Size	0.464***	0.463***	0.464***	0.470***	0.470***	0.470***	0.386***	0.385***	0.386***	0.636***	0.635***	0.636***
	(14.341)	(14.258)	(14.373)	(14.315)	(14.124)	(14.311)	(13.935)	(30.728)	(13.971)	(14.251)	(30.347)	(14.276)
Lev	−0.122	−0.122	−0.113	0.012	0.008	0.021	−0.216	−0.219***	−0.212	−0.545**	−0.552***	−0.539**
	(−0.760)	(−0.754)	(−0.704)	(0.069)	(0.043)	(0.124)	(−1.565)	(−3.032)	(−1.532)	(−2.324)	(−4.411)	(−2.305)
EstAge	−0.089	−0.097	−0.092	−0.210**	−0.221**	−0.212**	−0.052	−0.058	−0.055	−0.120	−0.130**	−0.123
	(−0.925)	(−1.007)	(−0.961)	(−2.070)	(−2.168)	(−2.103)	(−0.643)	(−1.476)	(−0.675)	(−0.957)	(−2.105)	(−0.983)
Roa	1.846***	1.911***	1.871***	1.738***	1.829***	1.761***	1.092***	1.144***	1.114***	2.406***	2.494***	2.433***
	(3.824)	(4.003)	(3.898)	(3.309)	(3.474)	(3.362)	(2.743)	(4.045)	(2.824)	(3.519)	(5.077)	(3.574)
CF	0.114	0.100	0.089	0.090	0.076	0.067	0.046	0.038	0.027	−0.443	−0.452	−0.466
	(0.402)	(0.353)	(0.317)	(0.299)	(0.254)	(0.224)	(0.195)	(0.228)	(0.117)	(−1.102)	(−1.547)	(−1.162)
Growth	−0.023	−0.018	−0.021	−0.064**	−0.058*	−0.062*	−0.047*	−0.044*	−0.046*	−0.013	−0.007	−0.011
	(−0.727)	(−0.585)	(−0.677)	(−1.969)	(−1.795)	(−1.931)	(−1.917)	(−1.805)	(−1.882)	(−0.288)	(−0.162)	(−0.258)
Capex	−0.691	−0.715	−0.670	−1.459***	−1.500***	−1.439***	−0.601	−0.624**	−0.587	−0.449	−0.493	−0.431
	(−1.387)	(−1.437)	(−1.347)	(−2.843)	(−2.920)	(−2.811)	(−1.411)	(−2.453)	(−1.381)	(−0.644)	(−1.059)	(−0.618)
Intaratio	−0.033	−0.018	−0.043	−0.201	−0.176	−0.210	0.218	0.232**	0.211	−0.204	−0.178	−0.213
	(−0.192)	(−0.101)	(−0.247)	(−1.142)	(−0.991)	(−1.189)	(1.551)	(2.187)	(1.503)	(−0.873)	(−1.069)	(−0.906)
Top1	−0.301	−0.311	−0.297	−0.241	−0.258	−0.238	−0.043	−0.053	−0.041	−0.288	−0.305**	−0.284
	(−1.403)	(−1.445)	(−1.392)	(−1.031)	(−1.092)	(−1.019)	(−0.236)	(−0.613)	(−0.221)	(−1.000)	(−2.178)	(−0.990)
Mshare	−0.948**	−0.929**	−0.963**	−0.407	−0.375	−0.421	−0.777**	−0.760***	−0.789***	−0.882	−0.849***	−0.897
	(−2.323)	(−2.309)	(−2.441)	(−0.895)	(−0.833)	(−0.956)	(−2.513)	(−4.372)	(−2.606)	(−1.575)	(−2.866)	(−1.632)
Instshare	0.195	0.178	0.190	0.042	0.019	0.038	0.241**	0.228***	0.238**	0.349	0.327***	0.345

(*continued*)

Table 9. Continued.

Panel A: Replace innovation indicators

	Refine patents application indicators						Replace patents indicators					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	P_Substantive			*P_Strategic*			*Granted_Patents*			*Patents_Cited*		
	(1.336)	(1.215)	(1.305)	(0.273)	(0.123)	(0.245)	(2.094)	(3.459)	(2.068)	(1.596)	(2.811)	(1.578)
Boardsize	0.002	0.003	0.003	−0.020	−0.020	−0.019	0.005	0.005	0.006	0.023	0.023*	0.024
	(0.125)	(0.141)	(0.182)	(−0.999)	(−0.980)	(−0.952)	(0.319)	(0.695)	(0.373)	(0.899)	(1.876)	(0.942)
Ind	1.283**	1.300**	1.287**	0.024	0.052	0.027	1.158**	1.174***	1.166**	1.741**	1.771***	1.751**
	(2.023)	(2.037)	(2.035)	(0.041)	(0.087)	(0.046)	(2.139)	(4.392)	(2.158)	(2.093)	(4.443)	(2.112)
Big4	0.221*	0.219*	0.228*	0.108	0.103	0.114	0.297**	0.294***	0.303**	0.345**	0.340***	0.352**
	(1.672)	(1.649)	(1.730)	(0.834)	(0.791)	(0.884)	(2.498)	(6.016)	(2.555)	(2.067)	(4.746)	(2.119)
Loss	−0.142**	−0.153***	−0.144***	−0.153**	−0.168***	−0.155***	−0.007	−0.015	−0.009	−0.188**	−0.202***	−0.190**
	(−2.572)	(−2.740)	(−2.617)	(−2.559)	(−2.778)	(−2.600)	(−0.155)	(−0.395)	(−0.205)	(−2.508)	(−3.065)	(−2.540)
Sustainable	−0.192	−0.213	−0.200	−0.147	−0.178	−0.155	−0.221	−0.238**	−0.230	−0.136	−0.165	−0.146
	(−1.086)	(−1.204)	(−1.139)	(−0.695)	(−0.830)	(−0.735)	(−1.463)	(−2.138)	(−1.529)	(−0.538)	(−0.871)	(−0.581)
EI	−0.004	−0.003	−0.004	−0.002	−0.001	−0.002	0.001	0.002	0.001	−0.010	−0.008	−0.010
	(−0.491)	(−0.423)	(−0.535)	(−0.209)	(−0.099)	(−0.246)	(0.150)	(0.260)	(0.135)	(−0.818)	(−0.797)	(−0.829)
GDP	0.185***	0.193***	0.186***	0.214***	0.226***	0.215***	0.144***	0.150***	0.144***	0.303***	0.313***	0.303***
	(4.113)	(4.262)	(4.154)	(4.499)	(4.623)	(4.544)	(3.846)	(9.039)	(3.861)	(4.713)	(11.212)	(4.726)
_cons	−0.144**	−12.915***	2.651***	−12.402***	−12.650***	−12.309***	−10.176***	−9.996***	−10.344***	−15.972***	−15.688***	−16.183***
	(−2.424)	(−24.219)	(5.208)	(−22.504)	(−14.090)	(−13.563)	(−14.335)	(−31.031)	(−14.494)	(−14.060)	(−29.578)	(−14.197)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7206	7206	7206	7206	7206	7206	7206	7206	7206	7206	7206	7206
adj. R^2	0.506	0.504	0.508	0.491	0.487	0.492	0.481	0.479	0.482	0.487	0.485	0.488

Panel B: IV and PSM

	IV					PSM	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	RiskPreferG5	*Patents*	*RiskPreferDiffG5*	*Patents*	*Patents*	*Patents*	*Patents*
RiskPreferG5		**2.086***			**0.097*****		**0.179*****
		(1.844)			**(5.359)**		**(4.381)**
RiskPreferDiffG5				**-0.392*****		**-0.047*****	**0.048**
				(−4.124)		**(−2.869)**	**(1.183)**
RiskPreferDiffG5 × RiskPreferG5							**-0.026****
							(−2.270)
RiskPrefer_IV	**0.720*****						
	(5.959)						
RiskPreferDiff_IV			**3.458*****				
			(10.157)				
RD	0.277***	8.563***	2.925***	10.035***	2.795*	3.050**	2.857*
	(3.094)	(11.060)	(4.065)	(12.927)	(1.884)	(2.007)	(1.928)
MissRD	0.002	0.821***	0.069	0.851***	0.907***	0.925***	0.910***
	(0.351)	(16.832)	(1.412)	(16.461)	(9.914)	(10.059)	(9.966)
Size	−0.001	0.532***	−0.032*	0.520***	0.547***	0.545***	0.546***
	(−0.276)	(31.270)	(−1.855)	(28.392)	(15.226)	(15.099)	(15.238)
Lev	−0.029**	−0.039	0.377***	0.035	−0.311	−0.317*	−0.301
	(−2.241)	(−0.360)	(3.483)	(0.314)	(−1.642)	(−1.659)	(−1.595)
EstAge	−0.012**	−0.136**	−0.025	−0.172***	−0.185*	−0.192*	−0.188*
	(−2.017)	(−2.549)	(−0.477)	(−3.142)	(−1.693)	(−1.748)	(−1.724)
Roa	0.139**	1.960***	0.089	2.260***	2.784***	2.876***	2.815***
	(2.000)	(4.153)	(0.186)	(4.872)	(4.563)	(4.773)	(4.637)
CF	−0.029	0.149	−0.326	−0.067	−0.000	−0.015	−0.029
	(−0.970)	(0.610)	(−1.255)	(−0.261)	(−0.001)	(−0.044)	(−0.084)
Growth	0.006	−0.062*	0.031	−0.037	−0.043	−0.041	−0.042
	(1.468)	(−1.667)	(0.898)	(−0.967)	(−1.164)	(−1.097)	(−1.136)
Capex	−0.109**	−1.176***	0.514	−1.225***	−1.622***	−1.669***	−1.585***
	(−2.271)	(−3.124)	(1.320)	(−3.222)	(−2.860)	(−2.933)	(−2.801)
Intaratio	0.045**	−0.241	−0.238	−0.253*	−0.037	−0.006	−0.049
	(2.456)	(−1.588)	(−1.578)	(−1.658)	(−0.181)	(−0.031)	(−0.237)
Top1	−0.023*	−0.357***	0.059	−0.372***	−0.473*	−0.474*	−0.465*
	(−1.693)	(−3.010)	(0.487)	(−3.039)	(−1.825)	(−1.809)	(−1.800)
Mshare	0.063**	−0.931***	−0.321	−0.925***	−0.743	−0.719	−0.765
	(2.165)	(−3.364)	(−1.184)	(−3.650)	(−1.433)	(−1.393)	(−1.528)

(*continued*)

Table 9. Continued.

Panel B: IV and PSM

	IV					PSM	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	RiskPreferG5	*Patents*	*RiskPreferDiffG5*	*Patents*	*Patents*	*Patents*	*Patents*
Instshare	−0.024**	0.139	0.011	0.081	0.139	0.124	0.132
	(−2.187)	(1.467)	(0.118)	(0.838)	(0.793)	(0.698)	(0.752)
Boardsize	−0.001	−0.011	0.012	−0.006	−0.019	−0.018	−0.017
	(−0.727)	(−1.116)	(1.218)	(−0.594)	(−0.870)	(−0.811)	(−0.795)
Ind	0.089**	0.588*	−0.373	0.663*	0.321	0.323	0.342
	(2.235)	(1.703)	(−1.037)	(1.875)	(0.490)	(0.487)	(0.524)
Big4	−0.003	0.130**	0.069	0.147**	0.030	0.030	0.039
	(−0.413)	(2.164)	(1.155)	(2.318)	(0.212)	(0.211)	(0.280)
Loss	−0.019***	−0.163***	−0.018	−0.208***	−0.165**	−0.182**	−0.168**
	(−2.811)	(−2.772)	(−0.320)	(−3.604)	(−2.256)	(−2.458)	(−2.294)
Sustainable	−0.032	−0.141	0.056	−0.183	−0.387*	−0.439*	−0.395*
	(−1.209)	(−0.819)	(0.287)	(−1.024)	(−1.686)	(−1.924)	(−1.738)
EI	0.002*	−0.005	−0.016*	−0.009	−0.002	−0.000	−0.002
	(1.701)	(−0.586)	(−1.745)	(−0.976)	(−0.160)	(−0.025)	(−0.188)
GDP	0.011***	0.232***	0.032	0.270***	0.214***	0.226***	0.215***
	(4.180)	(9.048)	(1.342)	(11.144)	(4.032)	(4.209)	(4.078)
_cons	−12.862***	−0.144**	−12.915***	2.651***	−12.402***	−12.650***	−12.309***
	(−14.231)	(−2.424)	(−24.219)	(5.208)	(−22.504)	(−14.090)	(−13.563)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7206	7206	7206	7206	5631	5631	5631
adj. R^2	0.228	0.528	0.031	0.476	0.550	0.546	0.551

Note: ***, **, and * indicate significant at the level of 1%, 5% and 10% respectively.
Source: The authors.

4.3.4. Propensity score matching (PSM)

Considering there may be a sample self-selection bias between risk preference and innovation capacity, we used Propensity Score Matching (PSM) to screen risk preference firms with similar characteristics to risk aversion firms as a control group. We construct the logit models based on the financial information of the affiliated firms. The control variables are same as Eq. (1), as a way to ensure that the characteristic factors that might affect innovation ability were consistent in the control group and the treatment group. Since the *RiskPreferD* is designed based on the median value in the original sample, the percentages of both sides are close to each other, resulting in little difference between the PSM sample obtained by 1:1 matching, we further forced to exclude the treatment group on the basis of 1:1 matching where the propensity value in the group was larger than the maximum propensity value in the control group or lower than the minimum propensity value in the control group. Where the maximum distance allowed between the control group and the matched control is 0.05, thus the PSM samples in further treatment remained 3669, in the control group 1979, total 5631. The regression results reported in Panel B columns (5) to (7) of Table 9 illustrate the robustness of the conclusions of this paper.

5. Further discussion

5.1. Intrinsic mechanism: the agency problem

The more important problem is what are the intrinsic mechanisms that influence the affiliated firms' own risk preference and innovation capability, given the cultural differences between the collective and individual within the business group? In modern corporate systems where ownership and operation are separated, the principal-agent problem of the shareholder and manager is the first type of agency problem, and the executive behavioral motivation is a key factor influencing a company's investment decisions. At the same time, in the Chinese capital market with high concentration of equity, especially in the business groups with pyramid structure, the principal-agent problem of majority shareholder and minority shareholders, that is, the second type of agency problem, and the behavior of the majority shareholder also affects the investment strategy of the company. Therefore, we analyze the mechanism from the perspective of two types of agency problems.

5.1.1. The principal-agent problem of shareholder and manager

Under the premise of separation of ownership and operation, the level of effort of executives themselves cannot be measured directly, so accounting surplus is commonly used as a measure of executive effort and used to formulate executive compensation contracts (Jensen & Meckling, 1976). Due to contractual incompleteness, investors pay close attention to the amount and quality of surplus as a way to judge whether executives are diligently fulfilling their fiduciary responsibilities. Innovation activities are characterized by large capital investment, long investment cycles, high asset specificity and uncertainty, and weak exclusivity of returns which are difficult to realize in the short term. Since the compensation contract mainly focuses on the level of earnings, it will reduce the prior willingness of executives to invest in innovation

Table 10. The heterogeneity analysis of the business group.

	(1) *SizeMax = 1*	(2) *SizeMax = 0*	(3) *Iscocurp = 1*	(4) *Iscocurp = 0*	(5) *Distrank<=500m*	(6) *Distrank > 500m*	(7) *SalaryMax = 0*	(8) *SalaryMax = 1*
RiskPreferDiff G5	0.126**	0.179***	0.113***	0.267***	0.141***	0.192***	0.124***	0.209***
	(2.220)	(3.964)	(2.657)	(4.654)	(2.870)	(3.665)	(2.970)	(3.536)
RiskPreferG5	0.023	0.020	−0.018	0.127**	0.027	0.037	−0.033	0.105**
	(0.439)	(0.476)	(−0.463)	(2.577)	(0.627)	(0.774)	(−0.819)	(2.073)
RiskPreferDiffG5 × RiskPreferG5	**-0.019**	**-0.025***	**-0.012**	**-0.047*****	**-0.017**	**-0.033****	**-0.007**	**-0.045*****
	(−1.154)	**(−1.941)**	**(−0.964)**	**(−2.871)**	**(−1.209)**	**(−2.258)**	**(−0.585)**	**(−2.764)**
RD	9.542***	8.984***	8.350***	9.185***	8.905***	9.022***	9.297***	7.916***
	(3.678)	(7.305)	(6.373)	(4.803)	(4.738)	(6.396)	(7.038)	(3.900)
MissRD	0.755***	0.897***	0.723***	1.055***	0.986***	0.633***	0.851***	0.771***
	(5.256)	(9.523)	(7.054)	(8.834)	(7.868)	(6.103)	(9.130)	(5.414)
Size	0.583***	0.475***	0.566***	0.468***	0.528***	0.520***	0.500***	0.592***
	(9.737)	(10.538)	(13.568)	(9.407)	(9.995)	(11.432)	(12.513)	(11.102)
Lev	−0.577	0.175	−0.138	0.029	−0.012	−0.011	0.040	−0.294
	(−1.602)	(0.901)	(−0.623)	(0.120)	(−0.046)	(−0.047)	(0.208)	(−0.893)
EstAge	−0.141	−0.049	−0.220*	−0.002	−0.084	−0.177	−0.143	−0.198
	(−0.989)	(−0.336)	(−1.882)	(−0.011)	(−0.479)	(−1.411)	(−1.101)	(−1.622)
Roa	1.161	2.157***	2.744***	1.571**	2.550***	2.061***	1.861***	2.150**
	(0.894)	(3.999)	(3.870)	(2.220)	(2.730)	(3.023)	(3.116)	(1.968)
CF	0.134	0.043	0.148	−0.117	−0.378	0.570	0.288	−0.416
	(0.252)	(0.115)	(0.385)	(−0.251)	(−0.776)	(1.509)	(0.774)	(−0.847)
Growth	−0.112*	−0.004	−0.064	−0.037	−0.014	−0.074	−0.053	−0.032
	(−1.734)	(−0.109)	(−1.533)	(−0.605)	(−0.267)	(−1.615)	(−1.254)	(−0.533)
Capex	−1.456	−1.210**	−1.684***	−0.364	−2.024***	−0.464	−1.083*	−1.962**
	(−1.510)	(−2.219)	(−2.677)	(−0.478)	(−2.849)	(−0.644)	(−1.813)	(−2.243)
Intaratio	−0.707**	0.108	−0.249	−0.187	0.317	−0.619**	0.041	−0.665**
	(−2.262)	(0.450)	(−1.038)	(−0.613)	(1.067)	(−2.391)	(0.177)	(−2.181)
Top1	−0.245	−0.422	−0.510*	−0.100	−0.657*	−0.229	−0.408	−0.337
	(−0.618)	(−1.458)	(−1.777)	(−0.292)	(−1.901)	(−0.661)	(−1.490)	(−0.874)
Mshare	0.225	−1.828***	−1.554*	−0.726	−0.004	−1.212**	−1.018**	−0.790
	(0.315)	(−3.458)	(−1.858)	(−1.405)	(−0.006)	(−2.009)	(−2.049)	(−1.031)
Instshare	−0.262	0.281	0.343*	−0.402*	−0.152	0.389*	0.265	−0.232
	(−0.991)	(1.545)	(1.779)	(−1.789)	(−0.701)	(1.738)	(1.448)	(−0.873)
Boardsize	0.008	−0.024	−0.009	−0.005	−0.056*	0.033	0.005	−0.031
	(0.224)	(−0.999)	(−0.383)	(−0.165)	(−1.952)	(1.229)	(0.201)	(−0.951)
Ind	0.576	0.619	0.509	0.662	−0.719	2.235***	0.998	−0.006
	(0.661)	(0.807)	(0.702)	(0.697)	(−0.792)	(2.694)	(1.391)	(−0.007)

(*continued*)

Table 10. Continued.

	(1) *SizeMax = 1*	(2) *SizeMax = 0*	(3) *Iscocurp = 1*	(4) *Iscocurp = 0*	(5) *Distrank<=*500m	(6) *Distrank >* 500m	(7) *SalaryMax = 0*	(8) *SalaryMax = 1*
Big4	0.288	−0.063	0.114	0.085	0.491**	−0.172	−0.029	0.288
	(1.436)	(−0.417)	(0.758)	(0.403)	(2.436)	(−1.059)	(−0.178)	(1.557)
Loss	−0.416***	−0.137**	−0.166**	−0.218**	−0.195**	−0.180**	−0.123*	−0.463***
	(−3.065)	(−2.023)	(−2.082)	(−2.163)	(−2.082)	(−2.073)	(−1.776)	(−3.820)
Sustainable	0.400	−0.177	−0.305	−0.164	−0.469	−0.019	−0.115	−0.120
	(0.865)	(−0.856)	(−1.154)	(−0.599)	(−1.318)	(−0.076)	(−0.544)	(−0.267)
EI	−0.036*	0.005	−0.008	−0.000	0.014	−0.016	0.000	−0.018
	(−1.879)	(0.424)	(−0.703)	(−0.008)	(0.926)	(−1.319)	(0.023)	(−0.959)
GDP	0.284***	0.242***	0.248***	0.241***	0.270***	0.234***	0.245***	0.261***
	(3.353)	(4.348)	(4.153)	(3.641)	(3.446)	(3.579)	(4.299)	(3.546)
_cons	−14.400***	−12.999***	−13.915***	−12.723***	−12.341***	−13.928***	−12.777***	−13.631***
	(−8.458)	(−12.469)	(−12.514)	(−10.065)	(−10.350)	(−12.002)	(−13.339)	(−10.012)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2580	4626	4896	2310	3279	3927	4626	2580
adj. R^2	0.584	0.515	0.555	0.534	0.560	0.546	0.530	0.571

Note: ***, **, and * indicate significant at the level of 1%, 5% and 10% respectively.
Source: The authors.

(Stulz,1988). However, technological innovation is also characterized by high risk and high reward, and once successful, technological innovation will bring huge profits and room for growth, as well as higher pay, more voice, and higher managerial market reputation for managers, thus executives of risk-preference firms are likely to prefer innovation as well. When intra-group cultural differences lead to more pronounced agency problems between shareholders and managers, manager of the affiliated firms are more likely to take their own interests into account and reduce their investment in innovation that is beneficial for long-term gains and potentially detrimental in the short term.

Thus, we measure management agency costs in terms of management expense ratio and investment efficiency. The existing literature suggests that executives manipulate overhead to satisfy their own interests, so overhead ratio can be used as a measure of management agency costs (Ang et al., 2000); investment efficiency is often due to managers' self-interested investment decisions, so in a sense, over investment can be used as a measure of management agency costs. The management expense ratio and investment efficiency were grouped according to the annual industry median. The coefficients of *RiskPreferDiffG5* × *RiskPreferG5* from the Table 4 columns (1) to (4) show that, in subsamples of the higher management expense ratio and lower investment efficiency, when the manager-shareholder agency problem is more severe, the intra group culture diversity will impede more on group affiliated firm's innovation.

5.1.2. The principal-agent problem of majority shareholder and minority shareholders

Actually, the shareholding of Chinese listed companies is concentrated and agency conflicts between majority shareholder and minority shareholders are more serious. The agency problems between majority shareholder and minority shareholders are usually more prominent because the headquarters in business groups usually control listed companies using a pyramidal shareholding structure. The characteristics of large investment and high risk of innovation investment mean that large amounts of capital are needed for continuous support upfront, yet the R&D results are unpredictable (Lall, 1992). In the affiliated firms of the business groups where the agency conflicts between majority shareholder and minority shareholders are more serious, the agency problems tend to lead to inconsistency in such high-risk decisions as innovation. At this point, if there are large cultural differences within a business group, the inconsistency in innovation decisions will be exacerbated. Even if the affiliated firms itself prefers it, and due to the group's collective relative conservatism toward risky investments, the majority shareholder is more likely to use risk aversion as a rational reason to withdraw funds from innovation inputs and reduce the innovation capacity of their affiliated firms.

Existing literature suggests that inter-shareholder agency problems tend to arise in firms with concentrated shareholdings of major shareholders (La Porta et al.,1999), which are mostly manifested in the appropriation of funds to other firms, so we estimate the agency problems between majority shareholder and minority shareholders through the two indicators of major shareholders' shareholdings and other receivables. From the coefficients of *RiskPreferDiffG5* × *RiskPreferG5* in the Table 4 columns

(5) to (8), it can be seen that in subsamples of higher shareholding of major shareholder and the firm with higher level of other receivables, when the major minority agency problems is more severe, the intra group culture diversity will impede more on group affiliated firm's innovation.

From the Table 4, we get the more evidence chain from the view of business group agency problems. When business group is widely existed in emerging countries, the firsly and secondly agency problems have great influence on group affiliated firm's risky decisions. We testify that intra group culture diversity impedes group affiliated firm's innovation through agency problems, help to understand the intrinsic mechanism of our story.

5.2. The heterogeneity analysis of the business group

In addition, existing researches of the business groups are almost based on firm-level factors and ignore the impact of group-level factors. The researches such as Cai and Zheng (2016) have argued that the compensation of executives of the business group affiliated firms depends not only on the performance of the firm itself but also on the performance of other group affiliated firms. While Duchin and Sosyura (2013) have pointed out that when a closer relationship exists between an affiliated firm and the business group headquarters, the firm has access to richer resources within the group. It is clear that the influence of the interaction factors between the affiliated firms of the business group cannot be ignored in the study about the business groups. Therefore, the more important question here is how heterogeneous characteristics at the business group level affect the relationship between group (collective) risk cultural differences on their affiliated firm (individual) risk preferences and innovation? So, we conducted a further extended analysis based on the characteristics of the business group.

We report the regression results in Table 10. Columns (1) $\sim$ (2) test the effect of the size of the affiliated firms in a business group. Its measure is that the affiliated firms in a business group is sorted by the size, the largest size in a business as a subgroup, and another subgroup of non-the largest size in a business group. Then the coefficient of $RiskPreferDiffG5 \times RiskPreferG5$ for column (1) is significantly negative, indicating that the smaller size of the company is more susceptible to its influence.

When executives of affiliated firms work in the business group headquarter, it will strengthen the control ability of the business group, which in turn will promote the effective implementation of group strategies and risk control measures in their affiliated firms; at the same time, it is also likely to promote the integration of different cultures among a business group, which will reduce the negative effect of group (collective) cultural differences on the relationship between affiliated firms (individual) risk preference culture and innovation capability. Therefore, we retest from the perspective of whether or not the affiliated firms' executives work part-time in the group headquarters. The $RiskPreferDiffG5 \times RiskPreferG5$ coefficient in column (4) is significantly negative, indicating that the affiliated firms' executives serving concurrently in the headquarters is conducive to eliminate the negative regulatory effect of group cultural differences on the affiliated firms' risk preference and innovation capability.

Columns (5) to (6) examine the effect of distance between business group affiliated firms on the cultural contagion effect. The coefficient of *RiskPreferDiffG5* × *RiskPreferG5* in column (6) is significantly negative, indicating that the closer the distance between the business group affiliated firms is, the more conducive to the communication of group affiliated firms, which in turn eliminates the negative moderating effect of cultural differences on affiliated firms' risk culture preference and innovation capability.

Columns (7) ∼ (8), on the other hand, test the effect of the executives' status of intra-group affiliated firms on the cultural contagion effect, which is measured by the grouping of executives according to their high and low salaries, with the largest salary being the group whose executives have more power, and the other group of non-maximum salary group in the group whose executives have less power. The *RiskPreferDiffG5* × *RiskPreferG5* coefficient of column (8) is significantly negative, indicating that intra-group firms' executive power is more conducive to intra-group firm communication when it is not very large within a group, which eliminates the negative moderating effect of group cultural diversity on affiliated firm's risk preferences and innovation capability.

5.3. The heterogeneity analysis of the affiliated firm in the business group

Further, we test the impact of the characteristics of the affiliated firms themselves. Fist, we examine the effect of the nature of property rights. The ultimate controller of state-owned enterprises is the government. Senior executives of state-owned enterprises are often appointed by governments, strictly abide by rules and regulations, and are more vulnerable to formal system constraints. On the contrary, the ultimate controller of private enterprises is a natural person or family, which is less restricted by government departments. Generally, the corporate governance mechanism is not perfect, resulting in more free ruling rights for major shareholders or managers. Culture, as a class of informal institutions, may be more obviously in private enterprises that are relatively less constrained by corporate governance mechanisms. This paper further tests the impact of risk cultural differences in business groups with different property rights nature, as seen from the Table 11 columns (1) to (2), the coefficient of *RiskPreferDiffG5* × *RiskPreferG5* in column (2) is significantly negative, indicating that for private business groups, the impact of group cultural differences on the relationship between risk culture preferences of affiliated firms and innovation capability shows a negative moderating effect, while state-owned enterprise group is less affected by cultural differences.

Second, we examine the effect of the quality of accounting information. Previous studies have identified the quality of accounting information as an important factor affecting corporate innovation. Both accrual and true earning management lead to lower R&D investment (El-Gazzar, 1998). So, what is the role of accounting information quality in the adjustment effect of cultural differences in business groups on the relationship between risk preference and innovation capability? As shown in 11 columns (3) to (4), in the better information quality subsamples, there is no significant effect of group cultural diversity on the relationship between risk preference and innovation capability, indicating that in a more transparent information environment,

Table 11. The heterogeneity analysis of the affiliated firm of the business group.

	(1) SOE = 0	(2) SOE = 1	(3) DA High	(4) DA Low
RiskPreferDiff G5	0.149***	0.225***	0.165***	0.168***
	(3.633)	(3.144)	(3.609)	(3.695)
RiskPreferG5	0.008	0.109*	0.062	−0.006
	(0.207)	(1.761)	(1.540)	(-0.142)
RiskPreferDiffG5 × RiskPreferG5	**-0.017**	**-0.049****	**-0.032****	**-0.016**
	(-1.430)	**(-2.488)**	**(-2.555)**	**(-1.209)**
RD	9.905***	4.928**	8.582***	8.696***
	(7.600)	(2.164)	(6.561)	(5.891)
MissRD	0.757***	0.952***	0.829***	0.803***
	(7.846)	(5.907)	(8.640)	(7.737)
Size	0.537***	0.504***	0.512***	0.552***
	(12.899)	(8.665)	(12.963)	(13.650)
Lev	−0.091	−0.078	−0.120	0.151
	(-0.436)	(-0.241)	(-0.605)	(0.636)
EstAge	−0.210*	−0.006	−0.101	−0.253**
	(-1.747)	(-0.033)	(-0.925)	(-2.086)
Roa	1.094	3.344***	1.722***	5.904***
	(1.642)	(3.647)	(3.224)	(4.281)
CF	0.025	0.551	0.220	−2.426***
	(0.066)	(1.002)	(0.710)	(-2.737)
Growth	−0.020	−0.124**	−0.045	−0.115
	(-0.475)	(-1.973)	(-1.029)	(-1.623)
Capex	−1.994***	−0.307	−0.708	−1.871***
	(-3.066)	(-0.350)	(-1.107)	(-2.957)
Intaratio	−0.137	−0.433	−0.257	−0.144
	(-0.640)	(-1.058)	(-1.038)	(-0.582)
Top1	−0.450	−0.643	−0.402	−0.429
	(-1.515)	(-1.622)	(-1.483)	(-1.489)
Mshare	−3.108**	−0.194	−0.839*	−0.817
	(-2.439)	(-0.351)	(-1.930)	(-1.205)
Instshare	0.025	0.397	0.166	0.032
	(0.134)	(1.215)	(0.852)	(0.169)
Boardsize	−0.008	−0.038	−0.011	−0.009
	(-0.315)	(-0.926)	(-0.483)	(-0.380)
Ind	0.981	−1.328	0.520	0.869
	(1.377)	(-0.965)	(0.735)	(1.198)
Big4	0.186	−0.126	0.279*	0.002
	(1.281)	(-0.396)	(1.647)	(0.014)
Loss	−0.212***	−0.075	−0.148*	−0.209**
	(-2.768)	(-0.722)	(-1.898)	(-2.262)
Sustainable	0.074	−0.484	−0.165	−0.335
	(0.296)	(-1.384)	(-0.753)	(-0.792)
EI	0.001	−0.036*	−0.004	−0.003
	(0.098)	(-1.849)	(-0.296)	(-0.220)
GDP	0.284***	0.180**	0.231***	0.269***
	(4.925)	(2.099)	(4.550)	(4.470)
_cons	−14.179***	−11.086***	−12.604***	−13.626***
	(-13.167)	(-6.695)	(-13.691)	(-13.063)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	5591	1615	3655	3551
adj. R^2	0.562	0.510	0.539	0.550

Note: ***, **, and * indicate significant at the level of 1%, 5% and 10% respectively.
Source: The authors.

it is easier for different group affiliated firm's to communicate, tolerate and coordinate with each other, which in turn reduces the negative effect of culture diversity on corporate innovation.

6. Conclusions

Under Chinese strongly policy incentives on innovation, we use group affiliated firms' data to analyses and testify how culture diversity affect and impede innovation.

First, we report that more risk preference brings more patents to group affiliated firms, which is consistently with relevant literature that risk promotes innovation. Then, after considering collective culture from the whole group, it shows that the higher degree of inconsistency in risk preference among different individualism of affiliated firms in group, the weaker impact of affiliated firm's own risk culture on patent.

Second, we document that intra group culture diversity will impede individual affiliated firm's innovation through aggravate agency problems. On one hand, when affiliated firm has more severe managerial problem, it's manager will be more self-interested, thus risk culture diversity from whole group to individual will impede more on affiliated firm's innovation. On the other hand, when existing more conflicts between controlling and minority shareholders, there might be more dissension from group headquarter to affiliated firms, thus risk culture diversity from whole group to individual will impede more on affiliated firm's innovation.

Third, we test the heterogeneity respectively from the whole group level and affiliated firm's level. From group level, we find that when size of affiliated firm is small, it's more susceptible to risk culture diversity of intra group, which brings a more negative impact on affiliated firm's innovation. Following the same logic, when affiliated firm's executives have no concurrent position in headquarter, affiliated firms located not very far from each other, or affiliated firm's executives are most powerful compared with other affiliated firms, there bring more negative impact on affiliated firm's innovation.

From affiliated firm's level, we testify in two points. For one hand, in state-owned group, executives from affiliated firms are mostly assigned from government, constrained by strictly regulations. On the contrary, in non-state group, corporate governance is not very complete, most of them are family groups, that informal regulation is more prevalent, thus are more easily affected by culture. For another hand, when affiliated firm has better financial information quality, there will be a better communication between headquarter and affiliated firms, thus are less affected by culture. We find that in non-state affiliated firms, as well as better in low information quality firms, there bring more negative impact on affiliated firm's innovation.

Overall, out findings suggest that, group affiliated firms are affected by both collective and individual culture, thus intra group culture diversity will impede individual affiliated firm's innovation, culture diversity brings dark side to the group. We provide a new perspective enabling external market stakeholders to understand the dark side of business groups. That group decision may be affected and impeded by intra-group culture diversity.

Although we focus on business groups in China, we do not have a priori reasons that suggest our findings do not apply to other emerging markets. Future research could validate our inference by extending our analysis to other emerging markets that are deeply affected by different cultures.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

Xu acknowledegs financial support from the National Natural Science Foundation of China (71862036), the Humanities and Social Science Foundation of the Ministry of Education of China (18YJC630210), the Basic Research Project of Yunnan Province (202101AT070219). Cheng acknowledges financial support from the Priority Academic Program Development of Jiangsu Higher Education Institutions (PAPD). Fang acknowledges financial support from the National Natural Science Foundation of China (71902035).

ORCID

Hui Xu http://orcid.org/0000-0001-6447-7447
Bo Cheng http://orcid.org/0000-0002-7994-5474
Qiaoling Fang http://orcid.org/0000-0002-3541-7696

References

Adhikari, B. K., & Agrawal, A. (2016). Religion, gambling attitudes and corporate innovation. *Journal of Corporate Finance*, *37*, 229–248. https://doi.org/10.1016/j.jcorpfin.2015.12.017

Aggarwal, R., Kearney, C., & Lucey, B. (2012). Gravity and culture in foreign portfolio investment. *Journal of Banking & Finance*, *36*(2), 525–538. https://doi.org/10.1016/j.jbankfin.2011.08.007

Almeida, H. V., & Wolfenzon, D. (2006). A theory of pyramidal ownership and family business groups. *The Journal of Finance*, *61*(6), 2637–2680. https://doi.org/10.1111/j.1540-6261.2006.01001.x

Ang, J. S., Cole, R. A., & Lin, J. W. (2000). Agency costs and ownership structure. *The Journal of Finance*, *55*(1), 81–106. https://doi.org/10.1111/0022-1082.00201

Baker, S. R., Bloom, N., & Davis, S. J. (2016). Measuring economic policy uncertainty. *The Quarterly Journal of Economics*, *131*(4), 1593–1636. https://doi.org/10.1093/qje/qjw024

Billett, M. T., & Mauer, D. C. (2003). Cross-subsidies, external financing constraints, and the contribution of the internal capital market to firm value. *Review of Financial Studies*, *16*(4), 1167–1201. https://doi.org/10.1093/rfs/hhg024

Boyd, R., & Richerson, P. J. (1988). *Culture and the evolutionary process*. University of Chicago press.

Braguinsky, S., & Mityakov, S. (2015). Foreign corporations and the culture of transparency: Evidence from Russian administrative data. *Journal of Financial Economics*, *117*(1), 139–164. https://doi.org/10.1016/j.jfineco.2013.02.016

Cai, G., & Zheng, G. (2016). Executive compensation in business groups: Evidence from China. *China Journal of Accounting Research*, *9*(1), 25–39. https://doi.org/10.1016/j.cjar.2015.06.003

Chemmanur, T. J., Loutskina, E., & Tian, X. (2014). Corporate venture capital, value creation, and innovation. *Review of Financial Studies*, *27*(8), 2434–2473. https://doi.org/10.1093/rfs/hhu033

Chen, C., Gotti, G., Kang, T., & Wolfe, M. C. (2018). Corporate codes of ethics, national culture, and earnings discretion: International evidence. *Journal of Business Ethics*, *151*(1), 141–163. https://doi.org/10.1007/s10551-016-3210-y

Cheng, B., Pan, F., & Wang, J. (2016). Confucian culture, information environment and internal controls. *Accounting Research*, *12*, 79–84. (in Chinese). https://doi.org/10.3969/j.issn.1003-2886.2016.12.011

Cheng, B., Xiong, T., & Pan, F. (2020). Trust culture, pay gap and firm innovation. *Scientific Research Management*, *41*(2), 239–247. (in Chinese). https://doi.org/10.19571/j.cnki.1000-2995.2020.02.024

Chen, L., Jin, Z., Ma, Y., & Xu, H. (2019). Confucianism, openness to the West, and corporate investment efficiency. *European Financial Management*, *25*(3), 554–590. https://doi.org/10.1111/eufm.12173

Claessens, S., Fan, J. P., & Lang, L. H. (2006). The benefits and costs of group affiliation: Evidence from East Asia. *Emerging Markets Review*, *7*(1), 1–26. https://doi.org/10.1016/j.ememar.2005.08.001

Cline, B. N., Garner, J. L., & Yore, A. S. (2014). Exploitation of the internal capital market and the avoidance of outside monitoring. *Journal of Corporate Finance*, *25*, 234–250. https://doi.org/10.1016/j.jcorpfin.2013.12.004

Cornaggia, J., Mao, Y., Tian, X., & Wolfe, B. (2015). Does banking competition affect innovation? *Journal of Financial Economics*, *115*(1), 189–209. https://doi.org/10.1016/j.jfineco.2014.09.001

Cumming, D., Verdoliva, V., & Zhan, F. (2021). New and future research in corporate finance and governance in China and emerging markets. *Emerging Markets Review*, *46*, 100792. https://doi.org/10.1016/j.ememar.2020.100792

Dechow, P. M., Sloan, R. G., & Sweeney, A. P. (1995). Detecting earnings management. *The Accounting Review, 70*(2), 193–225. http://links.jstor.org/sici?sici=0001-4826%28199504%2970%3A2%3C193%3ADEM%3E2.0.CO%3B2-Y

Dosi, G., Marengo, L., & Pasquali, C. (2006). How much should society fuel the greed of innovators?: On the relations between appropriability, opportunities and rates of innovation. *Research Policy*, *35*(8), 1110–1121. https://doi.org/10.1016/j.respol.2006.09.003

Du, X. (2015). Does Confucianism reduce minority shareholder expropriation? Evidence from China. *Journal of Business Ethics*, *132*(4), 661–716. https://doi.org/10.1007/s10551-014-2325-2

Du, X. (2016). Does Confucianism reduce board gender diversity? Firm-level evidence from China. *Journal of Business Ethics*, *136*(2), 399–436. https://doi.org/10.1007/s10551-014-2508-x

Duchin, R., & Sosyura, D. (2013). Divisional managers and internal capital markets. *The Journal of Finance*, *68*(2), 387–429. https://doi.org/10.1111/jofi.12003

El-Gazzar, S. M. (1998). Predisclosure information and institutional ownership: A cross-sectional examination of market revaluations during earnings announcement periods. *Accounting Review, 73*(1), 119–129. http://www.jstor.org/stable/248344

Eun, C. S., Wang, L., & Xiao, S. C. (2015). Culture and R^2. *Journal of Financial Economics*, *115*(2), 283–303. https://doi.org/10.1016/j.jfineco.2014.09.003

Fang, J. X., Pittman, J., Zhang, Y. Q., & Zhao, Y. P. (2017). Auditor choice and its implications for group-affiliated firms. *Contemporary Accounting Research*, *34*(1), 39–82. https://doi.org/10.1111/1911-3846.12276

Guiso, L., Sapienza, P., & Zingales, L. (2015). The value of corporate culture. *Journal of Financial Economics*, *117*(1), 60–76. https://doi.org/10.1016/j.jfineco.2014.05.010

Hall, B. H., & Harhoff, D. (2012). Recent research on the economics of patents. *NBER Working Paper Series*, *4*(1), 541–565. https://doi.org/10.3386/w17773

Hashi, I., & Stojcic, N. (2013). The impact of innovation activities on firm performance using a multi-stage model: Evidence from the Community Innovation Survey 4. *Research Policy*, *42*(2), 353–366. https://doi.org/10.1016/j.respol.2012.09.011

He, J., Mao, X., Rui, O. M., & Zha, X. (2013). Business groups in China. *Journal of Corporate Finance*, *22*, 166–192. https://doi.org/10.1016/j.jcorpfin.2013.05.001

Hilary, G., & Hui, K. W. (2009). Does religion matter in corporate decision making in America? *Journal of Financial Economics*, *93*(3), 455–473. https://doi.org/10.1016/j.jfineco.2008.10.001

Hofstede, G. (1991). *Cultures and organizations: Software of the mind*. MeGraw-Hill.

Holderness, C. G. (2017). Culture and the ownership concentration of public corporations around the world. *Journal of Corporate Finance*, *44*, 469–486. https://doi.org/10.1016/j.jcorpfin.2014.07.002

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, *3*(4), 305–360. https://doi.org/10.1016/0304-405X(76)90026-X

Jiang, F., Jiang, Z., Kim, K. A., & Zhang, M. (2015). Family-firm risk-taking: does religion matter? *Journal of Corporate Finance*, *33*, 260–278. https://doi.org/10.1016/j.jcorpfin.2015.01.007

Kanagaretnam, K., Lim, C. Y., & Lobo, G. J. (2014). Influence of national culture on accounting conservatism and risk-taking in the banking industry. *The Accounting Review*, *89*(3), 1115–1149. https://doi.org/10.2308/accr-50682

Kayalvizhi, P. N., & Thenmozhi, M. (2018). Does quality of innovation, culture and governance drive FDI?: Evidence from emerging markets. *Emerging Markets Review*, *34*, 175–191. https://doi.org/10.1016/j.ememar.2017.11.007

Khanna, T., & Palepu, K. (2000). Is group affiliation profitable in emerging markets? An analysis of diversified Indian business groups. *The Journal of Finance*, *55*(2), 867–891. https://doi.org/10.1111/0022-1082.00229

Khanna, N., & Tice, S. (2001). The bright side of internal capital markets. *The Journal of Finance*, *56*(4), 1489–1528. https://doi.org/10.1111/0022-1082.00377

Khanna, T., & Yafeh, Y. (2007). Business groups in emerging markets: Paragons or parasites? *Journal of Economic Literature*, *45*(2), 331–372. https://doi.org/10.1257/jel.45.2.331

La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (1999). Corporate ownership around the world. *The Journal of Finance*, *54*(2), 471–517. https://doi.org/10.1111/0022-1082.00115

Lall, S. (1992). Technological capabilities and industrialization. *World Development*, *20*(2), 165–186. https://doi.org/10.1016/0305-750X(92)90097-F

Lewellyn, K. B., & Muller-Kahle, M. I. (2020). The corporate board glass ceiling: The role of empowerment and culture in shaping board gender diversity. *Journal of Business Ethics*, *165*(2), 329–346. https://doi.org/10.1007/s10551-019-04116-9

Lichtenberg, F., & Siegel, D. (1991). The impact of R&D investment on productivity: new evidence used linked R&D-LDR data. *Economic Inquiry*, *29*(2), 203–229. https://doi.org/10.1111/j.1465-7295.1991.tb01267.x

Li, K., Griffin, D., Yue, H., & Zhao, L. (2013). How does culture influence corporate risk-taking? *Journal of Corporate Finance*, *23*, 1–22. https://doi.org/10.1016/j.jcorpfin.2013.07.008

Li, K., Mai, F., Shen, R., & Yan, X. (2021). Measuring corporate culture using machine learning. *The Review of Financial Studies*, *34*(7), 3265–3315. https://doi.org/10.1093/rfs/hhaa079

Lim, J., Makhija, A. K., & Shenkar, O. (2016). The asymmetric relationship between national cultural distance and target premiums in cross-border M&A. *Journal of Corporate Finance*, *41*, 542–571. https://doi.org/10.1016/j.jcorpfin.2016.07.007

Li, R., Xu, G., & Ramanathan, R. (2022). The impact of environmental investments on green innovation: An integration of factors that increase or decrease uncertainty. *Business Strategy and the Environment*, *31*(7), 3388–3405. https://doi.org/10.1002/bse.3090

Li, W., & Zheng, M. (2016). Substantive or strategic innovation? – The impact of macro-industrial policy on micro-firm innovation. *Economic Research*, *51*(4), 60–73. (in Chinese). https://kns-cnki-net-s.fzu.edu.cn/KCMS/detail/detail.aspx?dbname=cjfd2016&filename=jjyj201604005&dbcode=cjfq

Loughran, T., & McDonald, B. (2013). IPO first-day returns, offer price revisions, volatility, and form S-1 language. *Journal of Financial Economics*, *109*(2), 307–326. https://doi.org/10.1016/j.jfineco.2013.02.017

Na, P., Muzi, Y., & Na, C. (2017). A study of risk contagion effect of corporate groups-empirical evidence from group holding listed companies. *Accounting Research*, (3), 53–60. (in Chinese). https://doi.org/10.3969/j.issn.1003-2886.2017.03.009

Rajan, R., Servaes, H., & Zingales, L. (2000). The cost of diversity: The diversification discount and inefficient investment. *The Journal of Finance*, *55*(1), 35–80. https://doi.org/10.1111/0022-1082.00200

Richardson, S. (2006). Over-investment of free cash flow. *Review of Accounting Studies*, *11*(2-3), 159–189. https://doi.org/10.1007/s11142-006-9012-1

Scharfstein, D. S., & Stein, J. C. (2000). The dark side of internal capital markets: Divisional rent-seeking and inefficient investment. *The Journal of Finance*, *55*(6), 2537–2564. http://www.jstor.org/stable/222393 https://doi.org/10.1111/0022-1082.00299

Shi, W., & Tang, Y. (2015). Cultural similarity as in-group favoritism: The impact of religious and ethnic similarities on alliance formation and announcement returns. *Journal of Corporate Finance*, *34*, 32–46. https://doi.org/10.1016/j.jcorpfin.2015.07.003

Shin, H. H., & Park, Y. S. (1999). Financing constraints and internal capital markets: Evidence from Koreanchaebols. *Journal of Corporate Finance*, *5*(2), 169–191. https://doi.org/10.1016/S0929-1199(99)00002-4

Stulz, R. (1988). Managerial control of voting rights: Financing policies and the market for corporate control. *Journal of Financial Economics*, *20*, 25–54. https://doi.org/10.1016/0304-405X(88)90039-6

Wulf, J. (2009). Influence and inefficiency in the internal capital market. *Journal of Economic Behavior & Organization*, *72*(1), 305–321. https://doi.org/10.1016/j.jebo.2009.07.001

Zingales, L. (2015). The" cultural revolution" in finance. *Journal of Financial Economics*, *117*(1), 1–4. https://doi.org/10.1016/j.jfineco.2015.05.006

Appendix. Variable definitions.

Variable	Definition
Main regression model variables	
RiskPrefer	The culture of risk preference equals risk preference words minus risk aversion words, then divide by the total number of words and multiplied 100.
RiskPreferG5	Risk preference culture level (*RiskPreferG5*) divides *RiskPrefer* into 1, 2, 3, 4 and 5 levels according to the risk preference culture level of the industry in which the business group-affiliated firm is located every year.
RiskPreferDiffG5	the cultural difference (*RiskPreferDiffG5*) is measured by the degree of difference in risk preference culture *(RiskPrefer*) between different affiliated firms belonging to the same business group. The calculation steps are: first, calculate the difference in risk preference culture between different two affiliated firms within the same business group each year, and then calculate the absolute value; second, calculate the average value within a business group which represents the degree of business groups' cultural differences; finally, divide the value of business groups' cultural differences each year into 1, 2, 3, 4 and 5 levels (*RiskPreferDiffG5*).
RiskPreferD	An indicator variable equal to 1 if the value *RiskPrefer* greater than median value in the industry every year, otherwise is 0.
Patents	The total number of domestic and foreign patents applied for, and add 1, and then take the natural logarithm.
P_Substantive	The number of domestic and foreign invention patents applied for, and add 1, and then take the natural logarithm.
P_Strategic	The number of domestic and foreign utility model patents and design patents applied for , and add 1, and then take the natural logarithm.
Granted_Patents	The total number of domestic and foreign patents granted for, and add 1, and then take the natural logarithm.
Patents_Cited	The total number of patents cited, and add 1, and then take the natural logarithm
Control variables	
RD	The value that R&D expenditures divided by operating income, and if miss, the value is 0.
MissRD	An indicator variable equal to 1 if the R&D expenditures miss, otherwise is 0.
Size	The natural logarithm of total assets.
Lev	asset-liability ratio.
EstAge	The natural logarithm of the years from the company established.
Growth	The ratio of the sales growth.
Roa	The value that net income divided by total assets.
CF	The value that net cash flows from operating activities divided by total assets.
Capex	The value that cash paid for the purchase and construction of fixed assets divided by total assets.
Intaratio	The percentage of intangible assets.
Top1	The percentage of shares held by the first largest shareholder.

(*continued*)

Continued.

Variable	Definition
Mshare	The percentage of shares held by the executives.
Instshare	The percentage of shares held by the Institutional shareholder shareholding.
Ind	The percentage of independent directors in the board.
Boardsize	The number of Board members.
Big4	An indicator variable equal to 1 if the firm audited by top 4 major accounting firms, otherwise is 0.
Loss	An indicator variable equal to 1 if the net profit is negative, otherwise 0.
Sustainable	Sustainable growth ratio = ROE × retention rate / (1 - ROE x retention rate).
EI	The value is the non-recurring gains and losses divided by net income.
GDP	The natural logarithm of the GNP of the province where the company is located.
Other variables	
Mfee	The value is the administrative expenses divided by total assets.
Invest	The value is the regression residuals that are estimated according to Richardson's (2006) model, and then take the absolute value.
Other	The value is the other receivables divided by total assets.
SizeMax	An indicator variable equal to 1 if that the size of affiliated firm is the largest one within a business group, otherwise is 0.
SalaryMax	An indicator variable equal to 1 if that the salary of executive of the affiliated firm is the largest one within a business group, otherwise is 0.
Iscocurp	An indicator variable equal to 1 if that the CEO or chairman is concurrently appointed in the shareholder's firm for 1, otherwise is 0.
Distrank	The average distance of the affiliated firms within a business group.
DA	The value of accrued surplus management calculated according to Dechow et al. (1995), and the take the absolute value.
SOE	An indicator variable equal to 1 if the firm control by the state, otherwise is 0.