Are older directors less innovative? Evidence from textual analysis

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Abstract

Motivated by agency theory and resource dependency theory, we explore whether director age influences a firm's innovation. Using textual-based innovation measures proposed by Bellstam, Bhagat and Cookson (2019), we find that older directors impede the firm's innovation. Our findings are robust to additional analyses including 2SLS instrumental variable and GMM dynamic panel data estimations and unlikely to be driven by unobserved heterogeneity. We provide evidence supporting agency theory where information asymmetry inherited in innovation investment leads to substantial agency costs.

JEL Classification: G34, G39, M19, O31

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1. Introduction

For decades, researchers have been exploring variables, affecting firms' performance and returns. Investments in research and development (R&D) is one of the important factors driving firms' performance. Recently, Bellstam, Bhagat and Cookson (2019) propose a new measure of innovation based on textual analysis and report that this new measure is a meaningful indicator for growth and firm performance. Text-based innovation measure represents corporate innovation derived from the financial analyst reports via the textual description of firm activities. It encapsulates the notion of innovation in the form of processes, products, and systems, where it describes the level of innovation of the firms. Strategic decision making that will ensure the company to head in the right direction accounts for the major task of the board of directors (Duran, 2104; Chintrakarn et al., 2015). Composing boards with members that represent perspectives and interests, resulting in the firm's board characteristics, is one mechanism that can improve the decision-making within the board of directors, which in turns determine the firm's performance (Hambrick and Mason, 1984; Ling et al., 2016; Li and Rainville, 2021). This paper explores how the board characteristics, namely director age, affects text-based measure of innovation.

Innovation is an important factor for economic development, promoting long-term economic growth (Wong et al., 2015). Innovation plays a vital role in firm competitiveness at national levels (Tellis et al., 2009; Yang and He, 2019; Cuong and Hau, 2021). Previous evidence postulates a positive linkage between innovation and performance (Garcia-Morales et al., 2011; Kim et al., 2021; Yu and Hong, 2016). However, innovation requires commitments and long-term investment (Ongsakul et al., 2021). As such investing in innovation bears risk (Zhang, 2021). Corporate risk-taking is crucial to economic reward. Board is responsible for taking risks in pursuing strategic objectives to maximize shareholder's wealth. Risks embedded in the investment decisions will conclusively define the firm's competitiveness in their industry (Sila et al., 2016).

We propose two opposing hypotheses. First, from an agency perspective, information asymmetry inherited in innovation investment intensifies agency costs. Innovation projects, being complex and a long-term investment, are inclined to conflict with choices as managers are usually more informed regarding the project's specific information, such as its value and success rate (AlHares et al., 2018). Since older managers are more risk averse (Barker and Mueller, 2002) and

tend to put value on career and financial security as opposed to the preference of the shareholders, older directors would amplify conflict of interest (Fama and Jensen, 1983).

On the other hand, resource dependency theory postulates that the integration of experience in the board assists the firm to acquire valuable resources (Goodstein et al., 1994). Older managers are more experienced and can provide the firm with many advantages such as better market knowledge, effective problem solving and enhanced capability (Drees and Heugens, 2013). Broader range of perspective and experience allows the firm to deal with the variety of stakeholders' expectations, leading to the increase in innovation types implemented (Bear et al, 2010).

While resource dependency predicts a positive relation between director age and innovation, as an older director has more experience and access to resources, agency theory suggests otherwise. We empirically explore how director age influences innovation, by using textual-based innovation measure as proxy. Based on 2,939 firm-year observations, we find a negative relation between director age and textual-based innovation measure, confirming the prediction of agency theory. Our results remain valid even after controlling for endogeneity, an array of firm characteristics and variation over time and across industries. We further explore the effect of the global financial crisis (GFC) on the relation between director age and innovation. The GFC allows us to test our hypothesis when resources are scarce and firms are prone to investment (Pianeselli and Zaghini, 2014). We find a reduction in corporate innovation and a weakening negative relation between director age and corporate innovation during the stressful period. To ensure our results are robust, we perform a battery of robustness checks. We execute an instrumental variable analysis (IV) using sector mean and sector median as instruments. We also employ GMM dynamic estimation as robustness checks and obtain consistent results.

We contribute to the literature on the inconclusive debate over director age (Hambrick and Mason, 1984; Cheng et al., 2010), a specific governance mechanism, to corporate innovation, proxied by text-based innovation measure. Prior studies explore other general governance mechanisms tied with innovation, such as female directors (Chen et al., 2018) and independent directors (Balsmeier et al., 2017). Additionally, we extend the literature that explores the link between text-based innovation measure and firm performance (Bellstam, Bhagat and Cookson, 2019) by providing the first study that examines the link between text-based innovation and

director age for a cross industry sample. Finally, our findings likely indicate causal relation between text-based innovation and director age and are less subject to endogeneity issues.

2. Description of the Data and Method

2.1 Sample and Modelling

Our observations consist of 2,939 firm-year from 456 unique firms over the sample period of 1996 to 2010. We obtain data on textual-based innovation measures from Bellstam, Bhagat and Cookson (2019) and US firms' financial data from COMPUSTAT. To explore the relation between director age and corporate innovation, we estimate the following regression model:

$$Innovation = \beta_0 + \beta_1(Director\ Age) + Controls + Year\ Dummies + Industry\ Dummies + e_t \quad (1)$$

where *Innovation* represents text-based innovation constructed by Bellstam, Bhagat and Cookson (2019), and *Director age* is defined as the natural logarithm of the average age of board members. Text-based innovation represents the level of corporate innovation derived from the textual description of firm activities from the analyst reports. This allows researchers to decipher qualitative measures to quantitative ones and enables the data to be compared from the readability and scalability aspects from this kind of measure (Loughran and McDonald, 2016).

Additionally, we included several control variables that may influence the magnitude of innovation as identified by prior literatures. Specifically, we incorporate board size (the natural logarithm of the number of board members), independent director (the percentage of independent director sitting in the board), firm size (the natural logarithm of total assets), profitability (EBIT/total assets), leverage (total debt/total assets), capital investments (capital expenditures/total assets), R&D expense (R&D/total assets), advertising expense (advertising expense/total assets) and liquidity (current assets/current liabilities). To account for variation over time and across industries, we include year fixed effects and industry fixed effects.

Finally, we run several robustness checks to alleviate endogeneity problems, we estimate our baseline regression using a two-stage least square instrumental variable approach. Following Sheikh (2018), we use the sector mean and sector median age of directors as instruments in the 2SLS IV estimation. We further estimate our model with the two-step system GMM panel estimation following Arellano and Bond (1991).

2.2 Descriptive statistics

Table 1 presents the descriptive statistics of all the variables. The average figure for textual-based innovation measure is 0.197, along with the standard deviation of 0.919 with a minimum of -1.691 and a maximum of 3.697. The average age of directors in the sample is 61.286 years old with a spread of 3.526 years. Clearly, the variable does not fluctuate much, indicating a trend for the average age of directors. According to the Spencer Stuart Board Index (2019), the average age of directors for firms listed in the S&P 500 is 62.7 years old, slightly higher than those in our sample. The average board size is 10.439 directors with a standard deviation of 2.438, meaning that boards have a stable range of 8-13 directors. Our samples are in line with the Spencer Stuart Board Index (2019) where the average board size is 10.7. The mean percentage of independent directors in our sample is 72.06% with a standard deviation of 15.48%.

[Table 1 about here]

3. Main results and discussion

3.1 Effects of director age on textual-based innovation measure

Table 2 reports the OLS regression result on the effect of director age on innovation. Consistent with agency theory, the OLS results (Model 1) show a negative and significant relationship between director age and textual-based innovation measure. This confirms the findings by Galia and Zenou (2012) and Mahadeo et al. (2012) that younger directors have a higher tendency to adopt new innovations. This evidence is consistent with our predictions of a negative relationship between text-based innovation. Additionally, we confirm previous findings that larger board size can lead to conflict amongst the directors and important issues can get delayed leading to a declined initiatives on risk-taking (Cheng, 2008), large firms tend to invest more in innovation (Shefer and Frenkel, 2005) and high levered firms invest less in innovation as high levered firms tend to avoid adding more risk through innovation (Hitt et al., 1996).

For our robustness check, Table 2 also reports the estimation from two-stage least squares (2SLS) regression with textual-based innovation as the dependent variable. This approach mitigates potential endogeneity concerns that can lead to reverse causality, omitted variables and measurement errors. Our instrumental variable is the sector mean director age (Model 2) and sector median director age (Model 3). Our first stage regression results show that our instrument (sector

mean director age and sector median director age) is positively associated with firms' director age and significance. The results from the second stage regressions both show that the coefficient of the director age is negative towards textual-based innovation at 1% significance level. This evidence is consistent with our prediction of a negative relationship between director age and textual-based innovation and further confirms the results of Model 1, as well as proving there is no issue on the reverse causality. Moreover, our 2SLS IV finding confirms the literature by Bellstam, Bhagat and Cookson (2019), where there exists a positive relationship between text-based innovation and profitability at 1% significance level.

To further our robustness check, we employ the dynamic GMM panel estimation. This technique reduces the endogeneity bias that attributes to unobserved heterogeneity and focuses on the dynamic relationship that is inherent within the explanatory variables. Model 4 reports the result for the GMM panel estimation following Arellano and Bond (1991). It treats the explanatory variable as endogenous and uses their lagged values as instrumental variables, where our endogenous variable is director age. It describes the relationship between director age and textual-based innovation. The lagged value of textual based innovation is positive and significant while director age is negatively related to textual-based innovation at 5% significance level. This again proves our hypothesis and confirms our previous results that older directors tend to reduce corporate innovation.

[Table 2 about here]

3.2 Effect of the GFC on the relation between director age and corporate innovation

In general, GFC leads to a reduction in resources and cash constraints. Current accounting structures often treat innovation expenditures as costs rather than investments and firms generally focus on cost reduction to survive the crisis. Treating innovation as a cost lead to decisions to reduce innovation in an effort to reduce risk (Hausman and Johnston, 2013). A McKinsey survey of 500 global large firms indicates that 34% expect a decrease in R&D spending in 2009 (Guellec & Wunsch-Vincent, 2009).

We explore the effect of the GFC on the relation between director age and textual-based innovation by introducing the GFC dummy variable to the analyses, where GFC equals 1 for 2007-2009 and 0 otherwise. Model 5 indicates a reduction in corporate innovation during the GFC

period, consistent with the McKinsey survey (Guellec & Wunsch-Vincent, 2009). Further, our interaction term between director age and GFC dummy in Model 5 demonstrates that older directors tend to reduce corporate innovation in the stressful time less than in the general market condition. This evidence is consistent with the Schumpeterian hypotheses of creative destruction and technological accumulation (see Archibugi et al., 2012). Being older seems to be wiser such that these directors do not abruptly react to the short-term shock by massively reducing corporate innovation. It seems agency cost is lower during the time of crises, this follows Felicio et al. (2018) that different corporate governance mechanisms lead to a reduction in agency cost during the financial crisis. We also run robustness checks using the 2SLS IV analyses in Models 6 and 7. Our results from Models 6 and 7 confirm findings reported in Model 5.

[Table 3 about here]

4. Concluding Remarks

Motivated by agency theory and resource dependency theory, we explore whether director age affects textual-based innovation measure, which is found to improve firm performance (Bellstam, Bhagat and Cookson, 2019). Drawing on 15 years and 2,939 firm-year observations, we find robust evidence that director age impedes text-based innovation, where younger director is more innovative and inclined to take on risky investments for the long-term rewards in innovation, as projects that lead to innovation tend to have more complexity and take a substantial amount of time to complete. The negative relation from the results imply that older directors are more risk-averse and older directors intensify agency cost instead of using their experience and network to support resource dependency that would be beneficial to the firm. We then demonstrate that after controlling for two sources of endogeneity, unobserved heterogeneity, and reverse causality, through 2SLS IV analyses and GMM panel estimation, there is evidence that older directors disfavor corporate innovation. We also find evidence that this relationship is affected by the global financial crisis by weakening the negative relation between director age and corporate innovation. Even though resources are scarce which would lead to a reduction in investments by firms in general, older directors tend to reduce their investment in innovation less than those of younger directors, consistent with Schumpeterian hypotheses of creative destruction and technological accumulation. The level of agency conflict is lower during the time of crises. We propose the idea of innovation, through director age, as the integrated actions of a firm to become

more profitable. The main implication of our paper is the studies that attempt to link the board characteristic of firms' decision-maker to firm outcomes, in doing so, it gives an indication of firm performance through director age in accordance with the agency theory. Our findings allow the identification of those performance initiatives which can lead to competitive advantage.

Future studies could explore the strength of ties between other board composition, such as gender diversity, independent director and co-opted directors to textual-based innovation and shed some light on establishing the relationship between firm and stakeholders to reduce agency conflict. This would be of great contribution to the literature area of innovation in setting a basis for innovative firms.

Table 1: Descriptive Statistics

Textual-based innovation variable is from Bellstam, Bhagat and Cookson (2019). Director age is the average age of all directors sitting on the board. Board size is the number of directors sitting on the board. Independent director is the percentage of independent directors sitting in the board. Firm size is the natural log of total assets. Profitability is the EBIT divided by total assets. Leverage is the total debt divided by total assets. Capital investments is capital expenditures divided by total assets. R&D expense is the R&D expenditure divided by total assets. Advertising expense is advertising expenditure divided by total assets. Liquidity is the current assets divided by current liabilities.

VARIABLES	N	Mean	Std Dev.	min	max	p25	p50	p75
Textual-based innovation	2,939	0.197	0.919	-1.691	3.697	-0.473	0.185	0.757
Board size	2,939	10.440	2.440	3	23	9	10	12
Director age	2,939	61.290	3.530	45.559	71.88	59.200	61.570	63.560
Independent Director	2,939	72.060	15.480	0	100	62.500	75	83.330
EBIT/total assets	2,939	0.107	0.200	-2.874	0.357	0.070	0.112	0.163
Capital expenditure/total assets	2,939	0.055	0.045	0.001	0.289	0.025	0.043	0.070
Advertising/total assets	2,939	0.016	0.031	0	0.172	0	0	0.018
Total Asset	2,939	8.819	1.195	5.571	12.630	7.943	8.678	9.591
Leverage	2,939	0.232	0.156	0	1.073	0.120	0.227	0.328
R&D/total assets	2,939	0.031	0.050	0	0.605	0	0.007	0.042

Table 2: Baseline Regression

Model 1 reports the OLS regression of director age and textual-based innovation measure. Model 2 and 3 reports the 2SLS results of instrumental-variable (IV) regressions where we use sector mean (Model 2) and sector median (Model 3) director age as an instrumental variable in the first-stage regressions. We use predicted value director age obtained in the first-stage IV regressions as an explanatory variable in the second-stage IV regressions where the dependent variable is the textual-based innovation measure. The dependent variable is textual-based innovation measure. The key variable is the director age, which is calculated at the natural log of average director age. We control for several factors that may impact firm's innovation, we include board size (Ln of number of board members), independent director, firm size (Ln of total assets), profitability (EBIT/total assets), leverage (total debt/total assets), capital investments (capital expenditures/total assets), intangible assets (R&D/total assets and advertising expense/total assets) and liquidity (current assets/current liabilities). Model 4 presents the Arellano and Bond (1991) GMM analysis for the relationship between director age and textual-based innovation. Textual-based innovation (t-1) is the lagged value of textual-based innovation. The robust standard errors clustered at firm level are reported in parenthesis. The ***, **, * indicate significance levels of 1%, 5%, and 10%.

	OLS	IV 2SLS		IV 2SLS		GMM
	(1)	(2)		(3)		(4)
	Textual-based	IV Sector Mean		IV Sector Median		Textual-based
VARIABLES	Innovation	First Stage	Second Stage	First Stage	Second Stage	Innovation
Sector Mean Director Age		0.676***				
		(0.224)				
Sector Median Director Age				0.604**		
				(0.252)		
Textual-based innovation (t-1)						0.193***
						(0.033)
Director Age	**-2.098*** **		**-28.966*** **		**-28.552*** **	**-3.153** **
	(0.542)		**(4.228)**		**(5.189)**	**(1.370)**
Board Size	-0.593***	0.042***	0.813***	0.043***	0.795***	-0.213
	(0.141)	(0.011)	(0.201)	(0.011)	(0.240)	(0.165)
Independent Director	-0.002	-0.000	-0.004**	-0.000	-0.004**	-0.002
	(0.002)	(0.000)	(0.002)	(0.000)	(0.002)	(0.002)
Total Asset	0.153***	0.004*	0.235***	0.004*	0.233***	0.120
	(0.033)	(0.002)	(0.032)	(0.002)	(0.034)	(0.085)
Leverage	-0.928***	-0.003	-0.506***	-0.002	-0.507***	-0.887***
	(0.197)	(0.015)	(0.185)	(0.015)	(0.184)	(0.252)
Capital Investment	-1.311**	-0.033	0.062	-0.042	0.077	0.425
	(0.532)	(0.050)	(0.579)	(0.051)	(0.626)	(0.845)
Profitability	0.001	0.008	0.333***	0.009	0.328***	0.021
	(0.095)	(0.006)	(0.094)	(0.006)	(0.101)	(0.096)
R&D Expense	4.996***	-0.048	0.161	-0.062	0.209	-0.878
	(0.877)	(0.058)	(0.892)	(0.058)	(1.003)	(0.973)
Advertising Expense	2.722***	-0.197**	-4.268***	-0.200**	-4.170***	-3.525
	(0.967)	(0.099)	(1.396)	(0.099)	(1.601)	(2.192)
Constant	9.151***	1.144	113.827***	1.441	112.201***	12.995**
	(2.184)	(0.923)	(16.624)	(1.039)	(20.398)	(5.660)
Industry	No	Yes	Yes	Yes	Yes	Yes
Year	No	Yes	Yes	Yes	Yes	Yes
Observations	2,939	2,939	2,939	2,939	2,939	1,713
R-squared	0.201	0.327	0.452	0.322	0.437	
Number of firm_id						330

Table 3: Effect of GFC on relationship between Director Age and Textual-Based Innovation Measure – OLS and 2SLS IV approach

Model 5 reports the OLS regression of director age and textual-based innovation measure. Model 6 and 7 reports the 2SLS results of instrumental-variable (IV) regressions where we use sector mean (Model 6) and sector median (Model 7) director age as an instrumental variable in the first-stage regressions. We use predicted value director age obtained in the first-stage IV regressions as an explanatory variable in the second-stage IV regressions where the dependent variable is the textual-based innovation measure. GFC is a dummy variable equals to 1 if the year is 2007-2009 and 0 otherwise. The robust standard errors clustered at firm level are reported in parenthesis. The ***, **, * indicate significance levels of 1%, 5%, and 10%.

	OLS	IV 2SLS		IV 2SLS	
	(5)	(6)		(7)	
	Textual-based	IV Sector Mean		IV Sector Median	
VARIABLES	Innovation	First Stage	Second Stage	First Stage	Second Stage
GFC	-9.781*	0.378	-39.433***	0.161	-43.207***
	(4.990)	(0.605)	(7.643)	(0.700)	(7.893)
Sector Mean Director Age		0.700***			
		(0.234)			
Sector Median Director Age				0.612**	
				(0.263)	
Director Age	-2.970***		**-32.564*** **		**-31.678*** **
	(0.605)		**(4.127)**		**(5.151)**
Sector Mean Director Age X GFC		-0.083			
		(0.147)			
Sector Median Director Age X GFC				-0.030	
				(0.170)	
Director Age X GFC	**2.449** **		**10.004*** **		**10.907*** **
	(1.204)		**(1.848)**		**(1.911)**
Board Size	-0.504***	0.042***	0.943***	0.043***	0.899***
	(0.140)	(0.011)	(0.197)	(0.011)	(0.239)
Independent Director	-0.004**	-0.000	-0.004**	-0.000	-0.004**
	(0.002)	(0.000)	(0.002)	(0.000)	(0.002)
Total Asset	0.143***	0.004*	0.234***	0.004*	0.230***
	(0.033)	(0.002)	(0.031)	(0.002)	(0.033)
Leverage	-0.914***	-0.003	-0.473***	-0.002	-0.475***
	(0.193)	(0.015)	(0.181)	(0.015)	(0.181)
Capital Investment	-1.219**	-0.032	-0.056	-0.041	-0.012
	(0.519)	(0.050)	(0.567)	(0.051)	(0.619)
Profitability	0.005	0.008	0.378***	0.009	0.369***
	(0.100)	(0.006)	(0.092)	(0.006)	(0.099)
R&D Expense	5.009***	-0.048	0.035	-0.062	0.175
	(0.882)	(0.058)	(0.844)	(0.058)	(0.957)
Advertising Expense	2.575***	-0.196**	-4.723***	-0.200**	-4.473***
	(0.982)	(0.099)	(1.402)	(0.099)	(1.617)
Constant	12.665***	1.045	128.087***	1.407	124.627***
	(2.450)	(0.964)	(16.229)	(1.082)	(20.251)
Industry	No	Yes	Yes	Yes	Yes
Year	No	Yes	Yes	Yes	Yes
Observations	2,939	2,939	2,939	2,939	2,939
R-squared	0.225	0.327	0.470	0.322	0.452

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