Social Networks and Corporate Environmental Policy

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1. Motivation

- Rapid growing firms taking actions for environment
  - Almost every S&P 500 regularly publish sustainability reports

- Determinants of environmental policy decisions
  - Made within firms: Landier et al. (2007); Chava (2014); Di Giuli et al. (2014); Ferrell et al. (2016); Cronqvist et al. (2017); Fernando et al. (2017); Chen el al. (2020); Xu et al. (2022)
  - Affected by peer firm: Cao, Liang, and Zhan (2019), Li and Wang (2022)

- Social peers: Decision-makers' social networks
  - Individuals' decisions are affected by their social networks (Galeotti et al., 2010).

1. Motivation

- Social networks are widespread in the financial context
  - Merge and Acquisition (Ishii and Xuan, 2014)
  - Corporate Investment (Hochberg, Ljungovist and Lu, 2007)
  - Corporate governance (Intintoli, Kahle and Zhao, 2018; Schabus, 2022)

- Little systematic evidence about environmental policy and individuals' social networks
  - Social networks matter for corporate outcomes in systematic and predictable ways that may lead to correlated environmental policy across firms.

- This paper: Does environmental policy spillover through directors' social networks? If yes, how and why?

2. Contributions

- Spillover effect of environmental policy exist on the basis of social networks
  - Spillover effect on finance policies through social networks: Shue (2013); Fracassi (2017)

- Determinants of environmental policy
  - Existing studies typically assume such policy decisions are independently determined (Di Giuli and Kostovetsky, 2014; McCarthy et al., 2017; McGuinness et al., 2017; Iliev and Roth, 2020)
  - The environmental policy decisions of firms are also influenced by other firms within the same social network

- Highlighting the role of punishment in reinforcing social norms and reducing the chances of bad behavioral imitation
  - Most closely finding: Cheng et al. (2019)

- Spillover effect is driven by both dark-side and bright-side
  - Ongoing debate: doing well by doing good (Jiao, 2010; El Ghoul et al., 2011; Servaes and Tamayo, 2013) vs agency problem (Pagano and Volpin, 2005; Cronqvist et al., 2009; Ferrell et al., 2016)

3. Data and sample

3.1. Sample construction

- Environmental policy: MSCI KLD Environmental score, Sustainalytics Environmental Score, Refinitiv Environmental Score and carbon emission from Refinitiv.

- Board Network: BoardEx

- Control variables: Compustat and Hoberg-Phillips Data Library

- Sample**: S&P 1500** firms from **2009 to 2019**. My starting sample has **2180 firms** and **12,423,800 firm-pair year observations**. After merging with MSCI KLD and other necessary databases, my final sample has almost **1400 firms**, and **3,987,786 firm-pair year observations**.

3. Data and sample

3.2. Key variables definition

- **Current Employment**: Two individuals work in the same company.
- **Past Employment**: Two individuals worked in the past in the same company at the same time.
- **Education**: Two individuals went to the same school and graduated within one year of each other.
- **Other Activity**: Two individuals share membership in **clubs, organizations, or charities**, and had active roles in them.
- **All Connection**: The sum of the social connection dummies across the four types of connections.

3. Data and sample

3.2. Key variables definition

- Environmental Policy Dissimilarity:

$$|Environmental\ Adjusted\ Score_{i,t} - Environmental\ Adjusted\ Score_{j,t}\ |$$

- Other control variables: I calculate the absolute value of other control variables between two firms.

3. Data and sample

3.3. Summary Statistics

Panel A: Social Connections Variables					
VARIABLES	N	mean	sd	min	max
Past Employment	3,987,786	0.182	0.386	0	1
Current Employment	3,987,786	0.0577	0.233	0	1
Education	3,987,786	0.0608	0.239	0	1
Other Activity	3,987,786	0.103	0.304	0	1
All Connection	3,987,786	0.404	0.716	0	4

Panel B: Control Variables					
VARIABLES	N	mean	sd	min	max
Firm-pair-level control variables					
Environmental Policy Dissimilarity	3,987,786	0.0842	0.123	0	1.381
Cash Flow Dissimilarity	3,987,786	0.0797	0.0724	0.00105	0.387
Leverage Dissimilarity	3,987,786	1.793	5.034	0	40.60
ROA Dissimilarity	3,987,786	0.0759	0.0737	0.000944	0.402
Firm Size Dissimilarity	3,987,786	1.752	1.327	0.0272	5.804
Tobin's Q Dissimilarity	3,987,786	1.204	1.325	0.0115	7.115
Tangibility Dissimilarity	3,987,786	0.220	0.203	0.00221	0.813
Dividend Dissimilarity	3,987,786	0.0244	0.0323	0	0.194
MB Dissimilarity	3,987,786	5.411	14.43	0.0267	112.0
No. Director Dissimilarity	3,987,786	3.628	3.575	0	21
Rival	3,987,786	0.0134	0.115	0	1
Same BEA Economic Region	3,987,786	0.130	0.337	0	1
Same Industry	3,987,786	0.0376	0.190	0	1
Total Emission Dissimilarity	356,890	2.394	1.904	0	20.88
Indirect Emission Dissimilarity	280,768	3.084	2.327	0	17.47
Direct Emission Dissimilarity	269,830	1.945	1.442	0	9.518
Firm-level control variables					
Environmental Policy	9,365	0.0368	0.108	-0.714	0.833
Cash Flow	9,365	0.0941	0.0712	-0.139	0.308
Leverage	9,365	0.689	1.604	-7.862	8.514
ROA	9,365	0.0560	0.0691	-0.192	0.260
Firm Size	9,365	8.018	1.566	5.031	12.31
Tobin's Q	9,365	2.070	1.227	0.837	7.429
Tangibility	9,365	0.222	0.211	0.00434	0.876
Dividend	9,365	0.0173	0.0265	0	0.152
MB	9,365	3.344	4.657	-17.86	27.57
No. Directors	9,365	9.708	3.457	3	24
Total Emission	2,710	12.95	2.144	-2.254	18.78
Direct Emission	2,385	11.77	2.716	1.099	18.72
Indirect Emission	2,342	12.28	1.718	6.685	16.57

Almost **40% chance** that two firms are socially connected.

4. Baseline results

4.1. Theoretical Motivation

- Social network theory
  - Social interactions are capable of influencing managerial decision-making, primarily through the dissemination of information within social networks (Ellison and Fudenberg, 1995; Hong, Kubik, and Stein, 2005; Cohen, Frazzini, and Malloy, 2008)

- The uncertain information environment managers face and the financial implications of corporate environmental policy further enhances the importance of information acquired through social networks.

- Formal Hypothesis: Two firms that are socially connected make more similar environmental policy.

4. Baseline results

4.2. Empirical Results

	Environmental Policy Dissimilarity					
	Full Sample			Forward Dependent Variable		
	(1)	(2)	(3)	(4)	(5)	(6)
All Connection	-0.00238***	-0.00238***	-0.00237***	-0.00333***	-0.00330***	-0.00328***
	(-3.93)	(-3.91)	(-3.95)	(-5.15)	(-5.12)	(-5.16)
Cash Flow Dissimilarity		0.04720***	0.04727***		0.05212**	0.05228**
		(3.65)	(3.66)		(2.19)	(2.20)
Leverage Dissimilarity		-0.00079***	-0.00079***		-0.00070**	-0.00070**
		(-2.74)	(-2.73)		(-2.15)	(-2.15)
ROA Dissimilarity		-0.03426**	-0.03428**		-0.04909*	-0.04915*
		(-2.35)	(-2.35)		(-1.92)	(-1.93)
Firm Size Dissimilarity		0.00618***	0.00620***		0.00494**	0.00497**
		(3.57)	(3.59)		(2.08)	(2.10)
Tobin's Q Dissimilarity		-0.00218***	-0.00218***		-0.00192***	-0.00192***
		(-3.76)	(-3.76)		(-2.71)	(-2.71)
Tangibility Dissimilarity		-0.01899	-0.01897		-0.00217	-0.00219
		(-1.44)	(-1.44)		(-0.16)	(-0.16)
Dividend Dissimilarity		-0.02753	-0.02748		0.00713	0.00722
		(-1.11)	(-1.11)		(0.31)	(0.31)
MB Dissimilarity		0.00028***	0.00027***		0.00015	0.00015
		(2.79)	(2.79)		(1.61)	(1.61)
No.Director Dissimilarity			-0.00009			-0.00012
			(-0.28)			(-0.40)
Observations	3,987,786	3,987,786	3,987,786	3,013,497	3,013,497	3,013,497
R-squared	0.620	0.620	0.620	0.675	0.676	0.676
Year FE	YES	YES	YES	YES	YES	YES
Firm Pair FE	YES	YES	YES	YES	YES	YES

On average, one increases in the type of social connection, 2.8% more similar their environmental policies are.

4. Baseline results

4.3. Robustness

- Within industry, within region

- Alternative environmental score (Sustainalytics, Refinitiv)

- Subnetworks (Past Employment, Current Employment, Education, Other Activities)

- Externality (Carbon emission from Refinitiv)

Taken all together, the results show more social connections two firms share, more similar their environmental policies are, and this influence has a real impact on environment.

4. Baseline results

4.4. Endogenous

	Full Sample				Forward Dependent Variable			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Connected * After Death	0.01315**	0.01323**	0.02497***	0.02385***	0.00230	0.00505	0.02343***	0.02333***
	(2.38)	(2.20)	(7.62)	(6.69)	(0.28)	(0.51)	(3.76)	(3.74)
After Death	-0.00679*	-0.00663*	-0.04131***	-0.04021***	-0.00311	-0.00302	-0.04882***	-0.04756***
	(-1.87)	(-1.84)	(-11.98)	(-11.88)	(-0.87)	(-0.85)	(-14.17)	(-14.02)
Rival		0.00217		-0.00427***		-0.00108		-0.00460***
		(1.63)		(-3.38)		(-0.69)		(-3.30)
Cash Flow Dissimilarity		0.04651***		0.04977***		0.05186**		0.04400**
		(3.60)		(3.99)		(2.18)		(2.31)
Leverage Dissimilarity		-0.00078***		-0.00033		-0.00070**		-0.00034
		(-2.71)		(-1.06)		(-2.13)		(-1.05)
ROA Dissimilarity		-0.03375**		-0.03117**		-0.04885*		0.01525
		(-2.32)		(-2.29)		(-1.92)		(0.69)
Firm Size Dissimilarity		0.00624***		0.01183***		0.00501**		0.01343***
		(3.61)		(15.27)		(2.11)		(14.55)
Tobin's Q Dissimilarity		-0.00217***		-0.00404***		-0.00191***		-0.00455***
		(-3.76)		(-7.88)		(-2.71)		(-7.02)
Tangibility Dissimilarity		-0.01851		0.00138		-0.00196		0.00493**
		(-1.40)		(0.67)		(-0.14)		(2.42)
Dividend Dissimilarity		-0.02886		-0.01394		0.00627		0.01873
		(-1.16)		(-0.55)		(0.27)		(0.68)
MB Dissimilarity		0.00027***		-0.00001		0.00015		-0.00011
		(2.74)		(-0.13)		(1.56)		(-1.09)
No. Director Dissimilarity		-0.00010		-0.00012		-0.00014		-0.00030
		(-0.31)		(-0.48)		(-0.46)		(-1.13)
Observations	3,987,786	3,987,786	3,987,786	3,987,786	3,013,497	3,013,497	3,013,497	3,013,497
R-squared	0.620	0.620	0.373	0.384	0.675	0.676	0.389	0.402
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Pair FE	YES	YES	NO	NO	YES	YES	NO	NO
Double Firm FE	NO	NO	YES	YES	NO	NO	YES	YES

Use directors' sudden death to do DID because sudden death terminates social connections.

5. How spillover

5.1. Theoretical Motivation

- Social theory
  - The chance of imitation depends on the punishment of negative behavior (Bandura, 1965; Bandura, 1971)

- Economic theory
  - Cost–benefit trade-off

- Formal Hypothesis: Firms mimic negative environmental actions when the observed cost of these actions is low. Conversely, firms amend their environmental policy when the observed cost of negative environmental actions is high.

5. How spillover

5.2. Methodology

$$Environmental\ Policy_{j,t+1} = \alpha + \beta_1 Negative\ News_{i,t} * All\ Connection_{i,j,t} + \beta_2 Negative\ News_{i,t} + \beta_3 All\ Connection_{i,t} + Controls$$

- The dependent variable only includes the firm j that does not have negative environmental news before firm i that has negative environmental news when firm i and firm j have social connections.

- $Negative\ News_{i,t}$ is a dummy variable which equals to 1 if firm i has negative environmental news in year t.

5. How spillover: Imitation vs Reflecting

5.3. Empirical Results

Panel A: Negative News				
	Environmental Policy			
	(1)	(2)	(3)	(4)
Negative News Dummy * All Connection	-0.00245***	-0.00244***		
	(-2.82)	(-2.84)		
Negative News Count * All Connection			-0.00012***	-0.00012***
			(-2.70)	(-2.72)
Negative News Dummy	0.00121**	0.00120*		
	(2.09)	(1.82)		
Negative News Count			0.00015***	0.00014***
			(3.65)	(3.45)
All Connection	-0.00256***	-0.00215**	-0.00288***	-0.00246***
	(-2.67)	(-2.41)	(-3.07)	(-2.82)
Observations	2,689,236	2,689,236	2,689,236	2,689,236
R-squared	0.651	0.652	0.651	0.652
Controls	NO	YES	NO	YES
Year FE	YES	YES	YES	YES
Firm Pair FE	YES	YES	YES	YES

5. How spillover: Imitation vs Reflecting

5.3. Empirical Results

Panel B: Low Severity vs High Severity

	Environmental Policy			
	(1)	(2)	(3)	(4)
Low Severity * All Connection	-0.00023***	-0.00023***		
	(-3.27)	(-3.27)		
High Severity * All Connection			0.00109***	0.00108***
			(4.06)	(4.00)
Low Severity	0.00027***	0.00027***		
	(4.28)	(4.01)		
High Severity			-0.00096***	-0.00095***
			(-4.17)	(-3.76)
All Connection	-0.00280***	-0.00238***	-0.00344***	-0.00303***
	(-3.00)	(-2.74)	(-3.57)	(-3.36)
Observations	2,689,236	2,689,236	2,689,236	2,689,236
R-squared	0.652	0.652	0.651	0.652
Controls	NO	YES	NO	YES
Year FE	YES	YES	YES	YES
Firm Pair FE	YES	YES	YES	YES

5. How spillover: Imitation vs Reflecting

5.3. Empirical Results

Panel C: News Severity and Environmental Penalty				
	Environmental Policy			
	(1)	(2)	(3)	(4)
High Severity * All	0.00128***	0.00127***		
Connection	(4.31)	(4.26)		
Low Severity * All	-0.00026***	-0.00025***		
Connection	(-4.38)	(-4.34)		
Medium Severity * All	0.00002	0.00002		
Connection	(0.20)	(0.19)		
Environmental Penalty *			0.00140**	0.00136**
All Connection			(2.42)	(2.33)
Environmental Penalty			-0.00107**	-0.00102*
			(-2.02)	(-1.68)
All Connection			-0.00470***	-0.00404***
			(-4.42)	(-4.04)
Observations	2,689,236	2,689,236	2,614,609	2,614,609
R-squared	0.652	0.653	0.664	0.665
Controls	NO	Yes	NO	YES
Year FE	YES	YES	YES	YES
Firm Pair FE	YES	YES	YES	YES

6. Why spillover: Good behavior motivation or Bad behavior motivation

6.1.1. Good behavior motivation - Theoretical Motivation

- Environmental policy and differentiation strategy (Elfenbein et al. 2012; Ailawadi et al. 2014; Hilger et al. 2019)

- Highly Competitive environment and differentiation strategy
  - A competitive advantage is crucial in a highly competitive environment (Jones, 1995)
  - Ethical behavior enhance firms' competitive advantage (Turban and Greening, 1997)
  - Empirical evidence: Delmas et al. (2007); Flammer (2015)

- Formal Hypothesis: Firms in highly competitive environment exhibit stronger spillover effects of environmental policy through social networks

6. Why spillover: Good behavior motivation or Bad behavior motivation

6.1.2. Good behavior motivation – Empirical Evidence

	Environmental Policy			
	Low-Competition		High-Competition	
	(1)	(2)	(3)	(4)
Environmental Score * All Connection	0.00577*	0.00553*	0.01190*	0.01156*
	(1.83)	(1.76)	(1.84)	(1.74)
Environmental Score	-0.00308*	-0.00289*	-0.00633*	-0.00610*
	(-1.91)	(-1.80)	(-1.81)	(-1.70)
All Connection	-0.00498***	-0.00429***	-0.00258	-0.00289
	(-4.47)	(-4.17)	(-1.12)	(-1.37)
Observations	2,874,858	2,874,858	1,153,402	1,153,402
R-squared	0.677	0.680	0.705	0.710
Controls	No	Yes	No	Yes
Year FE	YES	YES	YES	YES
Firm Pair FE	YES	YES	YES	YES

6. Why spillover: Good behavior motivation or Bad behavior motivation

6.1.2. Good behavior motivation – Empirical Evidence

	Environmental Policy			
	Low-Competition		High-Competition	
	(1)	(2)	(3)	(4)
Environmental Score *	-0.00028	0.00019	0.00990**	0.00799**
Competition Dummy	(-0.09)	(0.06)	(2.36)	(2.10)
Environmental Score	0.00045	-0.00036	0.00019	0.00032
	(0.28)	(-0.22)	(0.26)	(0.19)
Competition Dummy	-0.00018	-0.00028	-0.00140	-0.00141
	(-0.44)	(-0.73)	(-1.22)	(-1.15)
Observations	828,913	828,913	343,941	343,941
R-squared	0.723	0.727	0.743	0.747
Controls	NO	Yes	NO	Yes
Year FE	YES	YES	YES	YES
Firm Pair FE	YES	YES	YES	YES

6. Why spillover: Good behavior motivation or Bad behavior motivation

6.2.1. Bad behavior motivation - Theoretical Motivation

- Environmental Policy and agency problem (Bénabou and Tirole, 2010; Barnea and Rubin, 2010; Cheng et al. 2014)

- Bad behavior propagates through social networks
  - Word-of-mouth communication (DeMarzo et al., 2013)
  - Individuals trust individuals with whom they have social connections more
  - Empirical evidence: Lavy, Silva, and Weinhardt (2012)

- Formal Hypothesis: Firms with higher agency problems display significantly stronger spillover effect through social networks

6. Why spillover: Good behavior motivation or Bad behavior motivation

6.2.2. Bad behavior motivation – Empirical Evidence

	Environmental Policy			
	Low Agency		High Agency	
	(1)	(2)	(3)	(4)
Environmental Score * All Connection	0.00659	0.00622	0.01330***	0.01346***
	(1.19)	(1.13)	(2.77)	(2.81)
Environmental Score	-0.00404	-0.00386	-0.00735***	-0.00738***
	(-1.55)	(-1.50)	(-2.85)	(-2.87)
All Connection	-0.00393***	-0.00342**	-0.00453***	-0.00421***
	(-2.90)	(-2.53)	(-2.90)	(-2.91)
Observations	2,176,918	2,176,918	2,112,565	2,112,565
R-squared	0.726	0.728	0.731	0.734
Controls	NO	YES	NO	YES
Year FE	YES	YES	YES	YES
Pair FE	YES	YES	YES	YES

7. Additional test: Learning capability and learning willingness

7.1. Learning capability

	Environmental Policy			
	Follower		Leader	
	(1)	(2)	(3)	(4)
Environmental Score * All Connection	0.00685	0.00642	0.01063***	0.01066***
	(1.49)	(1.41)	(2.60)	(2.63)
Environmental Score	-0.00409*	-0.00380	-0.00524**	-0.00528**
	(-1.76)	(-1.64)	(-2.43)	(-2.48)
All Connection	-0.00363***	-0.00315**	-0.00622***	-0.00571***
	(-2.67)	(-2.46)	(-4.16)	(-4.18)
Observations	2,275,216	2,275,216	2,246,634	2,246,634
R-squared	0.694	0.696	0.740	0.741
Controls	NO	Yes	NO	Yes
Year FE	YES	YES	YES	YES
Firm Pair FE	YES	YES	YES	YES

7. Additional test: Learning capability and learning willingness

7.2. Learning willingness

	Environmental Policy			
	No CSR Committee		CSR Committee	
	(1)	(2)	(3)	(4)
Environmental Score *	0.00530	0.00509	0.00919**	0.00864**
All Connection	(1.13)	(1.12)	(2.41)	(2.27)
Environmental Score	-0.00170	-0.00161	-0.00549**	-0.00491*
	(-0.79)	(-0.78)	(-2.03)	(-1.79)
All Connection	-0.00335**	-0.00385***	-0.00326**	-0.00228*
	(-2.17)	(-2.59)	(-2.28)	(-1.70)
Observations	2,326,991	2,326,991	2,100,733	2,100,733
R-squared	0.700	0.701	0.724	0.729
Year FE	YES	YES	YES	YES
Pair FE	YES	YES	YES	YES

8. Conclusion

- Spillover effect of environmental policy through social networks
  - For each additional type of social connection, the similarity in environmental policies between two firms increases by 2.8%.

- Asymmetric effects of good vs. bad behaviors
  - Punishment of socially connected firms determines whether focal firms mimic their socially connected firms (decrease environmental score) or amend their environmental policy (increase environmental score).

- Learning willingness and learning capability
  - The spillover effect is particularly prominent among successful firms (those capable of learning) and those with a CSR committee (those willing to learn).

- Why spillover – Bad behavior motivation and good behavior motivation
  - The spillover effect is because of both bad behavior motivation (agency problem) and good behavior motivation (differentiation strategy).