Greening Industrial Production in China: Reinvent a Cleaner Future through Policy, Strategy and Technology

Thèse

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Résumé

Notre recherche vise à découvrir pourquoi et comment les entreprises industrielles répondent aux problèmes environnementaux dans « l'atelier du monde ». Nous élaborons une approche interdisciplinaire en intégrant la modernisation écologique (MÉ) et l'hypothèse de Porter pour analyser l'action environnementale des entreprises aux niveaux méso et micro. Ces perspectives en sociologie et en gestion postulent une relation positive entre la protection environnementale et le développement économique. Pour évaluer la pertinence de ces perspectives, notre analyse se concentre sur l'identification des facteurs qui influencent les actions en réseaux d'acteurs et d'institutions, ainsi que sur le lien entre la réglementation et l'innovation. En utilisant les méthodes mixtes (observation participante, sondage et entrevue), nous avons collecté, lors de l'enquête de terrain (2013-2014) dans le delta de la Rivière des Perles, des données en provenance de plus d'une centaine d'entreprises dans quinze secteurs industriels. Quatre résultats clés se dégagent de cette étude. D'abord, 88% des entreprises interrogées ont pris des mesures. Notre typologie d'entreprise montre que les « traînards » résistent à l'action et que les « suiveurs » changent à contrecœur leur comportement. Les « adeptes » adoptent des technologies propres éprouvées; tandis que les « éco-innovateurs » créent de nouveaux produits. En outre, les réglementations strictes, les préoccupations financières et la concurrence sont les déterminants de l'action. Les firmes assujetties aux lois sévères ont tendance à se conformer. Celles qui desservent des marchés concurrentiels sont susceptibles d'innover. De plus, les réglementations strictes sur l'innovation produisent des résultats mitigés. Ces réglementations semblent nécessaires, mais elles sont insuffisantes pour déclencher l'éco-innovation. La relation entre le gain économique et environnemental est dynamique et dépend du type de mesures environnementales, des caractéristiques d'entreprise et des facteurs contextuels. Enfin, les affirmations de la MÉ sont partiellement confirmées par nos résultats. Ces derniers révèlent l'implantation répandue des instruments de marché, laquelle indique l'émergence de l'« économisation » de l'écologie. Contrairement aux études antérieures, la nôtre montre que les acteurs économiques contribuent à « écologiser » l'économie. L'État partage les responsabilités environnementales avec ces acteurs tout en exerçant son pouvoir cohésif. Pour faire avancer la recherche, nous proposons de conceptualiser un modèle hybride et d'incorporer la théorie de l'acteur-réseau dans un cadre élargi.

Abstract

The research aims to discover why and how Chinese industrial firms in the world's workshop are responding to environmental issues. We elaborate an interdisciplinary approach by integrating ecological modernization theory (EMT) and the Porter hypothesis. These sociological and strategic management perspectives postulate that economic growth can be associated with environmental protection. The perspectives complement one another through combining micro-level and meso-level analysis of corporate environmental actions. To assess the validity of the Porter hypothesis and the explanatory power of EMT, attention is given to identifying factors affecting actions and to analyzing the regulation-innovation nexus and institutional networks. Using mixed-methods research techniques (participant observation, survey, and interview), we conducted our 2013/14 fieldwork by accessing a sample group of over 100 firms from 15 industry sectors located in the Pearl River Delta region. Four major findings emerge from our analysis. First, 88% of the surveyed companies took environmental actions. A typology of the enterprises illustrates that "laggards" displayed resistance and "takers" took action reluctantly. "Followers" were inclined to adopt proven clean technologies, whereas "eco-innovators" created new products. Secondly, stricter environmental regulations, financial interests, and competition are key factors for driving corporate actions. The sampled firms subjected to stricter requirements tended to be compliant and achieved environmental goals, and companies serving competitive markets were most likely to be industry leaders engaging in eco-innovations. Our third finding reveals mixed results in the effects of stricter regulations on eco-innovation and on the financial outcome of environmental improvements. Stricter regulations appear necessary, but they are insufficient for triggering eco-innovation. The relation between economic gain and environmental benefit is dynamic, depending on the type of environmental actions, firm characteristics, and contextual factors. Finally, the claims made by EMT are partially supported by our fourth finding, wherein wide application of market-based instruments suggests the emergence of the "economization" of ecology. Contradictory to prior research, our study shows that economic actors contribute to "ecologizing" the economy. The state shared environmental responsibilities with non-state actors, while exercising its coercive power. For future research, we propose conceptualizing a hybrid model and incorporating actor network theory into a broader framework.

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List of abbreviations, initials, acronyms

Abbreviations

3D	three-dimensional
3S	three synchronizations system
6S	six-sigma
ADB	Asian Development Bank
ANT	actor network theory
Bn	billion
BOD	biochemical oxygen demand
BRIIS	Brazil, Russia, India, Indonesia and South Africa
CCTV	China Central Television
CEO	chief executive officer
CNY	Chinese yuan
CO	carbon monoxide
CO_2	carbon dioxide
COD	chemical oxygen demand
CP	cleaner production
CPA	cleaner production assessment/audit
CER	corporate environmental responsibility
CFC	chlorofluorocarbon

CSR	corporate social responsibility
CT	cleaner technology
DALY	disability-adjusted life year
EIA	Environmental Impact Assessment
EIC	Economic and Information Committee
EMS	environmental management system
EMT	ecological modernisation theory
ENGO	environmental non-governmental organization
EPS	Environmental Policy Stringency
EOP	end-of-pipe
EPB	Environmental Protection Bureau
EPL	Environmental Protection Law
EPTL	Environmental Protection Tax Law
EST	environmentally sound technology
ETC	Economic and Trade Commission
ETS	emission trading scheme/system
FDI	foreign direct investment
FYP	Five-Year Plan
GBRT	Guangzhou's Bus Rapid Transit
GDP	gross domestic product

GENGO	government affiliated and organized ENGO
GHG	greenhouse gas
GIS	geographical information system
HC	hydrocarbon
HCFC	hydrochlorofluorocarbon
HNTE	High and New Technology Enterprise
HR	human resources
IE	micro enterprise
INDC	Intended Nationally Determined Contribution
IPE	Institute of Public and Environmental Affairs
ISO	International Standards Organization
IT	information technology
ITDP	Institute for Transportation and Development Policy
JV	joint venture
km	kilometre
LE	large enterprise
ME	medium size enterprise
MEE	Ministry of Ecology and Environment
MEP	Ministry of Environmental Protection
MIT	Massachusetts Institute of Technology

MNC	multinational corporation
MPG	miles per gallon
MVA	manufacturing value added
NBS	National Bureau of Statistics
NCPC	national cleaner production centre
NDRC	National Development and Reform Commission
NGO	non-governmental organization
NOx	nitrogen oxides
OBM	Original Brand Manufacturer
ODM	Original Design Manufacturer
ODP	ozone-depleting potential
OECD	Organization for Economic Cooperation and Development
OEM	Original Equipment Manufacturer
OHSAS	Occupational Health and Safety Management Certification
PAT	pollution abatement technology
PM	particulate matter
PPM	parts per million
PRD	Pearl River Delta
PX	para-xylene
R&D	research and development

REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RoHS	Restriction of Hazardous Substances
ROI	return on investment
SE	small enterprise
SIM	Subscriber Identity Module
SME	small and medium-sized enterprise
SO_2	sulfur dioxide
SOE	state-owned enterprise
S & T	science and technology
tce	tons of coal equivalent
TQM	total quality management
UN	United Nations
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
VP	Vice President
VPN	Virtual Private Network
WHO	World Health Organization
WB	World Bank

À mes parents

« Un voyage de mille lieues commence toujours par un premier pas. »

Lao-Tseu

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Introduction : socio-environmental changes

Society, environment and globalization

Our world is facing major environmental problems, such as global warming, pollution, and loss of biodiversity, that are largely the result of human activities. These problems impose negative impacts on the physical environment, and the health and well-being of humans and other species. China, the world's largest greenhouse gas (GHG) emitter, is also the largest manufacturer of industrial goods[1], with a total of one-third of the world's production.[2] Between 2018 and 2019, the country recorded the largest increase in carbon emission (3.4%) (Crippa, Solazzo, Huang, et al., 2020) of any nation. The country saw a three-fold increase in industrial energy consumption during the past decades (1990 – 2014) (DRC and OECD, 2017). The sheer scale of China's industrial activities has caused significant environmental impacts (Linster and Yang, 2018). For instance, Chinese manufacturing sector alone produced one-quarter of the world's carbon dioxide (CO_2) emissions (Gao, 2012).

Chinese society has also been undergoing drastic changes in the past four decades from rapid industrialization (OECD, 2010), a fast-growing economy (30-fold increase), to increasing durable goods consumption (Mol and Carter, 2007) and private car ownership (Clemente, 2015). The former Deputy Minister of the Ministry of Environmental Protection (MEP), Pan Yue, indicated, "this miracle would end soon, because the environment could no longer keep pace." (Der Spiegel, 2005). Indeed, air pollutants have caused significant impacts on the environment (i.e., soil acidification, destroyed forests) (Topal and Chung, 2014) and human health, resulting in high social costs (OECD, 2016b; WHO, 2016) during a time when the country was "choking on growth" (Kahn and Yardley, 2007; Shapiro, 2012).

A few years ago, the Chinese government switched from blocking the Copenhagen climate change accord (Lynas, 2009; Rapp, Schwägerl, and Traufetter, 2010) to becoming one of

[1] Accounted for over a quarter of global manufacturing value added in 2016
[2] In terms of the manufacturing division of the International Standard Industrial Classification, according to the United Nations Industrial Development Organization (UNIDO) Gao. (2012)

the leaders of climate change policy, according to Erik Solheim, the Executive Director of the United Nations Environment Programme (UNEP) (Wong, 2016). For example, there was a 15-fold increase in environment-related patents in the first decade of the 21st century (2000 – 2012) (OECD, 2017b) in China. Its green industries have generated US$735 Billion (Bn) with a 15% annual growth rate (Topal and Chung, 2014). An international agreement to limit GHG emissions was supported by Chinese citizens[3], who have involved in environmental protection (Ho and Edmonds, 2008; Zeng, 2011). This represents a significant change of opinion, given that many citizens had little awareness of environmental problems (Boyd, 2013; Vermeer, 2000) in previous eras. Shifts in public opinion were accompanied by the adoption of more than 1,000 pieces of provincial and municipal environmental legislations (i.e., laws, regulations and norms) (Ferris and Zhang, 2005).

How did recent environmental changes occur in Chinese society? How did Chinese firms respond to environmental issues? There are very few studies that have addressed these questions. Understanding current environmental practices in China is important, because the country has an ongoing and significant impact on international initiatives for environmental protection. Today, more Fortune Global 500 companies are based in China than in any other country (Murray and Meyer, 2020). In spite of the expanding global reach of Chinese manufacturers, there is a paucity of empirical social science studies investigating their environmental responsiveness. The majority of existing research on environmental business practices and analyses of the natural environment have concentrated on Europe and North America (Hoffman and Georg, 2012). To fill the research gaps, our work intends to uncover corporate environmental practices.

[3] According to Pew Research Global Attitudes Project: "Environmental Concerns on the Rise in China". Survey conducted in 40 nations among 45,435 respondents from March 25 to May 27, 2015. Pew Research Center. (2015).

Thinking about changes: interdisciplinary perspectives

A number of disciplines in social science (e.g., psychology, management, sociology, and anthropology) have explained the correlation between changes and the environment on individual, organizational, social, and cultural levels. As organization, society and culture are interrelated, changes may occur simultaneously at all levels. To comprehend the complexity, our study conceptualized environmental changes by integrating multiple perspectives that may yield insights regarding major environmental impacts (Carolan, 2008), and may help to develop a broader and deeper understanding of the issues (Boix Mansilla and Duraising, 2007; Gardner, 2008; Miller and Boix Mansilla, 2004; Nikitina, 2002).

We adopted an interdisciplinary approach by drawing connections between environmental sociology and strategic management. The sociological perspective can shed light on analyses of environmental issues by examining social organizations and elucidating the contexts in which the entities operated. A considerable amount of sociological research focused on the causes of environmental problems (Dunlap and Rosa, 2000). Similarly, much literature regarding China's environment, including a number of books, wrote about environmental degradation and its impact (e.g., Economy, 2004; Edmonds, 2000; Ma, 2004).

Our work concentred on possible solutions by studying the environmental implementation that was a root cause of problems (Economy, 2007; Jänicke, 1997; OECD, 2007). The conceptual framework, combining ecological modernisation theory and the Porter hypothesis, investigated environmental responsiveness and particularly, practices that addressed environmental problems. Both proponents of EMT and the Porter hypothesis have examined environmental policy issues. The former analyzed the processes by which policies were implemented; the latter were concerned with the economic soundness of such policies. They also recognized the opportunities in protecting the environment. Scholars in both disciplines claimed that improving environmental performance enhanced competitiveness (Huber, 2009; Jänicke, 2008; Mol, 1995; Porter and van der Linde, 1995a, 1995b). EMT conceptualizes social dynamics of environmental reform processes (Mol,

2010) by focusing on the ways in which modern societies respond to ecological challenges. The processes of transformation give rise to ecological rationality, which aims to direct economic development toward ecological goals. The shift is described as institutionalizing ecology in production and consumption, as well as emancipating it from the economic dimension of modernity. Ecological efficiency is one of the concepts employed to identify ecologically rational processes.

Initial work by Joseph Huber, the "founder" of EMT (Mol and Sonnenfeld, 2000), analyzed ecological restructuring of industrial systems with an emphasis on technology and production reformation. The state and market were framed in an institutional context and economic structure that provided the conditions of technological development (Huber, 1989, as cited in Mol, 1995). Thus, the state can create a favourable regulatory framework for stimulating environmentally friendly practices and behaviours to advance transformation processes. Michael Porter, "the father" of business strategy (thinkers50.com, 2018), stated that policymaking was central in attempts to induce changes in firms and the policies created an environment in which companies gained competitive advantage (Porter, 1990).

Porter and his co-author Claas van der Linde (1995a, 1995b) argue that stricter environmental regulations tend to spur innovation and flexible policies provide firms with incentives. Along the same line, EMT theorists think that regulations and policies exert pressure and provide support for the innovation process (Jänicke, 2008). The Porter hypothesis suggests that stringent regulations may raise corporate awareness, reduce uncertainty, and level the playfield, leading to change mindsets regarding environmental issues. Furthermore, well-designed regulations can improve environmental performance and contribute to enhanced competitiveness (Porter and van der Linde, 1995a, 1995b).

The market is considered as being more efficient and effective than the state in solving some environmental problems. Private economic stakeholders such as entrepreneurs, insurance companies, and creditors have become key forces in engaging in the processes (Mol, 1995). Businesses are seen as part of the solutions to environmental problems and play positive roles in environmental protection (Mol and Jänicke, 2009). For example, they innovated (Huber, 1991, as cited in Mol and Jänicke, 2009), modified production processes and products, and introduced new operational strategies (Huber, 2009). To Porter and van der Linde, companies that innovated have built on a logic that linked resource productivity, environment, innovation, and competitiveness (Porter and van der Linde, 1995a, 1995b).

Environmental improvements made by firms included waste and pollution prevention (Banerjee, 2001; Huber, 2009), reduction of ecological impacts, and material and energy consumption intensity (Gunningham, Kagan, and Thoronton, 2003). Firms that have not started changes in time or picked ill-fitting solutions would lose. At the same time, corporations can benefit from new solutions, according to Kitty van der Heijden, Director of World Resources Institute's Europe Office (BCSDH, 2015). Financial gains may result from reducing energy bills (Banerjee, 2001), lowering legal expenses associated with liability (Huber, 2009; Jänicke, 2008; Mol, 1995), increasing resource productivity (Huber, 2009), improving eco-efficiency (Gunningham, Kagan, and Thoronton, 2003; Huber, 2009; Mol, 1995; Reinhardt, 1998), and generating additional demands for products (Reinhardt, 1998). Other advantages derived from superior environmental performance are improved corporate image (Reinhardt, 1998) and motivated staff (Huber, 2009).

Research in EMT and the Porter hypothesis focus on the positive roles of science and technology (S & T) that influence trajectories of environmental reform. Innovation not only delivers environmental benefits (Huber, 2004), but also permits the achievement of competitive advantage (Porter, 1990). Regulatory reform that sought to encourage industry participation, promote innovation-based solutions benefit both the environment and competitiveness (Porter and van der Linde, 1995a, 1995b). The Porter hypothesis proposed thinking on the relationship between the environment and industrial competitiveness and brought further attention to the effects of environmental policies, particularly those of stringent regulation (Porter and van der Linde, 1995a, 1995b).

Paying attention to economic and political organizations that are key social institutions (Buttel, 2010), we looked into the causes, the processes, and the effects of changes through environmental implementation in Chinese industrial firms. The study explored dimensions of the implementation to find out whether changes occurred, as well as why and how they unfolded. Studying implementation highlighted the execution of strategies and the dynamics surrounding key actions such as the application of S & T. Changing business practices were analyzed in institutional settings in which the key actors interacted. The research referred to the studies on production among the large body of work in ecological modernisation, as corporations not only influenced consumer choices (Etzioni, 1991) but also generated more environmental impacts than end-users (Huber, 2004). For instance, the cement industry produced 17% of industrial energy-related emission (Skjaerseth and Eikeland, 2013), whereas textile production alone emitted more GHGs than those of all international flights and maritime shipping combined (IEA, 2016).

Constructing mixed-methods research

Our study hypothesized that some firms were driven by stricter regulations, financial interests, and competition to implement environmental practices through multi-actor processes that led to positive outcomes. The strategic management approach was utilized to examine the logic of actions and the rationale for changes, while EMT was applied to understand how the changes in policies and practices occurred. We focused on identifying whether, and how, companies came to terms with environmental regulations and analyzing institutional systems in the context of globalized markets. Based on the results, our research assessed the validity of the Porter hypothesis and the explanatory power of EMT.

We adapted the models of the value chain (Porter, 1985) and the triad-network (van Koppen and Mol, 2009) that enabled us to identify the range and types of environmental practices and uncover the ways that resulted in modified behaviours. The value chain views business activities as interlinked and process-driven elements. This model was applied to describe activities, to illustrate linkages between them, and to determine the extent of their contribution to a firm's performance. The value chain provided analysis of changes from mechanisms that emanated from inside a firm. The triad-network model was employed to understand the contexts in which the firm was operating. The study brought perspectives on social, economic, and political contexts, and it identified and analyzed network participants, interactions among actors, and forces that shaped such networks.

Applying sociological analysis directed attention toward how environmental practices occurred in environmental governance systems where the state, civil society, and private institutions interacted (Mol, 1995). Government agencies and other organizations made decisions and engaged in practices, although companies chose the timing and the types of solutions to begin the change. For example, governments intervened through capital accumulation and investment (Buttel, 2000b; Leroy and van Tatenhove, 2000). Focusing on interorganizational interactions embedded in production systems, EMT elucidated the influence of social dynamics on corporate environmental behaviours. Moreover, it provided us a broader lens for interpreting environment-induced social changes and elevated the analysis of practices from a strategic management point of view to industry-government-society network perspective.

Earlier research in ecological modernization did not identify the factors influencing ecological transformation (Blühdorn, 2000). Our study intended to find out the reasons and factors for actions by asking "why" and "how" questions. These questions allowed us to assess the steps made by firms (Starik and Marcus, 2000) and evaluate the explanatory power of EMT (Mol, 1995). The Eurocentrism of EMT (Blowers, 1997; Blühdorn, 2000; Buttel, 2000a; Redclift, 1992, as cited in Mol 1995; Sachs, 1993) posed challenges for application of ecological modernization in developing countries (Blowers, 1997; Blühdorn, 2000; Frijns, Phuong, and Mol, 2000). Our work provided evidence that may enrich debate on EMT's applicability in non-democratic regimes and further research efforts in understanding social dynamics in ecological transformation.

Most research in ecological modernization consisted of national and transnational studies (Mol, 2010). The same can be said for studies on implementation that either focused on national and industrial levels (Ghisettiand and Pontoni, 2015; Zheng and Shi, 2017) or one specific environmental programme (Murphy and Gouldson, 2000; Rock, Yu, and Zhang, 1999). In fact, local actions such as regional planning and business initiatives have translated goals into changes (Jänicke, 2008; Jänicke and Jacob, 2004), even though nation states mediated between the local economy and globalized markets (Huber, 2000, 2008a; Jänicke and Jacob, 2004). In China, environmental problems are dependent on the circumstances of the region. For example, the more industrialized areas such as the Pearl

River Delta (PRD) had high fuel consumption[4], pollutants and industrial waste levels. Also, there were large regional variations in environmental protection (Economy, 2004; Jahiel, 2000) and in law enforcement (van Rooij, Zhu, Li, et al., 2017).

Few studies conducted in emerging economies addressed environmental innovation and the processes of innovation (Díaz-García, González-Moreno, and Sáez-Martínez, 2015). Our work attempted to fill this void and extend EMT research on China's environmental governance (Mol, 2006, 2010; Rock, 2009) by a more in-depth study of industrial firms and key stakeholders on a multilevel scale. Moreover, studies on business and the natural environment were conducted on large corporations (Bansal and Hoffman, 2012; Lenox and York, 2012). Much research in ecological modernization examined the sectors with technological processes such as the chemical industry (Mol, 1995), pulp and paper mills (Sonnenfeld, 2000), and high-tech industries (Yang, 2008). Little attention was given to traditional or small industrial sectors (Sonnenfeld and Rock, 2009; Spaargaren, 1997).

For instance, drawing interviews from one multinational petrochemical firm (Mol, 2006, 2010), previous research concluded that Chinese firms, except for large exporters, did not articulate environmental interest or play a key role in environmental reforms (Mol, 2006, 2010). Deriving conclusions from the world's third largest state-owned enterprise (SOE)[5] created questions regarding levels of appropriate representation. In addition, other research and news articles suggested the conclusions drawn from one source was not accurate. For example, if businesses lacked environmental approval, state-owned banks were prohibited from extending credit to borrowers (Ross, 2000). To get loans, regulated firms were required to improve environmental practices (Chang, 2014) and obtain Environmental Impact Assessment (EIA) approval (CDB, 2010; 2013-2015).

[4] Accounted for 76% of energy consumption, Jiang, Hong, Zheng, et al. (2015).

[5] In terms of total assets, according to Sovereign Wealth Fund Institute. (2008 – 2022), https://www.swfinstitute.org/fund-rankings/state-owned-enterprise

Uncovering evidence

Despite increasing environmental news reporting, publicly available firm-level environmental data was scarce. Our research sought to collect empirical evidence to overcome this weakness in data collection, particularly on small and medium-sized enterprises (SMEs). Since what actors actually did is a more convincing indicator than what they claimed to have done (Gray, Williamson, Karp, et al., 2007), we set to find out what firms did, through ground-level information gathering. Over 100 firms in 15 industry sectors participated in the study. We conducted our two-year fieldwork (2013 – 2014) in the PRD, the largest industrial region in the world, manufacturing 60% of the world's production of goods (OECD, 2010) and housing the most global industrial companies (Ai, 2012).

The PRD region deserved our attention because it came to feature as a model for national emulation in economic development and environmental protection (Zhong and Huang, 2016). The "biggest pollution hot spot in East Asia" (World Bank, 2016) has improved its eco-efficiency (OECD, 2010) and performance by upgrading (Lu, Wu, Zhou, et al., 2013). The PRD has become one of the most innovative regions in the world (Gurría, 2012; The Economist, 2017) and a pioneering exemplar of government environmental policy implementation (Zhong and Huang, 2016). Its recent development path reflected the dynamics of managing growth and the environment in the context of globalized production and markets. More importantly, the region offered an instructive case of local responses to environmental issues.

The study employed a sample that was representative in terms of the characteristics of the industries operating in a region. We used nonprobability sampling and selected sampled firms according to "target traits." The purposive sample was designed to secure a representational study group that allowed us to identify commonalities and differences in corporate environmental practices. The research was designed to reach the sample size necessary for theoretical saturation. To find out what actors were involved and how they brought about environmental changes, we attempted to gain access to potential participating companies by conducting field research.

We acted as a participant-as-observer and tried to establish relationships with people, who would become sources for research data and information. Engaging in participant observation helped us to reach respondents and lay the groundwork for conducting surveys and interviews. Questionnaires were chosen to provide a wider access to organizations and a higher degree of anonymity. The use of personal interviews allowed us to probe for additional information and more detailed answers. Combining surveys and interviews provided increased and complementary precision and access to respondents. In addition, using more than one method helped uncover insights into the journey of progress and regression that stakeholders have experienced in environmental implementation over the past decade.

Mixed-methods research served to facilitate the collection of data and investigation of phenomena that were otherwise inaccessible. The chosen methods enabled us to peek into the "black box" of corporate decision-making and to capture strategies and plans that turned into actions behind the scenes. The methods uncovered the roles played by Chinese companies and relevant actors in greening industrial production. To a large extent, they shed light on firms' dynamics that were ignored by aggregate macro-studies. Using more than one method expanded the breadth and depth of analysis and allowed for the bridging of meso-level and micro-level study. In addition, cross-sector analysis linked micro-level and macro-level analyses of social changes. More importantly, the combination of responses resulting from different forms of data collection increased the validity of the findings.

The integrative theoretical framework connected disciplinary knowledge and provided a more comprehensive understanding of environmental practices and their implications. Lessons drawn from implementing various environmental policies could be valuable (York and Rosa, 2003). Moreover, a typology of enterprises could offer policymakers a tool to design more adaptive environmental policies. Given that prior EMT research did not measure implementation outcomes (Murphy and Gouldson, 2000) and actual environmental change (York, Rosa, and Dietz, 2010), we proposed measuring the quantified outcomes to evaluate impacts of environmental protection efforts. For example, conducting a content analysis of environmental audit reports revealed how corporations managed to change their practices and achieve the effects of those changes. Furthermore, adopting a more comprehensive approach helped us better understand dynamics among key actors in multi-stakeholder processes and look beyond selective case sampling.

Outline

The thesis is organized in six chapters. To set the background for an understanding of the current environmental challenges the country faced, the first chapter on environmental protection in urban China begins with a brief literature review, provides an overview of the state of the environment, and outlines recent developments in climate action. It then describes environmental concerns and protests, civil society engagement, and links between the increasing influence of engagement and greater access to the internet and social media. The chapter highlights the increasing access has bolstered the effectiveness of civil society and illustrates how environmental governance has been evolving over the past decades. Confronted by citizens and communities who voiced their concerns regarding improving health and safety, top policy makers rebalanced industrial activities and environmental protection, and they replaced "growing first, cleaning up later" with a new rhetoric, investment in technology and innovation, and the promotion of greener urbanization. Chapter 1 ends with discussions of the adverse impacts of industrial production, corporate environmental responsiveness, and progress levels accomplished. Despite the changing trends, the country continues to face serious problems related to global warming in the decades to come.

The second chapter focuses on the theoretical framework, discussing the sociological and managerial perspectives in business and the environment. The origin and key ideas pertaining to ecological modernization are presented with a description of EMT applications, criticisms, and merits. Chapter 2 draws attention to EMT as an analytical framework for social change, outlines perspectives across disciplines in environmental practices, references the factors of action, change processes, and outcomes, as well as explains the application of an interdisciplinary approach. This chapter presents research questions, hypotheses and variables, illustrates an analytical schema including the factors, processes and outcomes of environmental implementation, and defines the value chain and triad-network models. The distinction between one model's identification of changes in business activities from a strategic management viewpoint (value chain) and the other's exposition of the roles of relevant actors and institutions in "policy-societal-economic" sphere engagement (triad-network). The chapter indicates that combining socioeconomic perspectives allowed for consideration of the determinants of actions, contexts, and interrelations between regulations, innovations, and performance.

The third chapter outlines fieldwork and mixed-methods research that exposes the PRD as a social research test bed. Known as the world's "biggest urban area" (Hilaire and Van Mead, 2016), the region was selected by us as a laboratory for understanding social changes. Studying a region at the forefront of industrialization, which is remaking its development model increased the chances of identifying recent social practices and assessing EMT's applicability. Following a presentation on research contexts, Chapter 3 describes data collection and analysis. Information was gathered from various sources and different stakeholders involved in corporate environmental actions, including literature sources, environmental audit reports, internal corporate documents, surveys, personal interviews, and participant observation. The chapter describes the data analysis process, from merging data, constructing a typology, to case study and comparison. It concludes with a discussion of the advantages and disadvantages of the fieldwork. Using major forms of data collection (observational methods, surveyed research, secondary data analyses and qualitative research) to study actions in formal and informal settings provides a more comprehensive understanding of corporate environmental stances and teases out the ongoing change processes at work.

The fourth chapter on environmental responses starts with the presentation of key findings. It describes the firms' characteristics (size, ownership, investment, headquarters, locations, served markets, and sectors), then presents the construction of an environmental value chain through identifying activities and the linkages among them. Articulations of environmental considerations were concentrated on four activities: operations, technology development, firm infrastructure, and human resource management. The chapter highlights the patterns of environmental responses (divergences, convergences, and interconnections) among the activities by focusing on environmental management and attitudes. The end of Chapter 4 identifies the main reasons for action or inaction, including stricter regulations and enforcement, strategic management decisions, and competitive positioning. It confirms that legal requirements were the predominant factor in determining corporate environmental actions and in changing attitude and behaviour toward the environment. However, coercive pressures differed across industries and firms, which led to homogeneity and heterogeneity in compliance. In addition, decision-making and positioning influenced how solutions were fashioned (i.e., process or/and product-oriented, organizational or/and operational process), as well as affecting the forms of environmental initiatives undertaken (e.g., environmental management system and cleaner production).

The fifth chapter, covering environmental implementation, focuses on analyzing processes that brought about changes in social practices. It illustrates shifting environmental policy and management systems in which a multi-pronged approach was deployed, the mechanisms by which people and organizations were held to account, and the specific policy arrangements made. Following a discussion of nonregulatory environmental initiatives adopted, Chapter 5 presents the triad-network implementation model, its application for analyzing political, economic, and social aspects of implementation processes, and describes the roles and relationships between actors in networks. It identifies driving forces for environmental initiatives (multi-stakeholder support, business opportunities, perceived obligations and impacts, and favourable regional contexts). Interacting with stakeholders such as local officials, professionals, and consultants helped the sampled firms increase their ability to find opportunities, create knowledge, and acquire resources regardless of their chosen options for change. Satisfying customer demands was key to the adoption of measures. More stringent local policy enforcement such as sanctions, paired with government support, drove companies to change their behaviours.

The sixth chapter on ideal typical analysis identifies regularities and patterns in implementation by comparing and contrasting performance. It shows the links between firm characteristics and environmental efforts, through consideration of compliance with regulations, going beyond compliance, and the development of resources for implementation. Chapter 6 categorizes adopters of ISO 14001 and cleaner production assessment/audit (CPA), describes a classification of configurational profiles, illustrates a typology of enterprises, and portrays eco-innovative firms. Using self-evaluated effects and audited results, this chapter presents the impacts of different implementation efforts and the relationship between stricter laws, eco-innovation, and firm performance. It discusses the major barriers to spreading initiatives, including particular difficulties for SMEs, effectiveness of government intervention, and the limits of market-based initiatives. Despite increased regulations, rapid development of institutions, and new forms of participation and networking, a relatively uniform pattern of policies did not provide appropriate solutions to problems. The sampled early adopters were most likely to be industry leaders, thereby producing more responses, employing advanced practices, and engaging in cooperation arrangements. They managed to translate their commitment into actions beyond compliance. On the contrary, the laggards failed to make change due to a lack of adequate government support, resources, technological capabilities, and management issues.

The concluding chapter discusses four major findings, presents the implications of the study, and provides recommendations for future studies. Our study identifies a tendency to respond to environmental regulations with conformity and a trend of adopting similar best practices. International regulations and standards become market-induced de facto requirements for exporters and supplier organizations selling products to multinational corporations (MNCs). The findings confirm our hypothesis that stricter regulations, financial incentives, and competition drove corporate environmental action. However, mixed results were found in the effects of regulations on eco-innovations and in those of environmental improvement on financial gain. Our work partially supports the claims made by EMT and raises new questions about its adequacy in understanding China's environmental governance systems. Our research identified the factors affecting implementation, created a typology of enterprises, and reached more generalized conclusions, as well as inherent weakness of our theoretical framework. Using an interdisciplinary approach with a wider range of methods has broadened the analysis. However, the results are limited by the sample size and geography of the survey. This chapter then discusses future research topics, suggests the criteria for analysis of international and regional dynamics and proposes a new hybrid model to improve our understanding of environmental change processes. Finally, we suggest drawing on actor network theory (ANT) to complement EMT in the network study of social dynamics.

Chapter 1 Environment: challenges and practices

This chapter discusses environmental issues and developments regarding urban environmental protection. Section 1 presents a brief literature review and takes a closer look at the state of the environment, impacts and costs of environmental degradation, as well as China's movements toward climate action. Section 2 describes the considerations regarding civil society in environmental protection. Our research highlights initiatives undertaken by citizens, environmental NGOs (ENGOs), media outlets, and individual journalists. We show how their increased influence on environmental protection, primarily through the internet, occurred in spite of restrictive policies. Section 3 looks into how the state responded to environmental problems during the same period. We review how the central government implemented policies and measures to encourage green growth and environmental consciousness through technology and innovation. The government issued a new urbanization plan, including targeted investments, and made changes in environmental governance. The last section of this chapter illustrates the environmental impacts of rapid industrialization, clean-up activities, increasing regulatory pressures, and corporate environmental behaviours. We demonstrate how growing cleaner and more productive sectors, along with industrial upgrading and restructuring, resulted in positive signs toward a path of green development.

1. Environmental protection: an overview

1.1. Brief literature review

The subject of China's environment has extensive bodies of literature and substantial resources (Seymour, 2005; Zeng and Eastin, 2011). Many publications described environmental degradation and its tangible aspects, causes, and implications (Cann, Cann, and Gao, 2005; Economy, 2004; Edmonds, 2000; Liang and Yang, 2007; Ma, 2004; Ma and Ortolano, 2000; Smil, 2000). A number of studies examined water issues ranging from an overview of water (Smil, 2000) and uses of water (Nickum, 2000), to causes and effects of water crisis (Ma, 2004). Scholars also investigated energy needs (Qu, Li, and Jiang, 1994) and development of energy sources such as nuclear (Lu, 1997) and renewable power (Qin, 2002; Raufer and Wang, 2003). Most authors predicted that coal would remain dominant in the near future (Edmonds, 2000; World Bank, 1985) due to abundant domestic reserves and inexpensive pricing (Andrew, 2013; Institute for Energy Economics and Financial Analysis, 2015; The Economist, 2013; Yang, 2013).

Many published works focused on politics, policies, and laws such as climate policy (Chen, 2012; Heggelund, 2007; McElwee, 2010), the application of environmental law (Ma and Ortolano, 2000; Zeng and Eastin, 2011), and access to environmental information (Ferris and Zhang, 2005). The broad consensus among scholars and practitioners noted here was that China's environmental challenges were rooted in policy implementation (i.e., Andrews-Speed, 2012; Brettell, 2013; Chen, 2009; Day, 2005; Edmonds, 2011; Ferris and Zhang, 2005; Grunow, 2011; Jahiel, 2000; Kitagawa, 2017; Ma and Ortolano, 2000; OECD, 2007; Smil, 2004; Zhang, 2011).

A number of researchers highlighted local implementation problems (Beach, 2001; Jahiel, 2000; Lieberthal, 1997) and their causes, such as a lack of resources (Beach, 2001) and competing economic and environmental interests (Economy and Lieberthal, 2007; Stalley, 2010). Some argued that such problems were linked to governance issues such as corruption (Lo and Fryxell, 2005), inadequate penalties (Lo and Tang, 2006), weak law enforcement (Yee, 2012), government-business inter-relationships (Ma and Ortolano, 2000), poor implementation mechanisms (Mol and Carter, 2006), and coordination problems among government agencies (Ohshita and Ortolano, 2006).

Concerning ways to move forward, a few authors suggested exploiting renewables (Raufer and Wang, 2003) and proposed building local government capacity, deploying market mechanisms to strengthen law enforcement (Chen and Uitto, 2003), and moving toward sustainable development (Gaudu, 1998) and a low-carbon economy (Andrews-Speed, 2012). Researchers were ambivalent about the current situation and its environmental future. Some were pessimistic (Seymour, 2005), while others were cautiously optimistic (Edmonds, 2000; Ren and Shou, 2013; Zusman, 2001). The next section looks into current environmental issues.

1.2. State of the environment

Almost one fifth of China's land territory[6] (1,880,000 km^2) has smog problems (Nanfang Daily, 2016). Less than 1% of the 500 largest cities met the air quality standards recommended by the World Health Organization (WHO). For example, residents experienced smog episodes dubbed "airpocalypse" and breathed concentrations of particulate matter (PM)[7] 2.5 level[8] beyond the upper limit of the Air Quality Index (500). The worst air pollution on record was 40 times the level deemed safe (1,000) according to the WHO (Albert and Xu, 2016; Topal and Chung, 2014; WHO, 2016). The former Prime Minister, Wen Jiabao, referred to approximately 450 cities with water shortages that challenged "the survival of the Chinese nation" (Albert and Xu, 2016). Water stress[9] began in the northern parts of China, where the Yellow, Yangtze, and Mekong rivers originate (Larmer, 2008). Nearly 70% of the rivers in Beijing-Tianjin-Hebei Province have been reported to run dry during the rainy season (Thompson, 2013). Adding to the region's ecological woes, 70% of rivers and lakes were polluted (Hong, 2006; Thompson, 2013) and 90% of cities were reported to be utilizing polluted groundwater (Thompson, 2013).

Reports indicated that burning coal emitted carbon dioxide (CO_2), sulfur dioxide (SO_2), and nitrogen oxides (NOx) which caused acid rain, forests destruction, air quality deterioration, and the contamination of aquatic ecological systems (Anderson, 2010; EIA, 2015; Qie, 2016; Smil, 1993). Half of the Yellow River was "biologically dead" and a third of the native fish species were heading toward extinction (Larmer, 2008). Almost 40% of mammals tested were "threatened," according to the China Species Red List (The Economist, 2013). The ecosystems were found to have continued a trajectory of degradation (ADB, 2015), which was exacerbated by climate change. Global warming hastened the advance of deserts that swallowed up a million acres of grassland annually (The Economist, 2013). More than 11% of the population living in low-elevation coastal

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[6] Released by the Ministry of Environmental Protection (MEP) from December 19 – 20, 2016

[7] Particulate matter is solid particles and liquid droplets of dust, dirt, smoke, organic chemicals, and metals suspended in the air. Topal and Chung. (2014).

[8] The PM2.5 level refers to the standard measure of air quality, referring to the number of micrograms of fine particulate matter (particles smaller than 2.5 micrometers) per cubic meter. Department of Health, New York State. (2018). https://www.health.ny.gov/environmental/indoors/air/pmq_a.htm

[9] Severe water stress is defined as access to less than 1,000 cubic metres of water per person per year. UN. (2014). https://www.un.org/waterforlifedecade/scarcity.shtml

zones (Center for International Earth Science Network, 2012) faced the highest global exposure to sea-level rise (Hanson, Nicholls, Ranger, et al., 2011; Nicholls, Hanson, Herweijer, et al., 2008).

1.3. Environmental effects

Pollution posed threats to livelihoods and interrupted economic activities. In 2015, "red alerts" concerning severe pollution resulted in school closures, traffic restrictions, grounded flights, and the temporary cessation of industrial activities and outdoor construction (Albert and Xu, 2016; Yan, 2016). A World Bank (WB) study estimated the total cost of environmental degradation at between 3 – 8% of gross domestic product (GDP) (Thompson, 2013). The rate reached 9% of gross national income when additional costs associated with energy and mineral depletion (World Bank and DRC, 2012) were considered. The estimated health related costs of air pollution were 6% of GDP (Matus, Nam, Selin, et al., 2012). Other costs, arising from pollution, soil erosion, and meteorological hazards were estimated at US$227Bn (Albert and Xu, 2016), US$10Bn (King, 2013), and CNY[10]¥192Bn per annum, respectively (Jiao, Song, Jiang, et al., 2015).

Pan Yue indicated there was significant human suffering alongside the serious economic losses (Der Spiegel, 2005). Over 400 million people have been affected by soil erosion (King, 2013). The Ministry of Health stated that air and water pollution increased the rate of cancer by 20% in the population studied (Larmer, 2008). Lung cancer, a known result of excessive inhalation of unhealthy levels of air contaminants, was the number one cause of death (Der Spiegel, 2005). More than 10% of digestive-system cancers could be linked to the consequences of unsafe drinking water (Albert and Xu, 2016). Massachusetts Institute of Technology (MIT) and Global Burden of Disease studies[11] showed that air pollution raised morbidity and mortality rates, medical costs and missed working days (Topal and Chung, 2014).

[10] Chinese yuan
[11] Referred to as the "most comprehensive worldwide observational epidemiological study," according to The Lancet. (2022). https://www.thelancet.com/gbd/about

Poor air quality caused approximately 4000 deaths per day (Rohde and Muller, 2015) and was responsible for one third of deaths in 74 cities reporting air quality assessment levels above PM2.5 in 2013 (Yan, 2016). During the same period, respiratory, cardiovascular, and cerebrovascular diseases (Albert and Xu, 2016; Clifford, 2015), underweight babies (Mathiesen, 2015), and a decline in male fertility (L. Lin, 2013) were also recorded. Ambient PM was one of the largest contributors to global disability-adjusted life-years[12] (GBD Risk Factors Collaborators, 2016). Smog shortened life expectancies by five and a half years in parts of the country[13]. The human toll continued to mount, as increasing temperatures magnify the adverse effects of air pollution on an individual's health (Kan, 2011). Projections indicated that the rise in mortality and premature death rates could be up to three times higher in 2060 than in 2010 (OECD, 2016b).

1.4. Movement on climate action

The official Chinese governmental stance on climate shifted from defending the "right to emit" to the "blue sky" emphasis (K. Li, 2017) on promotion of low-carbon development (Li, 2019). Climate change was treated as a scientific issue (Chen, 2012) and became a top priority (Xinhua News Agency, 2011). Quantitative targets[14] were set in the Intended Nationally Determined Contribution (INDC) to peak carbon emissions (NDRC, 2015). In 2014, a joint Sino American statement was signed, establishing a timetable and creating a path to the Paris Agreement. At a virtual climate summit hosted by President Joe Biden, President Xi Jinping reaffirmed his pledge to cease China's upward trend of emissions by 2030 and achieving carbon neutrality by 2060 (Gan and Griffiths, 2021).

The state adopted a renewable energy law (2006) to change the energy supply structure, reduce carbon intensity (CO_2 emission per dollar of GDP), and to set quantitative goals for

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[12] The disability-adjusted life year (DALY) is a measure of the overall disease burden expressed as the number of years lost due to ill-health, disability, or early death. Disability-adjusted life year (DALY), Wikipedia. (2017). "One DALY can be thought of as one lost year of "healthy" life. The sum of these DALYs across the population, or the burden of disease, can be thought of as a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability." WHO. (2017). Metrics: Disability-Adjusted Life Year (DALY).
[13] According to a joint study conducted by MIT, Tsinghua University, Peking University, and the Hebrew University of Jerusalem
[14] To peak carbon emissions by 2030, carbon intensity will be lowered by 60 – 65% of 2005 levels by 2030.

non-fossil-fuel consumption (Marquis, Zhang, and Zhou, 2011). Moreover, it introduced price structuring, taxation rates, and financial and economic incentives for biomass and waste incineration projects (FGE, 2015), as well as transmission infrastructure projects (Topal and Chung, 2014). Investment in wind and solar power doubled in the 12th Five-Year Plan (FYP) [15] (2011-2015), as compared with the 11th FYP (The Economist, 2013; OECD, 2016b).

Between 2005 and 2018, the representation of coal in China's energy mix dropped from 72% to 59% (Li, 2019). During this time, the world's largest consumer of electricity (Bradsher, 2011) became the largest producer of solar energy and wind power. In 2012, investment in renewables reached $67Bn, three times more than Germany's spending during the same interval (The Economist, 2013). In 2015, capital investment in the renewable energy sector amounted to $90Bn, which was 73% more than the next largest investor (United States) (Albert and Xu, 2016; RE100, 2015; The Economist, 2013; Topal and Chung, 2014). The next section addresses the civil society activities in environmental protection, many of which were undertaken during the capital investment shift previously described.

2. Civil society: making voices heard

2.1. Citizen engagement

A survey of Chinese citizens indicated the majority of respondents felt environmental problems were their main concern (Boyd, 2013). These concerns also figured in a cultural "list of anxieties" (Albert and Xu, 2016). An online poll of more than 600,000 individuals urged the National People's Congress to address environmental protection (Xinhua, 2013). Pollution has clearly been a primary concern for citizens (Hoffman and Sullivan, 2015). Since the late 1990s, surveys and opinion polls have consistently found that pollution was considered as "very serious" or "relatively serious" (Albert and Xu, 2016; Xi and Xu,

[15] The Five-Year Plan (FYP): the first FYP was introduced to align the economy with top policy goals in 1953. This directive is still used to communicate throughout the bureaucracy, which can be understood as indicators of the directions and changes in development. Fan. (2006).

1998). In a period of six years, the percentage of respondents rating air pollution as a "very big problem" increased from one third to almost half[16], according to Pew surveys conducted in 2007, 2012, and 2013 (Albert and Xu, 2016). Calls to a national hotline for reporting pollution doubled in the first decade of the 21st century (Moser, 2013).

Evidence of a newfound unwillingness to accept environmental degradation and its health implications (Clifford, 2015) was found. "Everyone knows the link between the environment and their own health," said Ma Jun, a well-known environmental activist (The Economist, 2013). In the decade spanning 1997 – 2007, the total number of environmental complaints increased six-fold, from 100,000 to over 600,000 (Jing, 2010) and the annual number of complaints nearly tripled[17] in the period 1999 – 2010 (van Rooij, Stern, and Fürst, 2016) in another quantitative evaluation. Each year, over 80,000 people submitted environmental petitions. If a petition failed, demonstrations, road blockages, and sabotage were reported to follow (Jing, 2010). People protested air and water pollution (Haas, 2016; Liu, 2013a; The Economist, 2013), as well as construction projects and operations pertaining to coal-fired power stations, chemical plants, smelters, paper mills, waste incinerators, and oil refineries (Liu, 2013a; Martina and Niu, 2015; Tang, 2012; Vines, 2014; Yang, 2007). An anti-PX (para-xylene)[18] movement beginning in Fujian province was followed by large-scale protests across the country (i.e., Guangdong, Yunnan, Zhejiang, Sichuan, and Liaoning) (Hoffman and Sullivan, 2015; Ruwitch, 2015).

A few protests turned violent, leading to arrests, and even deaths (SCMP, 2015). "This whole area is surrounded by chemical plants. I've had family members die of cancer and I bet everyone here has someone who has died of cancer," said one protester. "We're doing this for the younger generation. We don't want them to get sick," added another protester (Vines, 2014)." "[…] If the plant may cause cancer, how can people remain calm?" a retired official questioned (Zhang and Lin, 2014). The number of environmental protests increased annually by 29% (Liu, 2013b; Yang, 2007), reaching over 700 in 2013 (Albert

[16] A survey of China was conducted between March 4 – April 6, 2013. Face-to-face interviews were conducted involving 3,226 respondents. Pew Research Center. (2013).
[17] The reported numbers rose from 268,592 to 735,756.
[18] PX is a chemical derived from refined petroleum and used in making polyester fiber and plastics. Chemicalsafety.org. (2022). https://www.chemicalsafetyfacts.org/paraxylene/

and Xu, 2016; Zhang and Lin, 2014), which represented a quarter of all protests according to the Chinese Academy of Social Sciences (The Economist, 2013).

2.2. Involvement of ENGOs

People shared their views across social networks (Liu and Link, 2006). For example, air pollution created a buzz on social media sites. Searching for "PM2.5" and "air pollution" yielded more than 280,000 references on Weibo (China's equivalent to Twitter) in 2013 (Topal and Chung, 2014). Citizen groups published information through the internet platforms (Yang, 2009) and organized protests through social media sources (Albert and Xu, 2016). The growth of environmental community coincided with the prevalence of internet access. The first officially registered ENGO[19] was founded in 1994, when China was fully connected to the global internet. The number of ENGOs increased from nine to approximately 2,800 from 1994 to 2005, while individuals accessing the internet tripled between 1997 – 1998 (Yang, 2007). Over 224,000 people worked for ENGOs, and these organizations had cumulative funding of nearly CNY¥3,000Bn (Yang, 2005).

Electronic newsletters and bulletin board systems were used for networking and dissemination of information (Fu, 2007; Yang, 2007). The internet and social networking served as channels and forums (Ren, Shou, and Dong, 2016), which resulted in the ENGOs improving their effectiveness and capacity for citizen education, the mobilization of public participation, exertion of mass movement pressure (Fu, 2007; Sima, 2011), influence on political decision-making (Ren, Shou, and Dong, 2016), pushes for transparency (Lin and Guan, 2013), and facilitation of public input toward policymaking, implementation and monitoring (Lin and Guan, 2013; Yang, 2009; Zhang, Cao, Gu, et al., 2016).

Despite polarized opinions and the proliferation of disparate voices (Jiang, 2016; Liebold, 2011), prior studies showed that the internet built online alliances (Liu, 2011), and enabled ENGOs to strengthen their capacity (Guo and Saxton, 2014). However, users had to use codewords, images, sounds-like characters to get around censorship and media blackouts. Using Virtual Private Network (VPN) technology, online activists played "cat-and-mouse"

[19] Friends of Nature

with censors to circumvent the "Great Firewall."[20] Despite VPN shutdowns, a computer programmer, Yang, believed that "administrative power was too weak to take on algorithms," and that developers would find a more secure and undetectable way to transfer encrypted information. "I am willing to join the battle for information freedom anytime," Yang added (Lin, 2017).

2.3. Roles of the media and journalists

At this time, the media became more diversified and online information proliferated in the country. People had access to material from around the world and volunteers offered crowd-source translations of foreign press publications (Liu and Link, 2006). Contradictory to prior research on China's environmental reform (Mol, 2010), China Central Television (CCTV) was powerful but did not have a monopoly. In fact, over 3,000 global, national, and regional television channels were available (Chan, 2000). Meanwhile, four commercial free-to-air satellite channels figured among the top five most viewed channels (Zhou and Rao, 2018). Commercialised milieu has allowed mass media as whistleblower (Geall, 2013). For instance, TV environmental educational shows, radio programmes, and hotline call-in programmes multiplied to expose pollution violations (Yang, 2007). Chai Jing, a former state television reporter, produced a documentary (*Under the Dome*) in 2015, which attracted 100 million views online (Albert and Xu, 2016). Although Chai took a critical look at fossil fuels, heavy industries, and environmental enforcement (Tran, 2015), *People's Daily* (the Communist Party's official newspaper) was one of the first to post the video on its website. Chen Jining, the former Minister of the MEP, thanked Chai personally for raising environmental awareness, and said that the documentary reminded him of Rachel Carson's *Silent Spring* (Buckley, 2015).

A retired reporter and editor described his work as the "recording of words from the leaders and passing them down to the readers." The scope of reporting had been broadening, from policy announcements to investigative pieces. Reporters had leeway on reporting environmental issues, as long as they did not "cross the boundaries set by the government" (Hilderbrandt and Turner, 2002). "It is like playing ping-pong," journalists "nick the end

[20] By 2014, more than 140 million people used VPN to access the web undetected. Lin. (2017).

of the table," said a former editor of World Economic Herald (Liu and Link, 2006). A survey showed that environmental journalists believed their reporting reflected people's concerns, attracted governmental leadership attention, and increased environmental awareness (De Burgh and Rong, 2012). None of the surveyed journalists indicated that political limits were applied to their reporting. "I have never come across limitations, either political or legal," one reporter said (De Burgh and Rong, 2012: 55). Instead, the journalists indicated a lack of environmental expertise as a major obstacle (De Burgh and Rong, 2012), and resorted to learning from each other to "raise the standards of our investigative stories" (De Burgh and Rong, 2012: 39).

Investigative journalism, with its inherent naming and shaming of polluters, exerted influence (Tong, 2015; Xie, 2011). Press coverage and media reports could turn local stories into national topics. For instance, the publication of an article on Tiger Leaping Gorge on the front page of an influential investigative newspaper (*Nanfang Weekend*) became a significant headline environmental story covered by national and international media (J. Liu, 2013b). Since 2006, the Institute of Public and Environmental Affairs (IPE), an ENGO founded by a former investigative journalist (Ma Jun), has published an online list of companies violating laws concerning the environment. This list is released by *Nanfang Weekend* and picked up by broader media (Ma and Xu, 2006). Nearly 600 companies approached IPE, requesting to be removed from the list (Ford, 2012). To challenge polluting facilities, the Institute also developed a smartphone application showing real-time emissions data (Blue Map) that was downloaded three million times following the release of Chai's documentary (Hoffman and Sullivan, 2015).

2.4. Increased but limited influence

The vast majority of the environmental complaints raised during this time received response (van Rooij and Lo, 2010). Global environmental awareness was growing, even though people had greater concerns about local pollution than climate change and habitat destruction (Dasgupta and Wheeler, 1996; Wang and Zhou, 2020). Those suffering from the effects of pollution realized their rights thanks to legal assistance provided by ENGOs (Brettell, 2001; Cooper, 2003, as cited in Seymour, 2005; Rosenthal, 2000). International involvement was critical in the support of campaigning and to get the issue onto the international agenda (Boyd, 2013). For example, the World Wide Fund, a global NGO working on issues affecting nature, worked with the Ministry of Forestry to conduct an audit on the national reserve system and made recommendations for government action (Harkness, 1998, as cited in Ma and Ortolano, 2000). More space was given for environmentalists, who criticized and even forestalled construction projects (Lo and Leung, 2000), protected species (e.g., the Tibetan antelope and the sub-nosed monkey) (Boyd, 2013), preserved river systems (e.g., the Nu River and the Tiger Leaping Gorge), and improved air quality (primarily through vigilance around the PM2.5 threshold). Some authors spoke about the emergence of "green civil society" or the "green public sphere" (Chen, 2010; Ho, 2001; Sima, 2011; Yang and Calhoun, 2007). ENGOs won some decisive victories in conservation (Economy, 2004). Some environmental protests were not only tolerated (Ruwitch, 2015; Topal and Chung, 2014) but also achieved their objectives (Vines, 2014). These occurrences were unusual in a nation that regards protests as a threat to state security.

In spite of a strengthening advocacy role (Fu, 2007), ENGOs were less successful in holding officials accountable (Diamond, 1999). Faced with a shortage of funds and a lack of qualified staff (van Rooij and Lo, 2010), many ENGOs were disorganised (Fu, 2007) and relied upon the state (Ho and Edmonds, 2008; Zhan and Tang, 2013). Few environmental stories were published; for example, two local daily newspapers devoted between 2 – 5% of their publication space to environmental issues (De Burgh and Rong, 2012). The media remained self-censored, and Chai's documentary was blocked later (Albert and Xu, 2016). The level of trust that some people had in official sources "was very low," according to a protestor (Ruwitch, 2015). One month before an explosion in a PX plant, People's Daily claimed that the chemical was "no more harmful than a cup of coffee." (Hoffman and Sullivan, 2015). Environmental activists were tried for "libel" and "deliberately concocting false information to terrorize the public" (Hoffman and Sullivan, 2015). Some argued that the nation hit an "environmental turning-point" (Reuters, 2014; The Economist, 2013). If unchecked, environmental problems could result in a public policy outcry and, particularly from an official perspective, could hinder social stability (Kitagawa, 2017; Larmer, 2008; Yan, 2016). This emerging public awareness and activism role was an action requiring a reaction and the next section explores the initiatives undertaken by the central government to deal with such dynamics.

3. Government: fighting crisis

3.1. Paving the way for green development

Top levels of the political structure heard the public outcry and searched for appropriate responses. The size of the Chinese economy doubled every seven years (Clifford, 2015), drove high energy consumption (EIA, 2015), and increased resource demands (Economy and Levi, 2014). The country was the largest consumer of natural resources (fossil fuels, biomass, minerals, and metal ores) (World Bank, 2015) and coal (EIA, 2015; The Economist, 2013; Wong, 2013). Its coal consumption accounted for about half of the global quantity used in 2013, and this was three times more than in 2000 (IHS Energy, 2013). Almost half of the country's CO_2 emissions stemmed from power generation that largely depend on coal (Linster and Yang, 2018). The Prime Minister, Li Keqiang, acknowledged that smog was "nature's red-light warning against inefficient and blind development" (K. Li, 2017) while fighting a "war against pollution as we declared war against poverty." (Reuters, 2014)

The task before the government was to handle the level of economic development and environmental protection well, according to Zhou Shengxian, the former Minister of the MEP (Zhou, 2011). Beijing put caps on consumption, cut production of steel and cement, shut down coal plants (Reuters, 2014), prioritized expansion of natural gas-fired and renewable power plants (Andrew, 2013; Yang, 2013), and banned new coal-fired power plant construction in key economic regions (Topal and Chung, 2014). The government launched a nationwide retrofit programme, subsidized installation of denitrification equipment, and set standards and emissions caps for NOx, PM, SO_2 and mercury (Hill, 2013). By 2011, 95% of thermal power generators were operating with desulphurization technology (MEP, 2012). Coal-fired power plants were retrofitted with "ultra-low" emission technologies and were required to cut emissions to levels on par with natural gas usage (Li, 2016b). Between 1990 and 2014, solar, wind, and hydropower increased more than ten-fold, in terms of the primary energy supply (DRC and OECD, 2017), and two thousand smaller coal mines were closed from 2013 to 2016 (Zhang, 2014).

The notions of "green development" and "ecological civilisation" were added to the charter of the Communist Party (Wang, 2017) and the constitution. The 19th National Congress Report stated that the economy was transitioning toward "high-quality" development. The 12th FYP (2011 – 2015) proposed binding targets[21] and set goals for environmental infrastructure with an emphasis on a "circular economy" (reuse and recycle). It was the greenest FYP, said Hu Angang, the director of the Center for China Studies. "[…] Resource and environmental targets account for 33.3 percent of the total, up from 27.2 percent in the 11th FYP [....], the new plan puts forward an 'ecological security' strategy […]," commented Hu (Hu, 2011, as cited in Casey and Koleski, 2011). The 13th FYP (2016 – 2020) set targets for water, air, and soil quality and proposed the development of clean technologies (He, Lu, Mol, et al., 2012), thereby creating the "most ambitious" environmental reform agenda (Lehr, 2015).

3.2. Development of technology and innovation

The country had been shifting toward growth based on innovation and technological progress (Marquis, Zhang, and Zhou, 2011). According to President Xi, "[…] to improve the environment was to boost productivity" (Petricic, 2016). Innovation capacity enhancement constituted a pillar of the transition toward green development and a key area of focus for the National Strategic Emerging Industry Development Plan (2012), according to the Science and Technology Development Plan of 2020. A projected $600Bn was committed to information technology, clean energy, environmental protection, and scientific research and innovation (He, Lu, Mol, et al., 2012).

The National Development and Reform Commission (NDRC)[22] set up a special fund for promoting industry development and expanding the scale of venture capital investment (NDRC, 2011). Research and development (R&D) spending by government agencies had

[21] Such as CO_2 emission, renewables, forest reserves
[22] Major Tasks and Measures for Economic and Social Development

been increasing, in order to promote green development and support the broader transition (KPMG, 2011). Actions were taken to restructure (NDRC, 2015), decarbonize, and re-establish low-carbon industry systems (X. Liu, 2013). Seven sectors were designated as "strategic emerging" industries[23] and benefited from investment funds, finance, and taxation policies (State Council, 2010). The Made in China 2025 initiative was launched to move industry investment up the value chain (ISDP, 2018). The "value added" component in industry was 33 times larger in 2009 than in 1977 (World Bank, 2012). More than 40% of the surveyed firms had engaged in R&D activities, according to a report evaluating Chinese enterprises' innovation capacity[24].

Globally, the country was the fifth largest in filing environmental patents pertaining to climate change mitigation (76%), environmental management (20%), and water-related adaptation. From 1990 to 2014, the number of patents increased more than 60-fold, compared to three-fold and 18-fold increases in the Organization for Economic Cooperation and Development (OECD) and Brazil, Russia, India, Indonesia, and South Africa (BRIIS), respectively (Linster and Yang, 2018). Some energy-saving technologies[25], which originated in China reached the advanced international levels (State Council, 2011b). Chinese renewable energy companies invested \$89Bn in 2014 (Bloomberg, 2015; FGE, 2014; Nanfang Daily, 2017b; Xinhua, 2014) and became leading innovators in hydropower, solar energy, wind energy, and electro-mobility (Bradsher, 2010; Gurría, 2012; Lema and Lema, 2012; Urban, Nordensvard, and Zhou, 2012). Solar firms were dominant in technology, investment, manufacturing, and employment (Buckley and Nicholas, 2017).

China invested more in science, technology, and innovation than Japan and the European Union (OECD, 2016a), and became one of the world's 25 most-innovative economies, based on a nine-year-survey in innovative capacity across 100 countries (WIPO, 2016). It

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[23] Clean energy technology, next-generation information technology, biotechnology, high-end equipment manufacturing, alternative energy, new materials, clean energy vehicles. State Council. (2010).
[24] Released by China Technology Development Strategy Institute
[25] Cement production technology, electrolytic aluminum cathode cell manufacturing process. State Council. (2011).

was the first time a middle-income country had joined the "Global Innovation Index" [26] (WIPO, 2016), although China's R&D intensity (measured by the share of gross domestic expenditure on R&D) was below the OECD average (OECD, 2016a). At the time, the country had the largest number of industrial robots and connections of machine-to-machine SIM (Subscriber Identity Module) cards, and it was the third largest issuer of 3D (three-dimensional) printing patents (OECD, 2017a). As the largest intellectual property, brands, and industrial product design filer, China was heading toward R&D leadership as a major contributor in global technological advancement, according to the executive editor of Nature, Nick Kimbell (Nanfang Daily, 2017c).

3.3. New types of urbanization initiated

As a part of a structural reform programme and transition to a service-based economy (Hsu, 2016; Shaffer, 2014), urbanization has become one of "the most important parts of shifting the growth model," according to Sri Mulyani Indrawati, the Chief Operating Officer at the WB (Shaffer, 2014). China was an agricultural country with less than 20% of its population living in cities when "reform and opening" was launched in 1978 (Zheng, 2016). Between 1995 and 2015, the rate of urbanization increased from 36% to over 53% (Heggelund, Andresen, and Fritzen, 2010), which was predicted to reach 70% by 2025 (Johnson, 2013; Shaffer, 2014). "If half of China's population starts consuming, growth is inevitable […]," said the Vice Director of the Institute of World Economics and Politics (Johnson, 2013).

Urbanites were consuming nearly four times more energy than rural Chinese dwellers (Clemente, 2015). Moreover, rapid urbanization caused pollution, traffic congestion (Zheng, 2016), and increased energy consumption (Leibo and Li, 2013). The National New Urbanization Plan aimed to remedy the woes of unchecked urbanization (Shepard, 2016) and to make more gradual, "people-centered social progress" (Hsu, 2016; Johnson, 2014; Shaffer, 2014). A US$6.4 trillion plan, over the coming years, was predicted to bring 400 million additional people to cities and to improve their quality of life, as well as

[26] Released jointly by Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO)

providing better integration for former rural residents already living in cities (Johnson, 2014).

Car ownership rose to 295 million vehicles (Wan, 2017), representing more than a ten-fold increase over 2004[27]. In 2014, vehicle sales hit 23 million, already surpassing the sales volume previously predicted for 2020 (22 million) (Wang, Liao, and Hein, 2012). For each million new cars sold, 10,500 to 13,000 barrels/day was added to the annualized gasoline demand (Clemente, 2015). The government installed a "Vehicle Quota System" using auctions and lotteries to cap new auto registrations and to limit the use of private vehicles (Clemente, 2015). Car emissions had become a major source of pollution in cities, accounting for more than 80% of total carbon monoxide (CO) and hydrocarbon (HC) emissions and more than 90% of total NOx and PM levels[28] (Wan, 2017). The State Council (China's Cabinet) fast-tracked the National Phase V motor gasoline and gasoline emission standard. Such standard is similar to the Euro V standard that caps sulphur content in gasoline at 10 parts per million (PPM) (Clemente, 2015; Platts, 2015), and rolled out Phase VI in major regions (K. Li, 2017).

Despite high gasoline prices[29], electric vehicles accounted for less than 1% of new car sales (Clemente, 2015). A 10% purchase tax was imposed for non-electric vehicles, along with more stringent fuel economy standards[30] (Clemente, 2015). Rebate and trade-in programmes were implemented to offset the cost of hybrid and electric vehicles, and inefficient vehicles were replaced with fuel-efficient alternatives (Topal and Chung, 2014). Public transportation system and alternative energy use improvements were anticipated (Topal and Chung, 2014) in order to reach an urban public transport goal of 60% of all trips (Clemente, 2015).

Over two billion square meters of commercial building construction was completed annually, accounting for more than the total commercial building floor space in Canada or half of all new construction in the world annually. The construction boom required a large

[27] 27 million, according to NBS, as cited in Thompson. (2013).
[28] Liu Bing Jiang, Director of air control agency at the MEP
[29] Almost twice as high in China than in the United States Platts. (2015).
[30] From 34 miles per gallon (MPG) to over 47 MPG by 2020 Clemente. (2015).

amount of cement (Albert and Xu, 2016; Heggelund, Andresen, and Fritzen, 2010; Qi, 2013). Sources indicated that the government intended to create fiscal incentives for using more efficient materials and renewable energy (Bradsher, 2011). Since the 1990s, a mandatory energy efficiency standard system was applied to new building construction, and it had a compliance rate of over 95% in 2010 (Hill, 2013). In addition, a voluntary "green building" certification system (Hill, 2013) and energy labeling system was implemented for new commercial and government buildings[31]. Commercial buildings in China used 10 – 20% less electricity per square meter than those in Western countries (Bao, Zhao, and Zhu, 2012). The savings may have come from large-scale retrofits[32] (Bao, Zhao, and Zhu, 2012), a ban on selling 100-watt incandescent light bulbs (Gov.cn, 2011), and thermostats set to energy efficient temperatures during summer and winter (26 degrees Celsius and 18 degrees, respectively) (Bradsher, 2011).

A number of "ecocities," "low-carbon" cities, and "garden" cities have been built. Ecocities were "designed, built, and managed at the absolute highest levels of efficiency." [33] Located in newly developed areas in large, pre-existing cities (Shepard, 2015), ecocity projects introduced innovative environmental systems such as energy storage and heat capture, drinking water recycling and/or desalination, grey and black water capture systems, sky gardens, waste energy recovery systems, and new methods of public transportation. In the coming decades, it was reported that half of the new urban development projects would be labeled as "eco," "green," "low carbon," or "smart" (Shepard, 2015). A guideline was introduced to require a reduction in resource consumption by having cities equipped with more energy-efficient buildings, better wastewater and solid waste treatment, denser street networks, extended public transportation networks, and increased public green space (Zheng, 2016). In 2010, the wastewater treatment rate in urban areas reached over 80% (Hill, 2013).

In spite of a 20-fold extension of drainage networks since 1981, the infrastructure could not catch up with the rate of urban expansion. City planners experimented with mass urban

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[31] According to Hao Bin, the building energy-efficiency Director of the Ministry of Housing

[32] During the period of the 11th FYP (2006 – 2010), 190 million square meters of residential floor space were retrofitted. Bao, Zhao, and Zhu. (2012).

[33] According to Richard Brubaker, Professor at China Europe International Business School

water reuse systems and integration of new, climate-resilient urban designs such as "sponge cities," due to the increasing frequency of extreme weather events (Shepard, 2015; Wang, 2016). Rather than deflecting rainwater away with storm sewers and drainage systems, "sponge cities" collected and reused water locally. Rainwater permeated through porous concrete into the shallow aquifer or submerged cisterns. Gardens on rooftops held water in the soil or diverted it to tanks for drinking, cleaning, or irrigation purposes (Shepard, 2015). For example, the southern city of Shenzhen developed an area enabling the annual collection of 10,000 cubic meters of rainwater, whereas Chengde, in the north, replaced 15% of its impervious areas with rain gardens and bioswales (i.e., vegetated gullies) to remove silt and pollution from storm water. The central government pledged billions more in funding for the future development of "sponge cities" (Wang, 2016).

3.4. Evolution of environmental governance

According to the Merriam-Webster dictionary, governance refers to "the act or process of governing or overseeing the control and direction of something (such as a country or an organization)." Governance is a process through which a government exercises its authority, as defined by Jacques Theys. Based on Theys' broad conceptualization of governance (Guay, 2020), we considered the state as a key player in creating and implementing environmental policies. Environmental management was on the state's agenda following the Stockholm Conference (1972) (Ren and Shou, 2013; Wang, 2010). Since the enactment of Environmental Protection Law (EPL) in 1979, 28 environmental and resource laws, 150 national administrative regulations, and over 1,300 national standards have been introduced (He, Lu, Mol, et al., 2012). Between 2007 and 2013, 130 environmental courts have opened (Stern, 2014). The MEP has worked with police departments, and courts in administration and enforcement.

In 2018, the Ministry of Ecology and Environment (MEE) was created to replace the MEP, a decade after being elevated from the State Environmental Protection Agency (SEPA). The MEE has shared the responsibility of implementation of environmental laws and green financial policies with other agencies such as the State Administration of Taxation (Turiel, Ding, and Liu, 2017). According to the director of the Treasury Department, interministerial cooperation ensured the effective implementation of the law (Yu, 2018). Moreover, local authorities were able to retain all enforcement revenues and could make adjustments, such as applying tax rates within a defined range, while implementing environmental adherence and tax authority. The new system was more favorable for enforcement (Wu, 2018) than the prior fee scheme, under which the central government retained 10% of pollution-related levies.

The MEE was responsible for policies concerning climate change (MEE, n.d.), an area which was previously managed by a macro-economic commission (NDRC) and a scientific administration (Meteorological Administration) (Chen, 2012). Actions were taken to establish routine dialogue between Chinese delegations, civil society, and media outlets, introducing national environmental public hearings, and providing Instructions on Fostering and Steering the Regular Development of Environmental NGOs (2010). To an NGO observer, such moves "greatly boosted mutual understanding between China and the international community" (Li, 2019). Domestically, mechanisms have been established for citizen participation and information disclosure (Aizawa and Yang, 2010; Mol and Carter, 2006; Zhang, Mol, He, et al., 2010). For example, people were able to check PM2.5 levels on their phones due to changes in official air quality data collection and publication services (Andrews, 2011). Section 4 discusses how industries have confronted environmental issues, in light of the atmosphere already described.

4. Businesses: facing challenges

4.1. Effects of industry growth and clean-up

The share of industry accounted for above two-fifths of total GDP, which was higher than that of other emerging economies. The country was the world's largest producer of goods, ranging from labour-intensive sectors to knowledge-intensive segments such as textiles, computers, ships, robots, chemical fibre, machine tools, cell phones, home appliances, and high-speed trains (Linster and Yang, 2018). The average annual growth rate of industry was 12% (World Bank, 2012) and accompanied a sharp rise in exports (Gao, 2012). Since

2009, the country has become the largest, global merchandise exporter[34] (Gao, 2012). In 2015, it manufactured half of the global supply of crude steel and cement and more than a quarter of motor vehicles (Linster and Yang, 2018).

Rapid industrialization degraded habitats (The Economist, 2013) and large-scale exports exacerbated pollution (Chai, 2002). A recent study showed that China increased its trade-embedded carbon emissions (Outchiri and He, 2021). Prior research found that nearly a third of industrial carbon emissions could be traced back to export-oriented production (Ren, Yuan, Ma, et al., 2014). Industrial activities accounted for 15% of chemical oxygen demand (COD) (Hill, 2013) that caused oxygen depletion in aquatic life, death of fishes and plants, breakdown of food chains, and loss of biodiversity (Fussler and James, 1997). The industrial sector consumed 90% of national coal production, 70% of total energy (1990 – 2002) (NBS, 2004), and 75% of national electricity (FGE, 2014). The sector was the main CO_2 emitter (IEA, 2021), and produced more than 80% of SO_2 and over two-thirds of NOx emissions (DRC and OECD, 2017). Export-embedded carbon emissions accounted for between a quarter (The Economist, 2013) and a third (Heggelund, Andresen, and Fritzen, 2010) of total national carbon emissions. Other emissions associated with export volume included anthropogenic SO_2 (36%), NOx (27%), CO (22%), and black carbon[35] (17%) (J. Lin, 2013). Industrialized regions such as the PRD were affected by "acutely degraded" soil quality[36] (He, 2014; Qie, 2016) and contamination (Holdaway and Husain, 2014; Delang, 2017). It is estimated that 24 million people were impacted by contaminated grain (Lehr, 2016).

Efforts were made to clean up fast (ADB, 2015; OECD, 2016b; The Economist, 2013). Between 2013 and 2017, about $275 – 277Bn (equivalent to twice China's annual defence budget) was spent to improve air quality (Gardner, 2014; The Economist, 2013; Topal and Chung, 2014). One of the Science and Technology Programmes on water pollution control and treatment had a budget of over ¥30Bn over 12 years (2007 – 2020) (Chen and Gong, 2009). Goldman Sachs estimated the clean-up as a "multibillion-dollar opportunity" which

[34] In terms of amount and value
[35] In 2006
[36] According to a study conducted by the MEP and the Ministry of Land and Resources

would generate a $2.3 trillion gain (Koty, 2017). Environmental equipment sales amounted to $41Bn with an annual growth rate of 20% over the coming years (Lehr, 2016). The number of energy conservation service companies and associated employment opportunities, resulting from the movement toward ecological improvements, multiplied ten-fold (State Council, 2011b).

4.2. Restructuring, stricter regulations, and corporate behaviours

The central government removed tax rebates and imposed tariffs on energy intensive export products such as steel (Russell, 2016). NDRC released the Catalogue for Guiding Industry Restructuring (2019 version) that classified industry sectors as “encouraged, restricted, and to-be-eliminated” (NDRC, 2019) to promote high-quality manufacturing (Gov.cn, 2019). The government also reduced overcapacity (Reuters, 2014), and upgraded plants (EIA, 2015). For example, almost half of all obsolete production facilities[37] were eliminated from 2006 to 2010 (Gov.cn, 2010). Pollutant intensive and/or energy intensive companies, particularly small pollution sources, were designated “to-be-eliminated”[38] and were encouraged to consolidate with larger enterprises. This was done to provide opportunities for technological advancement across companies and sectors (Rock and Toman, 2015). In addition, these industries were moved away from urban centres (Reuters, 2014).

The Criminal Law (1997) included articles related to environmental protection. However, the implementation of environmental standards achieved limited results (UNDP, 2002). One ENGO estimated the rate of regulatory enforcement was only10%[39] (Larmer, 2008). Moreover, a majority of companies did not comply with the new emission standards[40] (Li, 2013). The latter was confirmed by inspections, reports, and studies (Friends of Nature, IPE, and Green Beagle, 2010, 2011; Warwick, 2003, as cited in Cushing, McGray, and Lu, 2008; Wong, 2013). Some firms had operational faults in depollution equipment and

[37] Iron (110 Mt), steel (68Mt), cement (330 Mt), coke (100 Mt), paper (10,3 Mt), glass (38 million weight cases). Gov.cn. (2011).
[38] Action plan of air pollution control and prevention (2014-2017), Guangdong 广东省大气污染防治行动方案 (2014-2017 年）List of key project 重点项目清单, Table 1 表 1: 2014-2015 entitled “Production capacity to-be-eliminated” 2014～2015 年落后产能淘汰项目表.
[39] Wang Canfa, Director of an ENGO
[40] Zeng Xiaodong, the deputy chair of All-China Environment Federation

falsified data (Chinanews.com, 2015; Qian and Aruhan, 2014; Sun, 2015; Zhao, 2014). More than a third of the soil spots (5,846) sampled in pollution-intensive sectors (690 businesses) exceeded national standards (Qie, 2017). Over 20 facilities (steel and paper mills, cement plants, power generators, and chemical companies) committed offences, ranging from ignoring output suspensions, "maliciously" evading inspections, and falsifying production data (Mackay, 2016), to resuming operations during a red alert smog ban (Haas, 2017).

There was a perceived lack of accountability (Institute of Environment and Development, 2005) and responsibility (Li, 2013). At the National People's Congress, President Xi pledged to "punish any violators who destroy China's ecology or environment with an iron hand" (Hoffman and Sullivan, 2015). The amended EPL imposed control "targets for the total emission volume of major pollutants," cumulative fines without ceilings, business license suspension capabilities, perpetrator detention authority, and criminal charges (Corne and Browaeys, 2017). The Deputy Minister of the MEP said, "we would absolutely not allow this new law to be an empty piece of paper" (Ma, 2015).

On-site monitoring systems and self-reporting methods have been used to assess pollution discharge levels (Zhao, 2014). Local environmental police forces were created (Haas, 2017) and inspectors were given the new authority to shut down facilities and detain those responsible (Corne and Browaeys, 2017; Delang, 2017). The days of insignificant fines were gone. For example, pollution fines which accumulated daily were imposed on 26 companies. Over 500 plants were permanently closed, and more than 200 firms were ordered to temporarily suspend operations (Hoffman and Sullivan, 2015).

More industrial firms became environmentally conscious (Li, 2012) and went the extra mile to protect the environment. For instance, 80 Chinese and Taiwanese companies founded an organization in 2004, and urged their peers to take responsibility to protect the environment through the Alxa Declaration (Yang, 2007). Each member organization made a commitment to donate CNY¥100,000 annually for ten consecutive years, to support environmental protection in Alxa, Inner Mongolia, an area significantly affected by desertification. The behaviours of the founding Declaration members indicated that corporations could be part of solutions for solving environmental problems. Environmental-economic indicators over the last 30 years confirmed some improvements, as described in the last subsection.

4.3. Toward "green industrialization"

Since the mid-1990s, industrial COD discharge has decreased by more than one million metric tons (Shi and Zhang, 2007; World Bank, 2001). The manufacturing sector improved its performance in wastewater treatment (Ma and Ortolano， 2000), energy use, CO_2 emissions, water use, and biochemical oxygen demand (BOD)[41] of effluent (measured by manufacturing value added[42]), from the 1990's onwards (Luken and Rompaey, 2007). Between 2000 and 2010, official statistics indicated that industrial smoke decreased, and the rate of sewage treatment increased[43]. By 2007, 85% of industrial wastewater was treated before discharge (Mol and Carter, 2006). Industrial water use (per unit of value-added) decreased by 20% in 2015 (Lu and Feng, 2017). China has narrowed the energy consumption gap (per unit of industrial products) compared to advanced countries (Gov.cn., 2011). The reduction in industrial coal consumption[44] (NBS, 2014) coincided with decreasing levels in PM2.5 and air pollution, new air pollution laws, and stricter emission standards (Dong, 2015).

Time series data from the late 1980s to mid-1990s indicated the reduction of SO_2, COD and rate of particulate suspension in urban areas, more particularly in the largest cities and despite increased population levels and economic activities (Rock, Yu, and Zhang, 1999; Wang and Lui, 1999, as cited in Rock, 2009). Chlorofluorocarbon (CFC) emissions continued to decrease beginning in the mid-1990s (Mol, 2010). Since the early 2000s, water pollutants (i.e., ammonia and nitrogen) declined (DRC and OECD, 2017).

[41] BOD is one of the most common measures of organic pollutant material in water. A low BOD is an indicator of good quality water, while a high BOD indicates polluted water. US Department of the Interior. (n.d.) https://www.usgs.gov/special-topics/water-science-school/science/biological-oxygen-demand-bod-and-water
[42] Manufacturing value added (MVA) of an economy is the total estimate of net-output of all resident manufacturing activity units and is obtained by calculating total outputs and subtracting intermediate inputs UNIDO. (2018).
[43] Based on China Statistical Yearbook. 2001, 2007 – 2011
[44] Reached to 41% in 2012, NBS. (2014).

Environmental and green growth indicators showed that SO_2 and NOx emissions peaked in 2006 and 2011 respectively (DRC and OECD, 2017). Over the past three decades, China achieved the decoupling[45] of environmental factors to economic growth levels and reduced energy and carbon reliance more significantly than OECD countries and BRIIS (DRC and OECD, 2017).

The first chapter delves into the evolution of environmental initiatives undertaken by relevant actors and institutions. In spite of progress made in solving some severe environmental problems such as air pollution, by low-carbon development (e.g., increased share of renewables in the energy mix, the creation of greener cities, and encouragement of cleaner industrial production), the country continues to be confronted with environmental degradation and health problems associated with pollution. A significant scholarly work showed that China's environmental challenges were rooted in ineffective local policy implementation related to environmental governance issues. Although civil society has increased its influence by expanding tools (the internet) and techniques (e.g., naming and shaming), evidence suggests that citizens, ENGOs, and media have had limited opportunities for participating in environmental management. After exposing environmental challenges and current practices, we present an interdisciplinary, theoretical framework that examines the implementation of environmental initiatives in the next chapter.

[45] Decoupling is referred to as "relative growth rates of environmental pressure and the economic activity with which it is linked." OECD. (1997).

Chapter 2 Applying an interdisciplinary framework

Chapter 2 presents a theoretical framework grounded in EMT, combined with its shared perspectives concerning strategic and economic thinking on business and the environment. Section 1 introduces EMT as the conceptual framework for analyzing socio-ecological change. The section briefly describes its origin and main ideas, illustrating how EMT explains changes, as well as its applications, criticisms, and merits. Section 2 explores multiple perspectives regarding different aspects of business and the environment covering environmental practice, factors of action, multi-actor change processes, and possible outcomes, as shared by environmental sociologists, business thinkers, economists, and practitioners. Section 3 discusses the application of an interdisciplinary approach, addresses integrative perspectives, presents research questions, hypotheses, variables, analytical schema, and core concepts.

1 EMT as an analytical lens

1.1 Origin and theoretical development

Originating in the early 1980s, ecological modernization has been referred to as a theoretical notion of environmental sociology (Hajer, 1995; Huber, 1991, as cited in Mol and Jänicke, 2009; Spaargaren and Mol, 1992). The notion has been used as a "general theory of environment induced social change" (Spaargaren, 1997: 3; Spaargaren and Mol, 1992), including as a paradigm for environmental politics and policies (Jänicke, 1988, as cited in Spaargaren, 1997; Simonis, 1989a; Weale, 1992; Zimmermann et al., 1990, as cited in Mol and Jänicke, 2009), as a programme put forward by political parties (van Driel, 1994, as cited in Mol, 1995), and with the involvement of environmental movements (Wams et al., 1992, as cited in Mol, 1995).

Murphy (2000) characterized the development of EMT in five dimensions: a theory of social change toward an environmentally sound society (Huber, 1982, as cited in Mol, 2000); economic reconstruction giving rise to environmental improvements (Jänicke, 1989; Jänicke, Mönch, Ranneberg, et al., 1989; Simonis, 1989); a prescription for government programmes; a cultural and political approach based on the analysis of political reactions and discourse (Hajer, 1995, 1996); and the role of social movements, NGOs, and reflexive reorganization of industrial society to solve ecological crisis (Mol, 1995).

1.2 Explanation of social changes

Prior EMT research focused on changes in social practices, environmental governance, and relationships between institutional developments, the environment, production, and consumption (Hajer, 1993, as cited in Mol, 1997; Huber, 1982, as cited in Mol, 2000; Jänicke, Mönch, and Binder, 1993; Mol, 1995, 1997, 2010; Spaargaren and Mol, 1992). Proponents of EMT claimed that environmental problems could be solved within the existing structures (Mol, 1995; Spaargaren, 1997) through a transformation of key institutions (Huber, 1982, as cited in Mol, 2000). To Huber (1991, as cited in Mol and Jänicke, 2009) and Mol (2006), governance styles were modified and modes of intervention shifted, moving from centralized, top-down, and hierarchical to decentralized, flexible, and consensual.

Governments' role in environmental governance was redefined (Bailey, Gouldson, and Newell, 2011; Blühdorn and Welsh 2008; Buttel, 2000b; Mol and Spaargaren, 2000). The state remained central (Buttel, 2000b; Mol and Spaargaren, 2000) and had responsibilities in planning (Sonnenfeld and Rock, 2009), creating networks (Mol and Jänicke, 2009), and favorable conditions (Mol, 1997). Corporations and associations emerged as the new forces carrying socio-ecological changes (Mol, 1995). Economic actors not only played vital roles (Berger, Flynn, Hines, et al., 2001; Gouldson and Murphy, 1997; Huber, 2008a; Mol, 2000; Mol and Sonnenfeld, 2000; Mol and Spaargaren, 2000; Seippel, 2000), but also became agents of change (Huber, 2008a; Welford and Hills, 2003).

Furthermore, EMT rejected the idea of competing interests between the economy and the environment (Gouldson and Murphy, 1997; Mol, 2000; Mol and Sonnenfeld, 2000; Mol and Spaargaren, 2000). On the contrary, ecological modernists advocated a harmony between environmental protection and economic growth (Hajer, 1996; Simonis, 1989a). Ecological problems could be resolved through "super-industrialization" (Spaargaren and Mol, 1992), decoupling of economic growth and resource use (Buttel, 2003). The ecological "switchover" constituted the "ecologization of economy" and the "economization of ecology," referring to the processes involved in making changes in production and consumption, while placing economic value on nature (Spaargaren and Mol, 1992).

The "ecologization of economy" required technological changes and innovations that delivered environmental benefits. According to Huber (2004), "industrial development and modernization should be ecologically readapted by way of state-of-the-art technology itself." Huber's publication[46] provided a theoretical foundation for "the greening of industry" based on S & T (Huber, 2004). Technological changes ranged from the introduction of end-of-pipe (EOP), cleaner production (CP), to preventive technologies, and socio-technological systems (Mol and Jänicke, 2009). Environmental innovation was seen as a necessary condition for long-term industrial growth (Jänicke, 2008), and an indispensable part of the path toward sustainability (Mol and Jänicke, 2009).

The ideas of ecological modernization went beyond compatibility between environmental protection and economic growth (Hajer, 1995; Mol, 2006) to include institutional changes from the emergence of economic mechanisms, self-regulation, and market-based instruments, such as taxes, levies, subsidies, and tradable emissions (Buttel, 2000b; Mol and Spaargaren, 2000; Mol, Spaargaren, and Sonnenfeld, 2013). Such changes enabled the incentivization of environmental improvements (Sonnenfeld and Rock, 2009), and promoted the sharing of responsibility with the private sector (Leroy and van Tatenhove, 2009).

1.3 Applications of EMT

Empirical research started from the "ecological switch-over" in industrialization processes (Huber, 1982, as cited in Mol, 2000) via "modernization of political processes" (Jänicke, Mönch, and Binder, 1993), industrial innovation (Murphy and Gouldson, 2000), and changes in infrastructure and consumption (Spaargaren and van Vlient, 2000). Ecological modernization was applied to analyze environmental policy making, policy implementation and innovation, technology adoption, the role of stakeholders (China

[46] Entitled *Die verlorene Unschuld der Ökologie*

Centre for Modernization research, 2007; Frijins, Phuong, and Mol, 2000; Gille, 2000; Hsiao and Liu, 2002; Lang, 2002; Lee and So, 1999; Rinkevicius, 2000; Studer, Welford, and Hills, 2006; Yang, 2005), technology and practice (Frijins, Kirai, Malombe, et al.,1997; Mol and van Buuren, 2003; Sonnenfeld, 2000), urban institutional capacity building and reform (Evans, 2002; Gille, 2007), and manufacturing industry (Huber, 2008b; Sondergard, Hansen, and Holm, 2004).

Early studies focused on prevention, innovation, and structural change toward sustainable development (Paulus, 1986, as cited in Simonis, 1989). Technological emphasis and innovation process conceptualization evolved from EOP to preventive technologies, such as clean technology (Cramer, 2006, as cited in Spaargaren and Cohen, 2009; Cramer, Schot, and Van den Akker, 1990; Murphy and Gouldson, 2000; Schot, 1992; Sonnenfeld, 2002). Linear and single-actor oriented investigation at the policy level were replaced by the systemic study of interactions at the multi-scalar level. Studies concentrated on inter-firm collaborations (Desrochers, 2004; Heeres, Vermeulen, and De Walle, 2004), supply chain management (van Koppen and Mol, 2002; Zhu, Sarkis, and Lai, 2012), and interactions among the companies embedded in production systems (Ashton, 2008; Seuring, 2004).

Recent work paid attention to multi-level, multi-actor processes and illustrated a broader, social analysis of technological changes (Schot and Geels, 2007). It placed emphasis on proactive strategies that entailed technology induced changes in production (Spaargaren and Cohen, 2009), carbon-neutral energy provision (Verbong and Geels, 2007, as cited in Spaargaren and Cohen, 2009), and technological improvement combined with institutional changes (Tukker, Emmert, Charter, et al., 2008). In addition, the geographic horizons of research have been broadening from western European countries, Northern Europe (Andersen, 1994; Jokinen and Koskinen, 1998), North America (Scanu, 2015), to Central and Eastern Europe (Andersen, 2002; Gille, 2004; Rinkevicius, 2000), South-America (Jepson, 2006; Milanez and Bührs, 2008), East and South-east Asia (Gouldson, Hills, and Welford, 2008; Mol, 2006; Rock, 2009; Sonnenfeld, 2000; Studer, Welford, and Hills., 2006; Yang, 2005), and Africa (Frijins, Phuong, and Mol, 2000; Oelofse, Scott, Oelofse, et al., 2006).

1.4 Criticisms and merits

Ecological modernization advocated deepening modernization (Spaargaren and Mol, 1992) without systemic and structural changes (List, 1993) or alteration of the capitalist mode of production (Buttel, 2000a, 2002; Mol, 1995). Such a proposal was challenged (Beck, 1992), which was on the one hand "too little, too late" (Mol and Spaargaren, 2000) and on the other hand, there was little evidence supporting the assumption that the modernisation led to overall environmental improvement (York and Rosa, 2003). Serious ecological problems persisted (Hannigan, 2006), and improvements suffered from rebound effects (Jänicke, 2008; Polimeni, Mayumi, Alcott, et al., 2008). For instance, aggregate consumption of minerals and raw materials has increased, despite improved eco-efficiency (Bunker, 1996, as cited in Buttel, 2000a).

EMT was criticized for its productivist orientation (Carolan, 2004), and for having reductive, technocratic, corporatist, technological, and optimistic perspectives (Berger, Flynn, Hines, et al., 2001; Buttel, 2000b; Christoff, 1996; Hannigan, 1995; Seippel, 2000; Toke and Strachan, 2006; Yearley, 1994). It risked being unmasked as "an ideology free zone" (Eckersley, 2004, as cited in Hannigan, 2006: 28), which ignored inequality (Buttel, 2000c), equity (Beck, 1992), social justice, power relationships (Gibbs, 2006; Leroy, 1996, as cited in Leroy and van Tatenhove, 2000), ethical issues (Blowers, 1997; Hajer, 1996), emancipatory concerns (Blühdorn, 2000), human agency (Smidt, 1996, as cited in Mol and Spaargaren, 2002), and struggles between interest groups (Blowers, 1997; Leroy and van Tatenhove, 2000).

Moreover, scholars expressed doubt regarding the positive influence of S & T (Beck, 1992), and suggested taking soft technology paths (Bookchin, 1989, as cited in Mol, 1995), ceasing complex technologies, in combination with economic sobriety, self-limitation (Sachs, 1987), and eco-ethics (Vermeersch, 1990, as cited in Mol, 1995). Theorists of EMT stressed that research expanded the conceptualization of technological change from add-on technology to structural change in socio-technological systems (Mol, 1995; Mol and Jänicke, 2009; Mol and Spaargaren, 2000), paid attention to institutional and cultural dynamics (Cohen, 1997; Hajer, 1995; Mol and Sonnenfeld, 2000; Spaargaren and Mol, 1992), and developed a more balanced view regarding the role of the state (Jänicke, Mönch, and Binder, 1993; Weale, 1992).

A lack of postulates and generalizability might have prevented EMT from becoming a dominant theory (Buttel, 2000a). Yet, it differed from past sociological scholarship that focused on environmental degradation. EMT was likely to have lasting influence on environmental sociology and had potential to "temper the pessimism." (Buttel, 2000a). Despite some of its weakness, EMT offered a method for "understanding national environmental policy as embedded in changing international context" (O'Neill, 1998, as cited in Fisher and Freudenburg, 2001), and became an important lens for viewing the changing relationships between the economy and ecology (Desfor and Keil, 2004, as cited in Hannigan, 2006). The next section covers the role of corporations in environmental protection efforts.

2 Shared perspectives on business and the environment

2.1 Corporate environmental practices

Studies in corporate environmental practices were referred to as "corporate or business environmentalism," which included research in management tools, methods, and practices toward making improvements (Bansal and Hoffman, 2012; Wright and Nyberg, 2012). Scholars found that companies were not only the cause but also part of the solutions for ecological problems (Bansal and Hoffman, 2012; Hoffman and Woody, 2008). Businesses took initiatives (Gunther, 2015) and made changes in diverse areas (planning, R&D, marketing, training and motivation of personnel, recycling, life-cycle analysis, environmental management system (EMS), pollution prevention, technology development, and product innovation) (Bansal and Hoffman, 2012; Huber, 2004; Mol, 1995; Wright and Nyberg, 2012). Such findings resonated with the sentiments of Katja Hall, Deputy Director of a British lobbying group:

"Business must be and wants to be part of the solution to tackling our climate change challenges. We need to recognize that green and growth can go hand in hand together, to secure the right deal, and provide the basis for business investment that will drive growth and jobs in a low-carbon economy." […] Global leaders need to "establish the right frameworks that will secure a green economy for future generations," Hall added (Medland, 2014).

Hall's remarks were restated by chief executives from the world's biggest businesses when calling for stricter government policy and ambitious global social and environmental goals (Gittsham, 2015). A coalition for climate action formed by senior corporate executives challenged governments to set strong targets (Alliance of CEO Climate Leaders, 2015). Some executives and entrepreneurs have played a leadership role in environmental protection, while achieving economic growth and ecological rationality (Gunningham, Kagan, and Thoronton, 2003; Jermier, Forbes, Benn, et al., 2006). Both news stories and business research reflected the thinking of proponents of EMT as an application of "ecological rationality," in the product design, performance, and evaluation of industrial production (Mol, 1995), and in the key roles of economic actors in ecological transformation processes (Huber, 1991, as cited in Mol and Jänicke, 2009; Mol, 1995).

2.2 Factors of action

Government interventions could stimulate new and more efficient industries (Blowers, 1997; Huber, 2008a; Jänicke, 2008; Jänicke and Jacob, 2004; Mol and Sonnenfeld, 2000; Weale, 1998). They helped firms develop environmental management practices (Chien and Shih, 2007; Hong, Kwon, and Roh, 2009; Yu and Ramanathan, 2015), and enhanced environmental adaptation capability (Murphy and Gouldson, 2000; Rugman and Verbeke, 1998). Regulation was the most important factor of environmental change (Jänicke, 1997; Jänicke and Weidner, 1995; OECD, 1996), as actors were unwilling to accept their responsibilities unless everyone was subject to legal constraint (Huber, 1991, as cited in Mol and Jänicke, 2009). Environmental standards changed the playfield and made the pursuit of green production more rational (Buttel, 2003). Increasing requirements affected the development of environmentally sound products, production processes, environmental management, and audits (Leroy and van Tatenhove, 2009), while competition reinforced incentives for pro-environmental decision-making and sound management (Buttel, 2003).

Firms were encouraged or pushed to raise their aspirations and moved to higher levels of competitive performance (Porter and van der Linde, 1995a, 1995b). The highest possible standards helped them gain market advantages (Berger, Flynn, Hines, et al., 2001; Huber, 2008a). Specifically, stricter environmental regulation was key to innovation (Ashford, 1993; Ashford, Ayers, and Stone, 1985; Huber, 2008a; Jänicke, 2008; Porter and van der Linde, 1995a, 1995b). Being in "sync with other countries or slightly ahead of them," regulations steered innovation and maximized export potential if they focused on market incentives, industry participation, and outcomes rather than methods (Porter and van der Linde, 1995a, 1995b). There was evidence showing positive links among regulations, R&D expenditures (Jaffe and Palmer, 1997), and environmentally related patents (Arimura, Hibiki, and Johnstone, 2007; Brunnermeier and Cohen, 2003; Johnstone, Hascic, and Popp, 2010).

2.3 Multi-actor change processes

EMT highlighted multi-stakeholder involvement in creating capacity and incentives that lead to changes in the global supply chain (Spaargaren, 1997; Young, 2000). Governments, industry, and ENGOs developed collaborative working relationships to solve ecological problems (Huber, 1991, as cited in Mol and Jänicke, 2009). ENGOs expanded strategy, kept the environment on public and political agendas, and participated in negotiations with economic agents and state representatives (Mol, 1995). Green business networks grew in size and numbers, and green entrepreneurial initiatives, such as the formation of international business green networks[47], were led by MNCs. Such networks[48] and arrangements[49] provided forums (Huber, 2000), which facilitated collaboration[50] among businesses, governments, NGOs, and academia (IISD, 2015).

Eco-innovations stemmed from interactions between the public and private sectors within a network of actors (Jänicke and Weidner, 1995). As a multi-actor process and a multi-

[47] Such as the World Business Council for Sustainable Development's Responsible care initiative for the chemical industry, the European Partners for Environmental Management, the Global Environmental Management Initiative

[48] For example, the European Round Table on Clean Technologies, the Greening of Industry Network

[49] For example, Business for the Environment, the Business & Climate Summit

[50] Such as B4E Summits, Business and Climate Summits

faceted phenomenon, innovation was developed at two levels: the first level involved interactions between firms, users, and producers within networks; the second level included infrastructures, processes, organizational, and institutional frameworks, and social contexts that created scientific knowledge (Kemp, Smith, and Becher, 2000). Governments were perceived as "catalyst", "challenger" (Porter and van der Linde, 1995a, 1995b), and "enabler" (Berger, Flynn, Hines, et al., 2001), who designed instruments, oversaw, and guided the processes that induced innovation (Huber, 2004). Non-state actors such as business associations acted as intermediaries, who not only assumed administrative, regulatory, managerial, and mediating responsibilities (Mol and Sonnenfeld, 2000), but also coordinated policy implementation that contributed toward achieving common environmental objectives (Mol, 1995).

2.4 Possible outcomes

EMT argued the potentials for changes that contribute to achieving environmental improvements. The argument seems consistent with recent trends in industry, and in some societies such as OECD countries. For example, a survey showed that "very few Canadians feel that it is a zero-sum game between the environment and the economy" (Gregg and Anderson, 2017). In addition, economic analysis such as environmental Kuznets curve suggested that pollutant emissions decreased simultaneously to increasing income levels per capita (Grossman and Krueger, 1995). "There's this theory that you have to pick one: economics or environmental performance. That's nonsense […]," said Mark Vachon, the Vice President (VP) of GE (Lacey, 2012). Studies revealed that businesses improved eco-efficiency and reduced emissions and wastes (Bansal and Hoffman, 2012; Huber, 2004; Mol, 1995; Wright and Nyberg, 2012).

Environmental protection has created profitable markets for eco-industry, producers of environmental technologies, and ecological service providers (Hajer, 1995; Mol, 1995). For example, environmentally conscious consumers in west European markets were willing to pay a higher price to facilitate eco-innovative development (Jänicke, 2008). "Certainly, there will be losers among companies and industries - especially, if they do not begin the change of their strategy in time; however, at the same time the majority of the companies can benefit greatly from the new solutions," said Kitty van der Heijden, the Director of World Resources Institute's European office (BCSDH, 2015).

The question of "whether it paid to be green or not" sparked debates in business research (Ambec and Lanoie, 2008; Dixon-Fowler, Slater, Johnson, et al., 2013; Elkington, 1994; Hart and Ahuja, 1996; Maxwell, 1996). Scholars argued for (Clarke, Stavins, Ladd Greeno, et al., 1994; Melnyk, Sroufe, and Calantone, 2003; Pagell, Wu, and Murthy, 2007) or against (Maxwell, 1996; Palmer, Oates, and Portney, 1995; Walley and Whitehead, 1994) a win-win relationship between environmental performance and economic benefit. Several researchers (Schaltegger and Synnestvedt, 2002) took a nuanced position on the relationship. In particular, some environmental practices did not receive compensatory advantage (Hoffman, 1999). The following section presents our research proposition that is directed at analyzing the disciplinary insights into environmental change.

3 Enlarging understandings

3.1 Integration of perspectives

According to Porter (1996), strategy was "about being different." The essence of strategy focused on choosing a "unique and valuable position." Cost leadership, differentiation, and focus were strategies to achieve competitive advantage by creating more buyer value or providing value more efficiently than one's competitors due to the use of labor, capital, and technologies rooted in activities difficult to match (Porter, 1985, 1990). Porter and van der Linde (1995a, 1995b) advanced a perspective that suggested better technology and methods for improving environmental performance and offsetting the costs of the improvement. This perspective, also known as the Porter hypothesis, takes into consideration of environmental improvements as a productivity and competitiveness enhancement, addresses innovation offset, cost saving, competition, and environment in a long-term, activity-based way. Although studies supported improved environmental performance and net cost savings (Esty and Winston, 2006; Hart and Ahuja, 1996; King and Lenox, 2002; Majumdar and Marcus, 2001; Reinhardt, 2000), the Porter hypothesis received criticisms. The most significant criticisms are that such perspective considered relations between regulations and innovations as linear (Parto, 2007), without analyzing technological innovation processes (Ashford and Hall, 2011) or institutional context (Parto, 2007).

Business researchers suggested drawing on environmental sociology (Banerjee, 2012), and expanding decision-making assumptions beyond profit making reasons (Bauer and Derwall, 2012). Ecological modernization accorded well with strategic management thinking, as it took into consideration the economic factors (Buttel, 2000b) contained within economics, environmental management, and business strategy (Mol, 1995). Moreover, EMT shared perspectives with the economic theories of innovation, sociology of science and technology (Perz, 2007, as cited in Spaargaren and Cohen, 2009), policy theories on innovation, social theory on technical change, and technology innovation, as well as diffusion theories (Buttel, 2000b).

Prior research showed that interdisciplinary approach could develop deeper, more comprehensive understandings and a better explanation than one discipline (Boix Mansilla and Duraising, 2007; Newell, 2001; Repko, Navakas, and Fiscella, 2007). Grounded in EMT, our approach is built on business environmentalism and environmental policy theories regarding innovation by integration of these disciplines with common perspectives to better understand issues surrounding corporate environmental action. The interdisciplinary approach conceptualizes strategic environmental practices, analyzes the influence of social, political, and economic systems on implementation processes, and studies two sides of the same implementation coin from the corporate and implementing agencies' perspectives.

Analysis at individual and institutional levels enables us to uncover business activities, identify key actors and their roles, and highlight the reasoning behind decisions made beyond cost-benefit calculations. Moreover, combining individualized and systemic approaches to study environmental innovation allows us to focus on technological opportunity, innovators, and the socioeconomic conditions that shape innovation (Kemp, Smith, and Becher, 2000). EMT is applied to study how societies cope with ecological crisis (Mol, 1995) through the understanding of the social dynamics of environmental reform (Mol, 1995; Spaargaren, 1997; Weale, 1992). We ask "why" and "how" questions to help comprehend the steps initiated by firms (Starik and Marcus, 2000), and assess the pertinence of EMT in explaining social transformation (Mol, 1995).

3.2 Research questions, hypotheses, variables, and analytical schema

1. The research questions are:

Why and how did Chinese industrial firms in the Pearl River Delta respond to environmental challenges?

2. The hypotheses are:

Driven by stricter regulatory requirements, financial interests, and competition, some Chinese industrial firms in the Pearl River Delta implemented environmental practices through multi-actor processes that brought changes and positive outcomes.

⇒ The surveyed firms subject to more stringent environmental requirements, including bigger enterprises, exporters, and pollutant and/or energy intensive companies, were more inclined to implement environmental measures and comply with the requirements.

⇒ The surveyed implementers were more likely to take eco-efficient measures that reduced expenses and environmental impact.

⇒ Those companies competing in eco-friendly markets tended to go beyond compliance and make green products that have been a source of competitive advantage.

3. Variables

- Dependent variable (DV): implementation of environmental practices

Environmental practices are defined as concrete measures taken by a company. The more measures present in business activities, the more advanced the implementation. The introduction of the independent variables, the response to them and the processes can be studied in a relatively short time. But the effects of such actions may take a long period to develop. Each independent variable incorporates various indicators and exerts its influence on the implementation.

- Independent variable (IV1): stricter environmental regulatory requirements at local and national levels

Indicators include higher standards and norms, stiffer penalties, tightened law enforcement, and increased surveillance and monitoring.

- Independent variable (IV2): anticipation of maintaining or improving the bottom line

Indicators are the estimated gains to be earned by reduced costs and/or increased revenue, and profits.

- Independent variable (IV3): anticipation of gaining or sustaining a competitive advantage

Indicators include expected superior margins compared to its competition generated by increased benefits, such as manufacturing products at lower cost, creating new or proprietary technology, positive image, and market share gain.

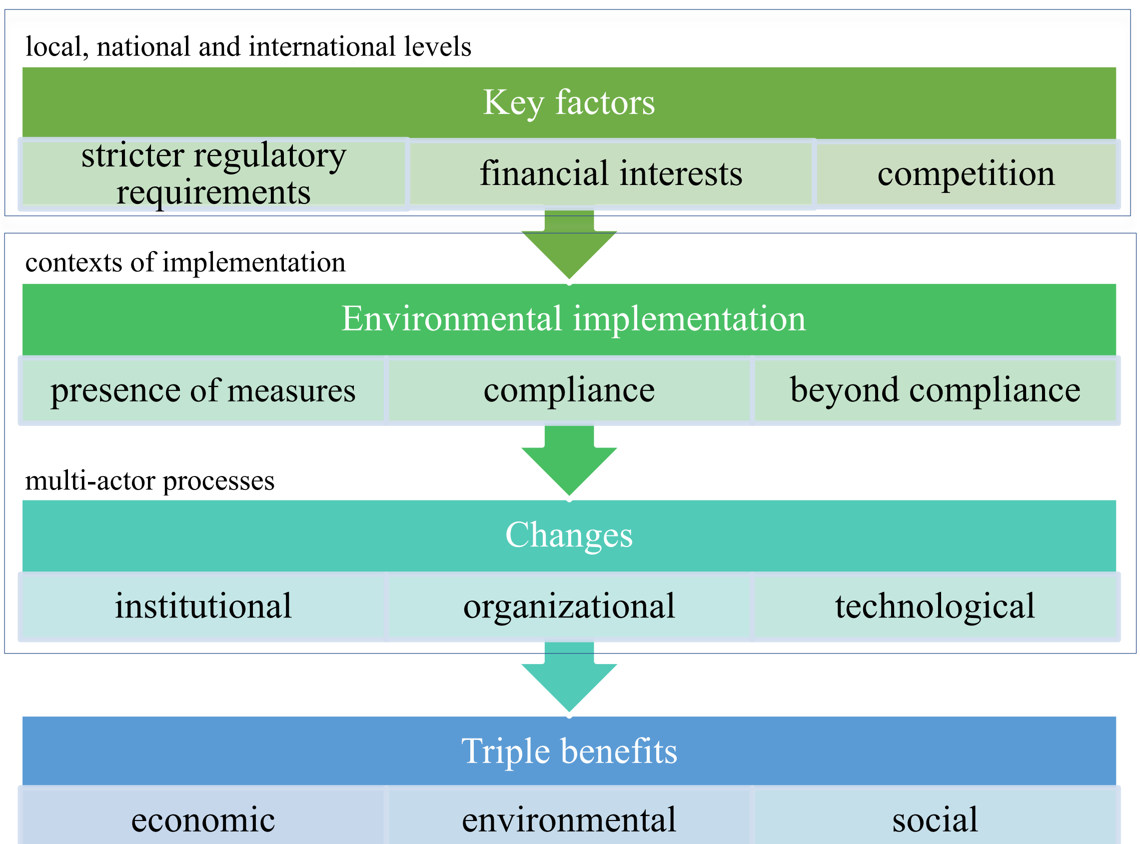
4. Analytical schema

An analytical schema (shown below) includes factors, processes, and outcomes of environmental implementation in firms (Figure 2.1). The schema illustrates the implementation of environmental practices as multi-factor and multi-actor processes that lead to changes in institutions, organizations, and technology, as well as positive outcomes for businesses, the environment, and society.

As an external factor, financial interests include potential business opportunities and anticipated revenues, and this differs from the economic outcome of the real benefit generated from a production process or a product. The multi-actor processes refer to a series of actions taken by firms and key stakeholders that lead to institutional, organizational, and technological changes.

Social benefits are outcomes related to health, working, and living conditions, as well as other positive effects on societies. The rationale for including such outcomes in our analysis is two-fold. First, the impact of industrial production activities on human life and ecosystems is significant, as shown by an empirical study (Hoque, Mohiuddin, and Su, 2018). Second, environmental health issues have become a major concern for Chinese citizens. Therefore, consideration of social benefits is important to find out whether their concerns have been addressed.

Figure 2.1: Analytical schema



3.3 Core concepts

- Porter's value chain

The term "value chain" is used for analyzing competitive advantage through descriptions of business activities. The value chain consists of a set of activities divided into primary activities (inbound logistics, operations, outbound logistics, marketing and sales, and service) and support activities (procurement, human resource management, technological development, and firm infrastructure) (Table 2.1) (Porter, 1985). Value chain activities are distinct and interdependent. The way in which activities are performed determines the performance of another activity and affects costs and profits (Porter, 1985).

Table 2.1: Primary and support activities

Primary activities	
Inbound logistics	Activities related to receiving, storing, and distributing inputs to the product
Operations	Changing inputs into final product
Outbound logistics	Delivering the product to buyers
Marketing and sales	Activities associated with persuading buyers to purchase
Service	Activities related to maintaining the value of the product
Support activities	
Firm infrastructure	General management, planning, finance, accounting, legal, government affairs, and quality management
Human resource management	Activities to recruit, hire, train, motivate, reward, and retain workers
Technology development	Know-how, procedures, and technology embodied in processes
Procurement	Function of purchasing inputs

Source: Porter. (1985)

Porter's "chain" approach allows for identifying the environmental changes made by firms, including choices made through sub-activities related to each primary and support activity, as well as the links between the activities. We use the value chain to uncover the presence of environmental measures, to examine the connections between practices, and to determine their implications. This tool also provides a basis for defining a general-purpose environmental value chain (Figure 4.5) that reveals overall practices, an understanding how they are connected, and for determining the sources of value (possible outcomes).

- The triad-network

Prior EMT studies applied the triad-network approach to analyze the interactions among actors involved in chemical firms (Schot et al., 1990, as cited in Mol, 1995), the retail food sector (Oosterveer, 2007), and industrial ecological initiatives (van Koppen and Mol, 2009). We employ it to identify stakeholders involved in environmental implementation, to provide analysis of the interactions among them, and to understand institutional changes. The approach enables us to study firms in "societal", "economic", and "policy" networks, and to investigate institutional development. The networks are interdependent, and each constitutes a specific perspective, distinct arrangements, and actors. "Policy" networks emphasize industry-government relations from a political-administrative perspective. "Economic" networks focus on interactions through economic rules and resources among actors, whereas "societal" networks concentrate on relations between economic sectors and civil society (Mol, 1995: 64). Environmental changes take place in networks, including redefinition of relations between business and government, environmental liability, and interactions between ENGOs and industries (Mol, 1995).

Furthermore, we apply an inductive approach and construct a network model of environmental implementation based on our empirical data, in order to illustrate initiatives, relevant actors, and participating organizations (Figure 5.1). In Chapter 5, we illustrate the model that highlights the intersections of interconnected networks in development of "new" institutional arrangements. By linking the value chain and triad-network approaches, we broaden the scope of analysis from an organizational point of view to a systemic perspective. This perspective improves our understanding of the interrelationships among environmental practices, institutions, and stakeholders in the context of implementation.

This chapter asks key research questions regarding why and how businesses responded to environmental challenges. The theoretical framework complements firm-level analysis with a meso-level approach, through integration of EMT and the Porter hypothesis. Strategic thinking on business and the environment allows for the conceptualization of environmental practices from corporate perspectives; whereas EMT analyzes the roles of key actors and institutions. Drawing on analysis at individual and institutional levels results in the identification of the conditions, reasons, and driving forces that influence corporate environmental actions in the social, political, and economic systems through which firms operate. Furthermore, thinking across disciplines enables us to develop methods to understand the complexity of environmental implementation processes. In Chapter 3, we describe the application of the perspectives and the development of a mixed-methods design.

Chapter 3 Conducting a mixed-methods study

Chapter 3 discusses various aspects of our empirical research and covers several methods of data collection and analysis. Section 1 provides background information on the PRD and explains the reasons why the region was chosen for field research. Section 2 describes the methods employed, including participant observation, survey, and semi-structured interviews to collect information. The mixed-methods research design allows for an increase in the quality of the information thanks to inferences and the triangulation of the data. Section 3 discusses the data analysis process, from merging data to construction of a typology through case study and comparison. The section points out that the advantages of fieldwork outweigh any disadvantages, as the work contributes to overcoming a lack of data and gaining insight into the factors.

1. PRD: testbed for social research

1.1. Theoretical concerns

The theoretical framework guided us to conduct field research to understand how industrial firms responded to environmental challenges and the reasons for action or inaction. We chose the PRD, known as the "world's factory" (OECD, 2010), due to its advanced industrial development and more open sociopolitical context. Studying this region increased our chances of identifying recent social practices in a newly industrializing country and assessing the explanatory adequacy of EMT in industrial societies (Mol, 1995; Mol and Spaargaren, 2000).

Located in Guangdong province on the southern coast, the PRD region is comprised of nine cities (Figure 3.1) located in the "inner delta" (Dongguan, Foshan, Guangzhou, Shenzhen, Zhongshan, and Zhuhai) and the "outer delta" (Jiangmen, Zhaoqing, and Huizhou). Although the region accounts for less than one-quarter of provincial territory[51], it is reported to account for more than 80% of provincial industrial production (W. Li, 2017).

[51] 11,000 square kilometers

Figure 3.1: Pearl River Delta

Source: Baidu.com. (n.d.)

A cradle of the Chinese revolution that terminated imperial rule, Guangdong has been a vibrant and liberal place. According to the National Bureau of Statistics (NBS), Guangdong became China's most populous province with over 100 million inhabitants (NBS, 2011). The density (2,372 habitants per square km^2 of habitable area[52]) was among the highest in the country (OECD, 2010). Having the highest GDP since 1979 (China Daily, 2018), the "dragon's head" maintained double-digit growth rates for three decades (Bloomberg, 2015; Li, 2012). Its economy's size[53] was equivalent to that of South Korea[54](Xin, 2018). Guangdong contributed 12% of national economic output (China Daily, 2018), one-eighth of fiscal revenue (W. Li, 2017), and over a quarter of foreign trade[55] (OECD, 2010).

Economic liberalism, matched by greater political openness, was named the "Guangdong model." Trade unions began collective bargaining despite being disliked by some local officials (The Economist, 2011). NGOs were given greater leeway and their registration involved fewer bureaucratic processes (Jacobs, 2012; The Economist, 2011). Opinion polls were used to assess "public happiness", which was a criterion for judging local

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[52] Based on administrative sub-units in 2007, OECD. (2010).
[53] GDP reached 8.99 trillion yuan ($1.42 trillion) in 2017. Xin. (2018).
[54] Whose economy ranked 11th globally in 2016, according to the World Bank.
[55] 28% of China's total exports, OECD. (2010).

leaders' suitability for promotion. Inhabitants could vote in local elections [56] (The Economist, 2011). Faced with an insurrection, Wang Yang, the former provincial Communist Party Chief, allowed villagers to elect new leaders[57]. "People here are proud of Guangdong's progressive streak," said Li Ding, a researcher at the Guangdong Academy of Social Sciences. "We are also happy to be far away from Beijing and the least controlled by it." (Jacobs, 2012).

1.2. Laboratory for changes

The PRD attracted people, foreign investment, and technology thanks to its geographic, regulatory, and fiscal advantages. International orientation and business experiences integrating with the land, labour, and skills of businesses created on the Mainland (Ai, 2012; Clifford, 2015). Its foreign direct investment (FDI) accounted for seven-eighths of Guangdong's overall result and a quarter of China's total (OECD, 2010). Over 30 million people moved in and out of towns, based on work opportunities. The inflow of migrant workers fuelled population growth[58] that was more than three times China's average. For example, 94% of residents were reported as migrant workers in a township of Dongguan (Ai, 2012). The most densely populated areas (parts of Guangzhou and Shenzhen) reached 40,000 inhabitants/km^2 habitable area[59] (OECD, 2010). "[…] The most serious problems of modern society are presented by the great cities and must be studied as they are encountered in concrete form in large populations," according to the American Journal of Sociology (Iresearchnet.com, n.d.). Inspired by the Chicago School of Urban Sociology, we considered the PRD as a social laboratory.

The PRD has been a fertile ground for reforms. In four decades, it has transformed what was mostly agricultural land into the "world's biggest urban area,"[60] according to the World Bank (Hilaire and Van Mead, 2016; The Economist, 2017). The region has seen

[56] In September 2011, Dadun (Guangzhou's satellite town) held a ballot for seats in the local legislature. In a village near Foshan, residents elected an independent candidate who did not have party backing. The Economist. (2011).
[57] Wang called off the riot police, tossed out corrupt local party officials, and allowed villagers to elect new leaders in the fishing village of Wukan. Jacobs. (2012).
[58] 2.8% between 1990 and 2008. Ai. (2012).
[59] Based on geographical information system (GIS) data in 2007. OECD. (2010).
[60] In terms of population and geographical size.

some of the most rapid urban expansion in human history (Hilaire and Van Mead, 2016). However, "the PRD has paid a great price in term of environment and resources for the economic miracles it has created," stated Pan Yue, the former Vice Minister of the MEP (Juhre, 2012). It became one of the most polluted coastal zones (Le Monde, 2013). Ninety-five percent of the Pearl River estuary was contaminated and declared "dead" by the United Nations Environment Programme (UNEP) in 2006 (Juhre, 2012). Many tributaries fell into the most polluted categories[61]. More than half of the region's rainfall was acid rain[62] (Greenpeace, 2009, as cited in Juhre, 2012). Sixty percent of wetland and mangrove forests were destroyed (Juhre, 2012). Marine wildlife was threatened, and 91 fish species were endangered (Maplecroft, 2006, as cited in Juhre, 2012).

The PRD accounted for 85 – 99% of air emission pollutants and contributed the largest share of GHG emissions in 2010 (GBS database as cited in OECD, 2010). Its low-lying areas were vulnerable to global warming due to rising sea levels. Guangzhou ranked among the world's cities most vulnerable to climate change risk[63] and it was in the top four cities with the highest population exposure[64] (Nicholls, Hanson, Herweijer, et al., 2008). Shenzhen was the 10th on the list (World Bank, 2013). Guangzhou, Foshan, and Zhuhai were at serious risk to flooding. Rising waters had already reduced train traffic and turned subway stations into virtual swimming holes (Kimmelman, 2017). In addition, the PRD faced an ageing population, increasing labour costs, and competition from the Yangtze River Delta, Vietnam, Indonesia, Bangladesh, and India (Bloomberg, 2015; OECD, 2010; The Economist, 2017). Some plants delocalized and manufacturing jobs declined (The Economist, 2016). The net inflow of migrants into Guangdong fell by almost half in the last decade (The Economist, 2017).

[61] China's system of environmental standards classifies water quality with a series of benchmarks, with "Class 1" the cleanest and "Class 5" the dirtiest. MEE. (2016). https://cjjg.mee.gov.cn/zsyd/hjkp/201906/t20190629_714982.html
[62] From January to June in 2008
[63] Measured as a percentage of GDP and the overall cost of damage
[64] Under the 2070 scenario, Nicholls, Hanson, Herweijer, et al. (2008).

1.3. Remake of the "Guangdong model"

The province was in for a bumpy ride, according to Andy Xie, former chief Asian-Pacific economist at Morgan Stanley (The Economist, 2017). To Zhu Xiaodan, the former provincial Governor, Guangdong's economy was in "the new normal at an earlier stage" of slower, more sustainable growth. "It's quite possible Guangdong will find a new growth model for China that relies more on innovation," commented Zhao Yang, Chief Economist at Nomura Holdings (Bloomberg, 2015). Home to the nation's largest telecommunications equipment company and a leading conglomerate specializing in various internet services[65], the province made inroads in R&D (Bloomberg, 2015). The advanced manufacturing industry's added value accounted for nearly half of the industrial value increases reported (Xie, Chen, and Zhong, 2017). The number[66] of hi-tech enterprises in Guangdong held the top position when ranked nationally (Zhu, Jiang, Zheng, et al., 2017).

Under the motto "open and innovative," the PRD has been at the forefront of creating a new development model. Selected as a pilot region for further reforms and an experimental zone for "scientific development," it was expected to become the main innovation centre in the Asia-Pacific region (OECD, 2010). Its R&D expenditure (2.8% of GDP) was equal to that of Germany and the USA[67] in 2016 (The Economist, 2017). Over 95% of Guangdong's hi-tech enterprises were established in the PRD[68] (Zhu, Jiang, Zheng, et al., 2017). Between 2015 – 2016, the number of such firms increased by 80% over the previous period's level[69]. Over the last five years, applications for intellectual property rights and patents increased (Zhu, Jiang, Zheng, et al., 2017). The PRD switched from being the world's workshop to being one of the most innovative clusters (The Economist, 2017).

Efforts were made to improve air quality and reduce GHGs. The first installment of zero-emission fuel cell buses hit the roads in Foshan[70] and the number of buses deployed (300) marked the largest in the country (Ballard, 2016). Starting with nothing, in two decades,

[65] Include social platforms, mobile payment, entertainment, and artificial intelligence
[66] 19, 857, based on official statistics in 2016
[67] Israel (4,4%), Finland (3,9%), Korea(3,7%), Sweden (3,4%), Japan (3,3%), Germany, and the USA (2,8%), The Economist. (2017).
[68] 18,880
[69] 8,320 is equivalent to 22 per day, Zhu, Jiang, Zheng, et al. (2017).
[70] An initial 12 buses in passenger service, Ballard. (2016).

Guangzhou developed a metro system[71] of nearly 400 kilometres (Guangzhou Metro, 2018), as did Shenzhen[72] (Shenzhen Metro, n.d.). Guangzhou's Bus Rapid Transit (GBRT) system, the first BRT integrating with bike lanes, bike sharing, and connecting to a metro system[73], had the world's highest number of passenger boardings and the highest bus frequency (McConville, 2010). GBRT won an international sustainable transportation prize[74] awarded by the Institute for Transportation and Development Policy (ITDP)[75]. According to Karl Fjellstrom, ITDP's Vice Director, "GBRT is revolutionizing perceptions of bus-based travel. The system is already having a significant demonstration impact in China, but we expect an eventual international impact as well"[76] (McConville, 2010).

1.4. Progress made

Both the environment and economy benefited from GBRT, which allowed people to move around the city regardless of an individual's income level. Jessica Morris, Programme director for ITDP, stated that it "goes against the idea of a burgeoning Chinese metropolis that's only serving the economy" (National Geographic, 2011). In fact, the value of the income disparity index[77] decreased in Guangdong[78] (Li, 2012). Previously, the highest per capita income in the PRD was four times more than the least developed regions (OECD, 2010). The region fulfilled its tasks associated with air pollution prevention and control one year ahead of schedule, serving as a reference for other regions (Jiang, Hong, Zheng, et al,, 2015). Guangdong became the second most energy efficient province (OECD, 2010) and ranked first in terms of green economic efficiency between 1996 and 2010[79] (Qian and Liu, 2013). The PRD, once the top GHG-emitting region (GBS database as cited in OECD,

[71] Opened the first metro line in 1997, Guangzhou Metro. (2018).
[72] A system covering 265 kilometres
[73] Provision of bike parking in the BRT station design, direct connections from the BRT platform to three metro stations, and sheer passenger volume.
[74] The 2011 Sustainable Transport Award
[75] An international nonprofit that works with cities on projects to reduce GHGs and improve the quality of urban life
[76] With 22-24m of road width in the middle of the road, given to BRT at all of the main stations, McConville. (2010).
[77] Income level of the wealthiest 20% divided by that of the poorest 20%, Li. (2012).
[78] From 6.08 to 5.33 between 2011 and 2012, Ibid.
[79] Based on various models of Slacks-based Measure, the non-radial, and the non-oriented model are used for estimating efficiency, while the Tobit model is used for examination of the determinants of efficiency Qian and Liu. (2013).

2010), became a first mover in initiating carbon trading pilots (Shen, 2013) and a leader in industry upgrading[80] (Lu, Wu, Zhou, et al., 2013) and restructuring (The Economist, 2017).

Several business leaders vowed to "reinvent Guangdong's manufacturing miracle" (Wu, 2010). Some Chinese firms operating in the PRD made changes in environmental practices and developed green products such as electric automobiles (Lin, 2010), energy efficient air conditioners (Zhou and He, 2010), household gas appliances (Dayoo, 2010a), electrical household appliances (Guo, 2010), kitchen and bath products, and resource and energy saving decoration products (Dayoo, 2010b). Industries, the second highest energy consumer[81], tried to implement the "decoupling" of production from resource consumption and pollution emission[82] (Su, Zheng, and Wang, 2013) and continued to increase its demand[83] (Jiang, Hong, Zheng, et al., 2015). Having presented social, political and economic changes in the PRD over the past decades, we address methodology in the next section to help understand empirical phenomena.

2. Using multiple sampling strategies

2.1. Collection of information

Data collection began with a systematic review of publicly available material, such as sustainability reports, scientific reports, and publications produced by companies, ENGOs, and international organisations. Alternative sources, from industry associations, regulatory agencies, and certified environmental consultants, provided a wide range of environmental information (spills, cleanup, expenditures, emissions, wastes, toxic chemical releases, compliance records, staffing data, policies, records of penalties and awards). Although

[80] Measured by the decoupling elasticity value, the ratio of the change of resource consumption or pollution emission to the gross industrial output value, as the evaluation index of industrial transformation and upgrading. The value is composed of a number of indicators: industrial water consumption, fuel consumption, COD, and sulfur dioxide emission. Lu, Wu, Zhou, et al. (2013).
[81] Accounts for 38% of fuel consumption, Su, Zheng, and Wang. (2013).
[82] Based on the Industry Green Development Performance Index: the bigger the value, the worst the performance. The Index is weighted by a grade approach, including resource consumption (energy, water, land) and pollutant emissions (effluent, air pollutants, solid waste). Ibid.
[83] Almost 30% 2012 – 2017, Jiang, Hong, Zheng, et al. (2015).

business organisations conducted activities visible to outsiders, access to these organisations required considerable effort due to their lack of openness to public inspection. Without authorisation, outsiders could not enter a factory setting. Participant observation was indispensable for us access to firms, which was also necessary (Jorgensen, 1989), and useful for social scientists (Coulon, 2020).

In 2013, we initiated a preliminary study as an exchange scholar at Sun Yat-sen University. Early fieldwork concentrated on gathering information and gaining access. We contacted researchers who shared similar interests, submitted a formal request to the hosting department, spread the word about the project, and checked out sources of information. Simultaneously, we initiated unsolicited calls to talk with prospective respondents and relied on our social networks when contacting potential respondents who were harder-to-find. Professor Zhou Yongzhang responded to our request, provided guidance, and invited us to join his research team. Thanks to Dr. Zhou's involvement, we were introduced to his associates, some of whom became our key collaborators and informants.

2.2. Engagement in participant observation

We conducted participant observation at two organisations over six months. Beginning as a "complete" observer, we acted as a participant-as-observer by revealing our identity and the goals of our research. We assumed different tasks, as provided by the settings. We shared office space with members of an association promoting low-carbon technologies; and this location facilitated the establishment of relationships. It was natural to help, for example, with small tasks such as collecting the mail and answering the phone. Furthermore, the association needed people involved in the delivery of services. We were asked to contribute our expertise (translation) and we assisted in specific activities (training, editing, administrative work). We strived to spend time observing, while participating in these activities. Meeting our key collaborators, Messrs. Zhang Jiepei and Qiu Guanping, owners of an environmental consulting firm, was a game-changing moment for our field research. Their corporate connections enabled us to gain access to industrial firms. Getting along with these collaborators created excellent opportunities for meaningful exchanges. Gradually, we were invited to participate in professional activities as an observer and, occasionally, as an active team member.

Earning trust and confidence was necessary for cooperation. Participating in joint activities created common experiences. Shared experiences and self-revelation resulted in a level of confidence that was conductive to building friendships with our collaborators. The longer we were in the settings, the more people took our existence for granted. Gaining acceptance, without calling attention to ourselves, was fundamental for developing relationships. Circumstances and situations influenced trust and cooperation and impacted the quality of our data. Our collaborators became advocates for our research, from within the various settings. They gave advice on data collection, asked their clients to participate in our study, and used the high perceived value of the doctoral degree (seen as a prestige) to persuade entrepreneurs and local authorities to accept us.

It was equally important that people valued our subject matter. Most respondents did not have anything to gain from our research. The most common questions asked were "What is in this project for us?" and "Why should we participate in this research?" We addressed these questions and communicated our position as a researcher attempting to understand "what is" instead of "what ought to be" (Ringer, 1997). Weber (1948) suggested focusing on describing and reporting practices, instead of evaluating the correctness of being in a situation of non-conformity. Our Weberian position contributed to our ability to initiate relationships with people, as individuals were more comfortable with sharing their experiences in this context. The more a corporation's management supported our project, the more likely the organisation would participate in our study and grant permission for obtaining environmental information.

The stakeholders involved in our study, especially our key collaborators and information sources, hinted that they would appreciate communication of our findings in a language they could understand. Therefore, we decided to author our work in English, as a way to acknowledge our common interests. To solidify cooperation and trust by engaging in the exchange of information and friendship, we expressed our gratitude, showed sincere interest and respect for others' work, and offered small thank-you gifts to participants. In the process of mutual sharing, we rendered some assistance to our collaborators as they were able to expand their business horizons through their participation. When our information approaching a state of saturation, we left the field. We had the intention of conducting further field research on related matters and maintaining periodic contact with our key collaborators following our departure.

Participant observation allowed us to take advantage of whatever opportunities were presented (Whyte, 1984, as cited in Jorgensen, 1989). For example, we could assist in efforts to promote environmental initiatives and programmes that were inaccessible for nonparticipants. Such activities were related to the implementation of environmental measures, including "promotion tours" (site visits to plants) for cleaner production/energy conservation, training workshops on carbon trading, negotiations between multiple stakeholders, meetings, conferences, and on-site environmental audits. We collected information on ancillary topics, acquired knowledge in policy implementation, and observed actors who displayed the details behind behaviours. Asking questions about the discussions and probing for attitudes grounded in dynamic contexts helped us to understand perspectives. More importantly, we sustained access by engaging in interactions with stakeholders from corporations, regulatory agencies, local governments, and environmental service providers. By easing and enriching communications, the rapport established with potential respondents resulted in insights into tacit and explicit aspects of organisations. Assuming the participant-as-observer role helped us to find resourceful and reliable information sources, enhanced our access to information, and allowed us to gain different levels of stakeholder insights.

2.3. Design and implementation of a survey

Based on literature review and suggestions from our thesis supervisor and collaborators, we elaborated questionnaires and semi-structured interviews covering the same themes, in order to produce findings across methods. The multiple-choice questionnaire (in Chinese) was comprised of ten open-ended questions, grouped in five sections (Appendix A[84]). The first section contained background questions about the firm being surveyed, and the second

[84] Chinese and French versions along with brief instructions in English

part addressed the factors influencing corporate environmental policy. The third and the fourth sections were devoted to environmental management and environmental performance. The last part involved perspectives regarding the environment. Broader questions requiring more time and thought were placed in the last part to avoid reducing a respondent's motivation to cooperate. The questionnaire was pilot tested with a small sample of respondents after consulting with two key stakeholders. Based on the feedback received, we uncovered new issues, modified sub-questions, and made changes in wording, format, layout, and question order.

We used nonprobability sampling to maximize variations and identify commonalities and differences in environmental practices. Samples were collected with the "target traits." At the beginning, snowball sampling helped increase the number of participants. By focusing on "sectors" (one of the four selection criteria of size, ownership, sector, and markets served), we obtained the widest possible range of firms. The sample was as big as necessary for theoretical saturation with a range of firms. Potential respondents were selected according to their responsibilities. Staff who served environmental functions or decision makers, including executives and managers, were invited to complete the questionnaire. Nearly 40% of the respondents were lower-level management, one third were in top management, 15% in middle management, and employee level participants comprised 15%. More than 40% of respondents were between 31 – 45 years old, followed by 35% over 45 years old, and 25% were 30 years old and younger. The same proportion of the respondent population (33%) had 2 – 5, 6 – 10, or over 10 years' experience in industry and/or working for the company[85].

The survey was conducted through questionnaires and personal interviews. When possible, we approached people and provided copies of questionnaires before and after workshops and training sessions. The questionnaires were administered via email or in-person, for companies that had previously agreed to participate in the study. At the end of the third week, we sent a reminder email to those who had not responded. The second follow-up consisted of another reminder email and a replacement questionnaire (after six weeks). A

[85] Optional section entitled "information on respondents"

telephone reminder was our final follow-up step. For very busy respondents, we proposed collecting questionnaires at their convenience. In addition, our collaborators helped us distribute, collect, scan, and return electronic copies of the completed questionnaires.

From 2013 to 2014, a total of 86 valid responses were obtained from 103 firms located in eight cities. Responses from service sectors and invalid data, such as missing answers to the firm's background information, were removed. Instances of non-response data were mostly due to the respondents' wariness toward providing financial and technological information. Only a handful of firms did not return the questionnaire. Our presence during the pre-questionnaire timeframe established ties with people and encouraged a high response rate. It was more difficult to refuse our in-person requests. Face-to-face communication increased the quantity and improved the quality of the responses. By contrast, our cold calling efforts only resulted in the participation of one firm. In addition, being in Guangzhou when cadmium[86] was detected in nearly half of the rice sold in the city provided us with a unique occasion for discussions about industrial production and its environmental impacts.

Firms in emerging sectors from the most economically developed cities were more willing to participate in the study. Large companies in the electro-mechanical and special equipment sector had the highest level of representation, in terms of the total number of respondents. This phenomenon is understandable, given that these sectors were more environmentally friendly or produced less negative ecological impacts. Such representation was not unique, as prior research found that firms implementing environmental actions were more likely to answer questionnaires than others (Ytterhus, 2006). Another study showed that manufacturers of machinery were the most represented in questionnaire responsiveness (Henriques and Sadorsky, 2004). Since our study focused on environmental actions, the overrepresentation of an environmentally active or less polluting sector would not hinder the understanding of corporate initiatives.

[86] Coming from contaminated soil, prolonged exposure to cadmium may harm the liver, kidneys, lungs, and the respiratory system and can lead to cancer, Delang. (2017).

Our sources of empirical data included questionnaires, cleaner production audit reports (32), environmental impact assessment (EIA) reports (2), environmental evaluation reports (2), self-examination reports of energy consumption (2), and circular economy initiative documents (1), supplemented by documentation such as official sources, awards, and photos. A few of the companies' reported activities occurred over five years prior to our study. Most audited environmental reports covered performance evaluations between 2012 and 2016, as measured by relevant indicators. The audited firms were studied at two points in time, in order to include the degree of verifiable changes the companies underwent. Information obtained varied in quantity and quality. A majority of the respondents provided accurate responses and some of them included exhaustive documentation. In cases of doubt, the questionnaire respondents consulted with their colleagues. Inaccurate or erroneous answers to factual questions were detected from respondents who did not know the information requested or were reluctant to share it.

2.4. Conducting semi-structured interviews

Having established rapport with people, we conducted more interviews during the later stage of fieldwork. Personal and business contacts helped us identify potential interviewees. The scheduled interviews resembled structured questionnaires and consisted of a standard set of open-ended questions (Appendix B[87]). Each interview lasted between 30 and 90 minutes. We conducted a dozen semi-structured interviews with entrepreneurs[88], executives[89], midlevel managers[90], environmental service consultants, and one director of an association for low carbon technologies. None of them found it necessary to receive our interview themes in advance. The interviewees talked about what they felt were the most important issues.

The particular themes we explored varied from policy issues to benchmarking, included decision-making about costs and benefits, and touched on environmental perceptions. Interviewees provided information on the initiatives, resources devoted to them, and

[87] Bilingual text (in Chinese and French)
[88] Companies sampled #22, 45, 69
[89] Companies sampled #14, 19, 47
[90] Companies sampled #15, 20, 21, 46, 49

incidents which had occurred related to environmental challenges. Some interviewees went beyond describing environmental practices and provided detailed explanations of their roles, work activities, career history, and attitudes toward the environment. Face-to-face interviews helped us gain strengths in inductive-contextual research by providing supplementary information for unpacking the arrangements of corporations and understanding the dynamics among governmental, corporate, and organizational actors. Most importantly, these interviews contained not just answers, but also the reasons for the answers. The last section of this chapter illustrates our data processing and analysis.

3. Elaboration on data analysis

3.1. Merging data

During the course of observations, we wrote fieldnotes and kept details in a logbook for a comprehensive chronological record. Notes of site visits were organized by times and particular observations. Only one interviewee allowed us to audiotape the interview and we fully transcribed this interview. Notes taken during interviews were recorded along with photographs, remarks, comments, concerns, and descriptions of events and processes observed. Content analysis was used to identify patterns of environmental implementation in firms based on the reports submitted (39). The purpose was to interpret and understand the processes the companies undertook, as well as uncovering the subsequent results. We categorized words according to four themes (environmental consideration, strategy, concrete action, and actual outcome). The themes of consideration and strategy captured ideas, beliefs, values, vision, attitudes, strategic stances, orientations, and choices. The themes of action and outcome were task-related and focused on measures taken and performance.

A hand-coding process was used to conduct qualitative analysis. Qualitative data was transformed into quantitative datasets by integrating all of the data into the creation of new consolidated variables (Appendix C), allowing the correlation and comparison of the data (Onwuegbuzie and Teddlie, 2003, as cited in Creswell and Plano Clark, 2011). The consolidated database was sorted into subgroups for comparison purposes. Responses were translated into numbers, and data was digitized. We analyzed the conversion of qualitative data type with the quantitative database together. Given that the sample size was not large, we employed statistical analysis with a two-way table and cross-tabulation involving two variables and the correlation association between dependent and independent variables.

Quantitative and qualitative methods were equally important. The size of qualitative data was much smaller than that of quantitative data. However, size differential was not a problem, as the intent of data gathering was complementary for both data sets. Qualitative analysis emphasized firms' perspectives and elucidated their contexts, capturing an overall picture of environmental implementation through the provision of background information. The quantitative method benefited from qualitative preliminary input and a follow-up extension which reinforced the significance of the interactions and improved the quality of analysis. Quantitative investigation, checked against qualitative data, determined the accuracy of the study. Comparing data revealed similarities and highlighted inconsistencies, whereas combining data revealed the trends of environmental practices.

3.2. Case study, comparison, and typology

Case study was used to determine the pertinence of ecological modernization (Frijins, Phuong, and Mol, 2000; Mol, 1995; Sonnenfeld, 2000) and to test the Porter hypothesis (Jaffe and Palmer, 1996). A purposive sample allowed for the inclusion of variety and examining cases. Information and data provided by the case companies regarding manufacturing processes, products, site locations, and financial data helped us to understand the processes and mechanisms that led to changes. Investigating the inner workings of these firms enhanced our ability to gain the best possible explanations. A subset of more successful implementers was used to identify the key ways to improve performance. Comparing firms who performed well to others enabled us to pinpoint the specific factors that affected the different performance of the companies.

Comparisons made around thematic lines, such as common characteristics, shed light on commonalities and dissimilarities between adopters and contributed to our work regarding the sorting of the facts into types. This process was similar to the analytic induction advanced by Znaniecki (1935, as cited in Jorgensen, 1989). We organized classes according to the characteristics of a given category of facts. An analysis grid containing activities taken and topics covered was employed to elaborate a typology of enterprises. Using the inductive approach, comparative and sectoral analysis of the firms with above average performance enabled us to uncover patterns of environmental implementation and understand how environmental issues were articulated and acted on in situations where firms competed.

3.3. Advantages and disadvantages

Where members of corporations were more receptive to quantitative proposals than the qualitative component, the combined approach smoothed our access to research sites in similar ways to prior studies (Faules, 1982; Smith, 1986, as cited in Bryman, 1992). The survey permitted the collection of a uniform set of information with quantitative measurements. The use of questionnaires resulted in increased reach to more firms, without having to be physically present. Gaining access to the insider's world, seeing and hearing from the people involved in environmental implementation, contributed to ensuring the highest possible data accuracy. We discovered how things operated in their settings. Physical evidence and realities of the informants and respondents improved our understanding of the quantitative portion of the study. Observations generated logical linkages and created a coherent sense of the processes. Conducting a survey by interview in a setting in which the researcher acted as a participant-as-observer was beneficial, as indicated by prior studies (Marshall, 1981, as cited in Bryman, 1992). When things did not go smoothly, such as a lack of cooperation, we were able to seek help from our collaborators.

Survey research and structured interviews enabled us to obtain data from people who were knowledgeable about the matters involved. In addition, casual conversations and informal interviews resulted in the gathering of obvious information from numerous stakeholders (government officials, technological experts, environmental consultants, equipment suppliers, carbon market managers and executives, journalists, and university researchers).

Having different types of information sources enabled us to corroborate findings, enhanced inter-observer reliability, and allowed us to assess the consistency of the results. For instance, disconfirming evidence was checked against information gleaned from external reviewers and site visits. Corporate responses were verified with records filed in local environmental bureaus, documents certified by third and fourth parties, as well as news reports. Secondary data analysis not only triangulated toward better understanding, but also increased the sample size and its representativeness.

Mixed-methods bridged meso-level and micro-level study, addressed social and individual corporate behaviours, and added breadth and depth to analyses. Quantitative research allowed us to establish relationships among variables. Qualitative analysis reflected social interactions and investigated implementation processes. Using content analysis enabled us to uncover interactions between relevant stakeholders and the trends and emerging environmental technologies, to compare actions across firms and industries, and to construct a typology of enterprises. Juxtaposing quantitative and qualitative analysis elucidated how changes were implemented in practices within socioeconomic structures. Findings resulting from different methods informed and enriched one another. For example, employing ethnographic case methods to triangulate results improved our understanding of corporate environmental practices (Howard-Grenville, 2006). Integrating qualitative and quantitative analysis allowed us to peek at corporate environmental decision-making and the social forces that shaped organizational behaviours related to the environment.

The study was expensive; it took months to gain access to corporations and years to complete. It was dependent on the participation of businesses. Even a well-known international funding organization had previously failed to carry out this kind of project in the region. A "little student," like our project represented, would not be able to accomplish such an "ambitious project," one scholar cautioned. Similar difficulties were encountered by other researchers (Stalley, 2010). Typical problems included a lack of interest and an unwillingness to participate without anticipated benefits. Reciprocity, social skill, intellectual persistence, and a commitment to the topic allowed us to meet people who not only communicated their knowledge, but also helped us to establish a network of relationships.

Although we attempted to hold the number of companies in each "target criterion" constant as the sample size grew, in the end it was overrepresented by firms with better performance. Also, self-reported information was not free from self-perception and self-selection bias. However, there were more advantages than disadvantages. Nationally, aggregate data had suggested that industries improved environmental performance. Individual-level data was not previously available publicly to help understand how industrial firms dealt with environmental issues. Our study resolved these gaps in data and threw light onto factors that influenced environmental implementation and its outcomes.

The PRD region was selected as a social laboratory for studying the implementation of environmental initiatives by the business sector. Having positioned ourselves as a participant-as-observer who made attempts to understand environmental practices on the factory floor, we explain the research process and the methodology, suggesting that mixed-methods research was the most suitable approach for providing answers to our questions. This chapter elucidates how methods were applied to conduct data collection and analysis through descriptions and reporting in empirical research. The next chapter begins the presentation of our data and the analysis of our core findings at the firm level.

Chapter 4 Heterogeneous environmental responses

Chapters 4 through 6 present our data analysis and findings. Section 1 of this chapter portrays the firm characteristics, including size, ownership structure, and source of investment. It describes the corporate headquarters and locations, illustrates their served markets, and the types of industries sampled, in terms of growth and environmental impacts. Section 2 identifies environmental measures using the value chain method and analyzes linkages between implementation occurrences, related to four activities (operations, technology development, firm infrastructure, and human resource management). Section 3 illustrates the patterns prevailing in responses and pinpoints divergences, convergences, and interconnections between activities by focusing on environmental management and attitudes toward the environment. Section 4 identifies the primary reasons for the surveyed firms' adoption of environmental actions: stricter regulations and enforcement, strategic management decisions, and competitive positioning.

1. Company portrait

   1.1. Firm-specific characteristics

   - Size of company

Size diversity within the industrial population can be measured in terms of annual turnover and number of employees, according to the NBS (Table 4.1).

Table 4.1: Business size

Indicators	Large	Medium	Small	Micro
Number of employees (X)	X≥1,000	300≤X<1,000	20≤X<300	X<20
Turnover (Y) (ten thousand yuans)	Y≥4000	2000≤Y<4000	300≤Y<2000	Y<300

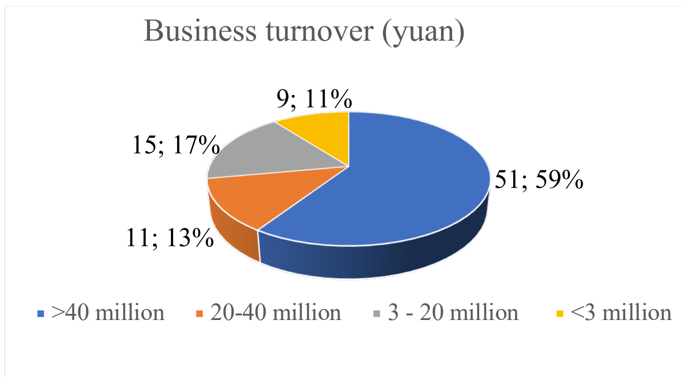
Source: NBS of People's Republic of China, 2011

We used the rate of annual turnover, as defined by the NBS, except for one company that omitted to indicate its revenue. Nearly 60% of the sampled companies (51) were large enterprises (LEs), and 13% of the participants (11) were medium size enterprises (MEs).

Two dozen organizations were small enterprises (SEs) and micro- enterprises (IEs) (Figure 4.1).

In Guangdong, the proportion of large firms in the economy has been increasing. In 2017, the total aggregate revenue of the 500 largest enterprises increased by over 13%, as compared to 2016 (Nanfang Daily, 2017a). Eleven companies headquartered in the PRD[91] ranked on the Fortune 500.

Figure 4.1: Sampled company size by turnover



Large size, as measured by the number of employees, may not correlate with higher revenue (for example, labor-intensive sectors will differ from technology sectors). In fact, only 16% of the surveyed firms (14) would be classified as a large enterprise based on number of employees. Moreover, many workers in the PRD region had been replaced by robots (Che and Meng, 2017), and temporary workers (Harney, 2016). Our study used the criterion of overall turnover, as it was more appropriate than total number of employees for measuring a firm's impact on environmental innovation and investment.

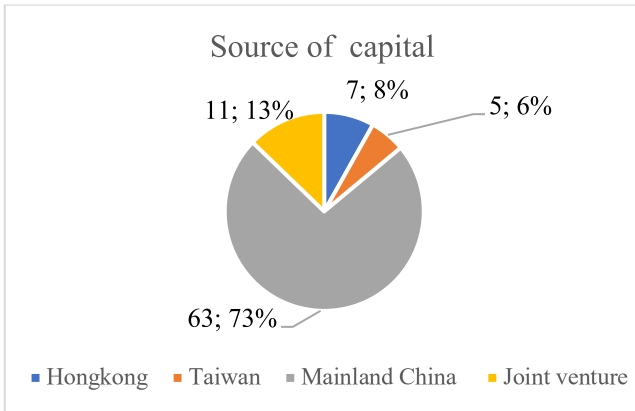
- Ownership and source of investment

Twelve state-owned enterprises (SOEs) accounted for 20% of the sampled firms and 100% of the mainland Chinese capital (63). Eleven firms were joint ventures (JVs), and 12

[91] Six in Shenzhen, three in Guangzhou, and two in Foshan, Nanfang Daily. (2017a)

companies represented investment from Hong Kong and Taiwan (Figure 4.2). Twelve firms were listed on a stock exchange.

Figure 4.2: Source of capital



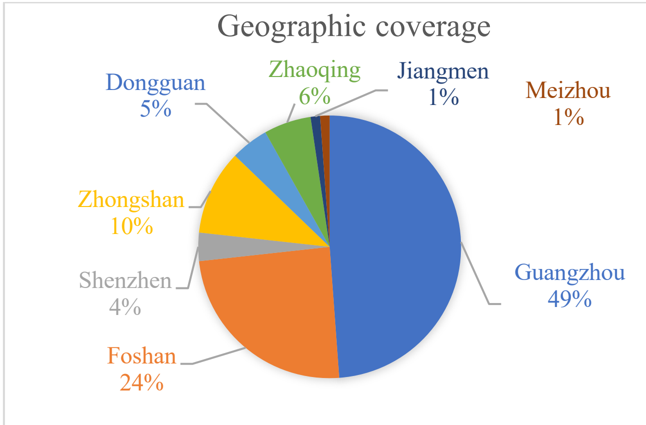
From 1978 to the late 1990s, the proportion of SOEs decreased from 100% of industrial GDP to less than 20% in the PRD region (Enright, Scott, and Chang, 2005). The share in industrial output was below a third in 2005 (DRC and OECD, 2017). More recently, only four from over one hundred of the largest SOEs were located in the PRD (The Economist, 2017). By contrast, private enterprises increased ten-fold, compared to 2002[92] (HKTDC, 2016). For example, 70% of the enterprises based in Foshan were privately owned (HKTDC, 2018).

1.2. Corporate headquarters and locations

Over 80% of the surveyed firms were in economically dynamic cities (Guangzhou, Foshan, Shenzhen, and Dongguan). More than 70% of them were headquartered in the largest cosmopolitan Guang-Fo region, including Guangzhou (41), Foshan (22), Zhongshan (9), Zhaoqing (5), Dongguan (4), Shenzhen (3), and Jiangmen (1). One energy intensive company was headquartered in Meizhou, a region where the firm has relocated pollutant and/or energy intensive industries away from the PRD (Figure 4.3).

[92] In Guangdong, 2.48 million in 2015, up from 258,620 in 2002, HKTDC. (2016).

Figure 4.3: Geographic coverage



Half of the sampled facilities were located in industrial parks, which constituted part of the industrial zones[93]. Such zones accounted for nearly 50% of China's GDP in the 12th FYP (Liu, 2018). The rest of the facilities were in urban industrial areas (15), downtown (11), high-tech development zones (8), and other areas (9).

1.3. Served markets

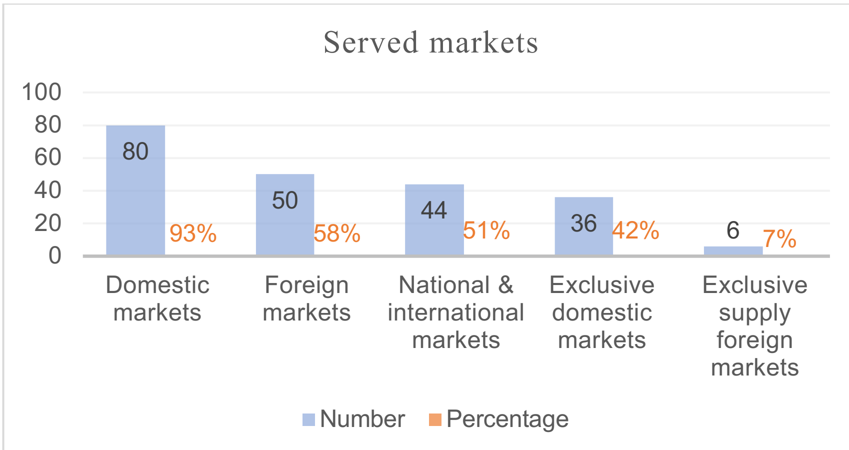
For grouping, we used the market terms Chinese, domestic, and national interchangeably, in addition to the separate export-focused grouping identified as foreign and international markets. Ninety-three percent of the surveyed companies sold their products in domestic markets (80) and 58% were exporters (50). Fifty-one percent of the firms served both national and international markets (44). Thirty-six firms exclusively served domestic markets (42%) and six enterprises only supplied foreign markets (7%) (Figure 4.4).

European countries were the top export destinations (served by 30 enterprises), followed by non-Japanese Asian markets (29), American and Canadian markets (28), and the Japanese market (16). Each of the following regions and continents had nine firms serving the geographic area identified: Australia and New Zealand, Africa, and Latin America.

[93] Industrial zones were established in 1979, including industrial parks, the Economic and Technological Development Zone, the High-tech Industrial Development Zone, the Border Economic Cooperation Zone, the Free Trade Zone, and the Duty-Free Zone. ProLogis. (2008). "China's Special Economic Zones and National Industrial Parks—Door Openers to Economic Reform." ProLogis Research Bulletin (Spring).

Thirteen firms were supplied MNCs. Twelve companies were original equipment manufacturers (OEM)[94] and nine exported using their own brands.

Figure 4.4: Served markets



1.4. Types of sectors

The sample included more than 15 industries. We assigned a code number to each sector (Table 4.2). Four industries (electro-mechanical and special equipment, textiles and clothing, information technology and electronics, and chemical industry) accounted for almost half of the participating firms (in bold).

Table 4.2: Sectoral distribution

Code#	Industry Sector	Number	Percentage
1	**Electro-mechanical and special equipment**	**14**	**16%**
2	Automobile industry	5	6%
3	**Textiles and clothing**	**10**	**12%**
4	Food and beverage	4	5%
5	Construction materials	5	6%
6	Pulp and paper	2	2%
7	Pharmaceutical industry	2	2%
8	**Information technology and electronics**	**9**	**10%**
9	Petrochemistry	2	2%
10	Printing industry	4	5%
11	**Chemical industry**	**9**	**10%**
12	Electroplating industry	6	7%

[94] OEM makes products for foreign companies or manufactures a part and subsystem for these firms，BOI, OEM Businesses and the Foreign Business Licenses (“FBL”), Asian Legal and Tax Strategies Ltd. (2015).

13	Other light industries	6	7%
	Footwear Industry	2	
	Manufacturer of cleaning products & equipment	1	
	Manufacturer of doors and windows	1	
	Piano manufacturer	1	
	Conglomerate	1	
14	Plastics	4	5%
15	Metallurgy, tools and hardware manufacturer	4	5%
	Total	**86**	**100%**

The sample included all key industries of Guangdong's economy including "traditional" sectors (textiles and clothing, food and beverage, construction materials), sectors with "potential" (pulp and paper, pharmaceutical industry, automobile industry), and "emerging" sectors (electro-mechanical and special equipment, information technology and electronics, petrochemistry) (Xing, 2010). The sample contained more growing sectors, as measured by gross industrial output (2000 – 2007), than non-growth sectors. Special equipment manufacturing, machinery, and chemicals figured in the top three industries for growth, whereas textiles and clothing, pharmaceuticals, food/beverage, and papermaking declined during the same period[95] (OECD, 2010).

In terms of environmental impact, the sampled sectors contained the "most polluting and/or energy intensive" industries (chemical industry, pulp and paper, textiles and clothing, petrochemistry, cement industry), industries producing "significant environmental impacts" (electroplating industry, automobile industry, food and beverage, information technology and electronics), and "less polluting" industries (electro-mechanical and special equipment), according to the classifications of the MEP (MEP, 2010).

The pollutant/energy intensive sectors consumed significant amount of energy and/or emitted large volumes of emission/effluent/waste. Some of these sectors (petrochemical, chemical, building material, paper, and textiles) figured among the nine industries accounting for one third of gross energy consumption, and nearly half of industrial energy consumption (NDRC, 2006). Other sectors, mostly with higher technological content such

[95] Based on Guangdong Bureau Statistics, 2000 – 2007

as manufacturing of communication and electronic equipment, displayed the opposite pattern.

We categorized the surveyed industries as pollutant/energy intensive sectors (28), sectors targeted by cleaner production assessment (CPA) (24), and other sectors (34). The sector/environmental impact breakdown is shown below (Table 4.3).

Table 4.3: Sector – environmental impact breakdown

Sectors (code#)	Number
Pollutant/energy intensive sectors	Subtotal: 28
3	10
5	5
6	2
9	2
11	9
Sectors targeted by CPA	Subtotal: 24
12	6
8	9
2	5
4	4
Other sectors	Subtotal: 34
7	2
1	14
10	4
13	6
14	4
15	4
Total	86

The next section presents the environmental measures undertaken using the value chain model.

2. Environmental measures and the value chain

2.1. Operations

The top three measures implemented in operations were energy and resource conservation (60), reduction of atmospheric emissions, effluent, and solid waste (56), and production process improvement, technological innovation, raw material substitution, or product design (49). The rest of the measures were the reduction of cooling needs through natural cover (using trees/shrubs/plants to lower surface/air/roof temperatures) (40), control/containment/elimination of noise (40), use of clean/renewable energy or energy combination systems (34), production management improvement (34), regular maintenance of depollution equipment, equipment replacement and renewal (34), and other measures such as circular economy solutions and integrated environmental consideration in product life cycle from design to disposal[96].

The measures listed above figure among the cleaner production (CP) practices classified by the United Nation Industrial Development Organization (UNIDO). The sampled firms implemented all types of CP practices, except generating useful by-products in operations. They deployed good housekeeping (e.g., enhanced maintenance management, paperless offices[97], reusing packaging materials, recycling metal barrels, collecting spillage, installing steam traps and sensors) and initiated technological changes. The type of practices with their applications are illustrated below (Table 4.4).

Table 4.4: CP practices – type and application

Type	Application and example
Good housekeeping	Maintenance and operating practices: prevent/eliminate leakage and spill through instruction, maintenance, and inspection
Input material change	Substitution input materials: use less toxic or renewable raw and ancillary materials

[96] Questions (Q) 6, 6a
[97] Company sampled #P9

Better process control	Modify procedure, instruction, and process record-keeping to improve efficiency, generate less waste and pollutant
Equipment modification	Replace boiler, equipment
Product reformulation/modification	Manufacture water-based paint
Technology modification	Multiple rinsing systems (electroplating industry) and energy efficient equipment
Production of useful by-products	Application not found
On-site recovery and reuse	Reuse solvent, waste materials, recover heat, resource recovery from wastewater

2.2. Technology development

Some sampled companies applied both corrective and preventive approaches. One approach, end-of-pipe (EOP) technology, reduced discharge to legal levels prior to release into the environment; another monitored resource consumption and reduced pollutant, wastewater, and solid waste. For example, wastewater treatment was used in combination with aerobic microorganisms to recover resources for non-potable reuse. Environmentally sound technologies (EST), including pollution abatement technology (PAT) and cleaner technology (CT), have been used to reduce pollutant discharge at the end of production processes, eliminating, minimizing, or controlling waste. PATs collect, separate, or neutralize pollutants, and CTs analyze the sources of waste (OECD, 1995b). The surveyed firms deployed CTs on their own (through energy efficient engines and generators) or in tandem with modified industry processes arising from re-engineered production process lines utilizing pressurized nozzle points, processing cement at lower temperatures along with clinker substitution, and reusing coal ash as an additive. CTs were also applied beyond shop floor operations to light, cool, and heat buildings.

Furthermore, the sampled firms introduced modified technology and developed intellectual property products, including water-based, heavy metal free, organic screen-printing inks, paints and pigments, eco-cotton yarn, eco-wood plastic composite, energy efficient electrical and mechanical equipment (lighting, power cable, current transformer, escalator, parking systems), heat pump systems, eco-friendly blended fuel, and denim washing with lasers. Fundamental change required environmental innovation, which was referred to as eco-innovation. In the 1990s, the notion of eco-innovation was introduced to define innovations that reduce negative environmental impacts (Fussler and James, 1996). Most scholars defined eco-innovation by the resultant environmental effects and/or the intentions of innovators (Triguero, Moreno-Mondéjar, Davia, 2013). According to Kemp and Pearson (2007), eco-innovation is:

"The production, assimilation or exploitation of product, production process, service or management or business method that is novel to the organization (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resource use (including energy use) compared to relevant alternative."

We used Kemp and Pearson's definition, providing empirical criteria, setting forth processes, and classifying solutions to environmental problems in industrial production. In addition, it covers "innovation object" (product, process, service, management, and method), "level" (novel to the firm), "phase" (life cycle considered for material flow reduction), "environmental aspect" (reducing negative impact), and input and output factors relevant to resource consumption (Schiederig, Tietzer, and Herstatt, 2012).

The adoption of environmental technologies and eco-innovation involved capital investment and R&D spending. The percentages of environmental investment relative to total value of project investment (38) ranged from under 5% to over 20%. Those relative to revenue (10) were between 1 – 20%, whereas R&D spending relative to revenue (45) ranged from less than 1% to greater than 10%, as displayed below (Table 4.5).

The spending was comparable to the rest of the High and New Technology Enterprise (HNTEs) at between 2.53 – 10% per annum, respectively[98]. For example, one sampled facility paid CNY¥45,000 to build a wastewater treatment installation, which accounted

[98] According to internal and audit CPA reports

for 30% of the total value of its project investment. Another plant injected 1M yuans, representing 2% of the total value of investment[99].

Table 4.5: R&D and environmental spending				
percentage	R&D relative to revenue	percentage	environmental spending relative to	
	number		Revenue number	project investment number
<1	8	1<3	3	N/A
1<3	9	3<5	4	N/A
3<5	21	<5	N/A	18
5-10	5	5≤10	2	8
>10	2	10<20	1	7
N/A	N/A	>20	N/A	5
Total	**45**		**10**	**38**

CTs seemed to be less expensive than EOPs. For instance, the spending on CT simple options ("low-cost") by the sampled firms ranged from ¥3,000 to over ¥70,000, whereas complex options ("middle/high-cost") amounted to between ¥13,000 and over ¥33M. Compared with EOPs, CTs not only had lower costs, but also enjoyed favourable rates of return and shorter payback periods according to a surveyed firm[100]. Such findings supported those of prior research (Luken and Rompaey, 2007; OECD, 1995b, 2001). The next section continues examining the actions taken in firm infrastructure.

2.3. Firm infrastructure

Nearly half of the surveyed firms developed written environmental policies (42), and 30% stipulated some guidelines (26). Twenty-one percent of the firms did not have a policy or guideline (18)[101]. More than 80% of the firms had fixed objectives regarding compliance (57). Next were sales and marketing (i.e., product differentiation, product image enhancement, maintaining market share, and boosting competitiveness) (47), cost and efficiency (45), risk management (23), and other objectives (2). Forty percent of the

[99] Ibid.
[100] Company sampled #46, internal CPA report
[101] Q5

companies indicated specific targets (34). The targets included conservation and reduction of energy and resources (29), pollution control and prevention (27), carbon emission reduction (9), and other targets (1) (Table 4.6).

The companies with written policies were significantly more likely to set objectives and targets. They accounted for more than two-thirds of the goal setting for all issues except for risk management. These firms were more inclined to conserve and reduce energy and resources, as well as controlling and preventing pollution than those without policies. Only a fraction of the surveyed firms targeted reducing carbon emission, and this result was in line with a survey that found very few firms implemented a climate strategy (Willman, 2008).

Table 4.6: Environmental policies, objectives and targets

Objectives and targets	Written policies	Some guidelines	Without policy/ guideline	Total
Objective	Number			
Compliance	38	18	1	57
Sales & marketing issues	33	13	1	47
Cost reduction & efficiency	32	13	0	45
Risk management	15	8	0	23
Others	2	0	0	2
Target	Number			
Energy & resource conservation & reduction	25	3	1	29
Pollutant control & prevention	24	2	1	27
Carbon emission reduction	7	2	0	9
Others	1	0	0	1

Nearly 80% of the participating firms (60) designated a person with explicit environmental responsibilities, either senior managers or middle managers (93%). Few enterprises allocated the responsibilities to members of their board of directors (1) or their lower-level management and employees (3). Nine firms did not have staff designated as having responsibility for environmental issues. Over half of the companies established hierarchical and functional responsibilities systems (49)[102]. Almost half of the companies monitored environmental practices (40). A minority of the surveyed companies compiled

[102] Q8a-c

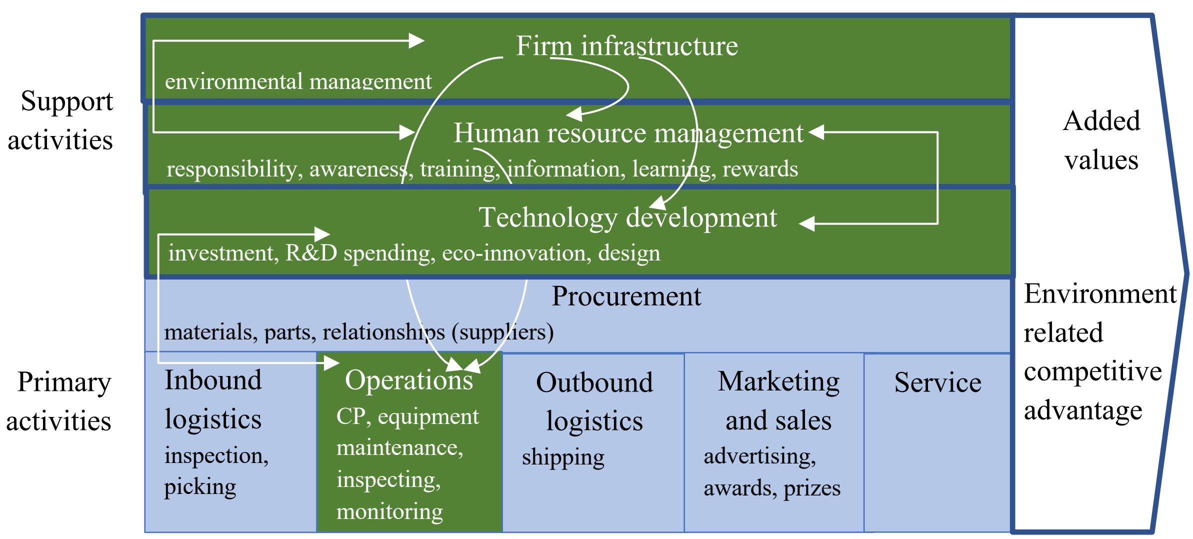
files, collected environmental information and statistics (38), conducted environmental audits (21), and corrected non-conformities (15).

Almost half of the firms offered promotion, education, and training programmes related to environmental protection (39). Over 40% established schemes of rewards and penalties with environmental criteria (35). The proportion with established, written environmental policy was lower than that of Canadian facilities (Henriques and Sadorsky, 2004); but the number with rewards and penalties tied to environmental criteria were higher. The last part of this section shows the environmental activities outlined above in a generic value chain in order to view the links between activities.

2.4. Linkages among activities

Environmental measures were mainly implemented in firm infrastructure, operations, technology development, and human resources management (in a darker shade on Figure 4.5). Few actions were found in the rest of the business activities (procurement, inbound and outbound logistics, marketing and sales, and service).

Figure 4.5: Environmental value chain



Note. Adapted from Porter. (1985)

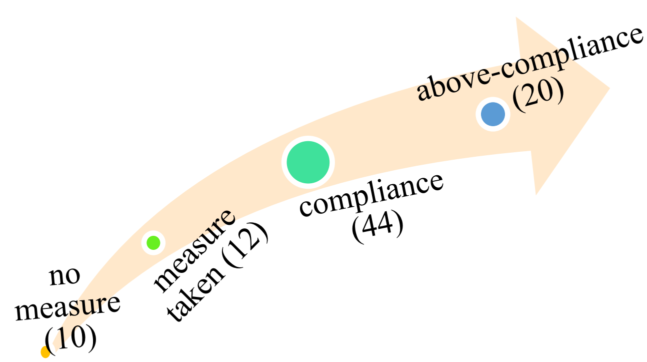
There were numerous linkages among activities, with the most significant links represented by arrow lines on the value chain. Firm infrastructure strongly influenced activities throughout the environmental chain. More than 95% of the surveyed firms with hierarchical and functional responsibility systems had written policies (75%) or guidelines (20%). Over two-thirds of the firms had designated staff stipulated written policies (40). All firms, except for two, had schemes of rewards and penalties established with accompanying written policies (29) or guidelines (4). Operations, technological development, and human resource management were closely related. They brought about changes in processes from training, design, fabrication, maintenance, inspecting, and monitoring that contributed to added values such as cleaner product, improved reliability, and environmental features. Environmental R & D were directly involved in product innovation activities. Procurement was related to both product quality and product form, while marketing was the least likely to contribute to innovation. The next section furthers our analysis to identify patterns in environmental responses.

3. Patterns of environmental responses

3.1. Divergences, convergences, and interconnected activities

Environmental responses ranged from having no measures in place to over-compliance, as shown in a continuum (Figure 4.6). In total, 76 companies undertook at least one environmental measure.

Figure 4.6: Continuum of responses



Three schemes of environmental implementation were educed from the data[103] (Figure 4.7).

Figure 4.7: Schemes of environmental implementation

Scheme 1

Written policies (42) ⇒ Plans/strategies
- Compliance (22)
- Above-compliance (20)

Scheme 2

Some guidelines (26)
- → Plans/strategies
  - Compliance (20)
  - With measure (2)
  - No measure (1)
- → No plan/strategy
  - With measure (1*)
  - No measure (2*)

Scheme 3

Without policy/guideline (18)
- → Plans/strategies
  - Compliance (2)
  - With measure (5)
- → No plan/strategy
  - With measure (4*)
  - No measure (7*)

Amounts in parentheses indicate numbers of enterprise
(*) means corrections made according to verifiable sources

Occurrence or absence of the measures allowed us to uncover the interconnections between activities (Table 4.7). With a few exceptions (highlighted in tri colours), identical combinations between policies/guidelines and plans/strategies were associated with similar

[103] Q5, 6 & 6a

types of implementation. For instance, the lack of policies/guidelines and plans/strategies tended to be associated with non-implementation, whereas written policies, plans, and strategies were most likely to be linked with compliant and over-compliant measures. However, the presence or absence of policy/guideline and plan/strategy did not automatically lead to implementation or non-implementation. Table cells highlighted (the last row) show the convergences in implementation, implying the existence of standardized practices.

Table 4.7: Interlinked measures

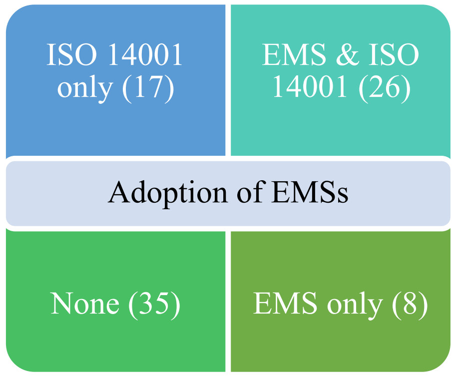
Type of implementation	Written Policies	Some guidelines	No policy guideline	Plans/strategies	
				Without	With
Absence	N/A	√	N/A		√
		N/A	√	√	N/A
		√	N/A	√	N/A
Presence	N/A	N/A	√	N/A	√
		N/A	√	√	N/A
		√	N/A		√
		√	N/A	√	N/A
Compliance	N/A	√	N/A		√
		N/A	√	√	N/A
Above-compliance	√	N/A			√

√: presence of measure

3.2. Environmental management

Thirty-four sampled companies established an in-house environmental management system (EMS) and 43 firms were ISO 14001 certified. In-house EMS systems vary in scope and sophistication, whereas ISO 14001 was defined by the International Standards Organization (ISO) (ISO, 2004, 2012; Welch, Mori, and Aoyagi-Usui, 2002). Twenty-six firms adopted both systems. Thirty-five companies did not implement any system (Figure 4.8).

Figure 4.8: Adoption of EMSs



All certified companies, except for two, had stipulated policies/guidelines. Compared with non-adopters, certified adopters took more measures to reduce negative environmental impacts, maintained depollution equipment regularly, and improved production management. Proportionally, more ISO 14001 adopters filed information, conducted environmental audits, offered education and training programmes, established reward schemes, and corrected non-conformities. Most certified firms had designated staff for environmental protection, whereas a majority of the sampled companies without a designated person were non-adopters. The surveyed ISO 14001 adopters implemented the majority of compliant and over-compliant measures, which supports previous findings that indicated certified firms tended to comply and over-comply (Ferrón, Vílchez, and Darnall, 2016; Potoski and Prakash, 2005b).

Most certified firms surveyed shared similar practices, from defining environmental objectives and targets and planning implementation processes, to adopting control measures, checking against commitments, and reporting results. On the contrary, only four non-certified companies set objectives. Two-thirds kept records related to environmental information[104], including legal obligations, training records, and evaluations. A majority of the certified companies applied standardized procedures for registers of environmental aspects, objectives and targets, training, document control, auditing, and other requirements. Regularities found in planning, implementation, and operations among these firms were in

[104] Q8a, Q9a

line with those found in previous research (Bansal and Bogner, 2002; Neumayer and Perkins, 2004).

3.3. Environmental attitudes

The sampled EMS or ISO 14001 adopters provided us with more accurate and detailed self-assessments than those without environmental policies. Most respondents answered factual questions, but few expressed their opinions on environmental issues[105]. Some refrained from commenting, while others felt the industries were being unfairly judged by public opinion. "No matter what we do, we are condemned [by citizens]," said one entrepreneur. A number of executives and owners we met were uncomfortable or reluctant to talk about environmental protection. According to an owner, the uneasiness may arise from a lack of environmental knowledge and consciousness. Indeed, senior management personnel with more environmental consciousness tended to state their environmental opinions in our study.

Top managers showed different attitudes toward corporate environmental action[106], which can be described as overtly hostile, resistant, uninterested, hesitant, and engaged. A few surveyed entrepreneurs were resistant or uninterested, and the rest of them were between hesitant and engaged. Only a couple of entrepreneurs were overtly hostile. The more top management was engaged, the more likely the surveyed companies had implemented advanced measures such as participation in environmental pilot projects. On the contrary, the more management was resistant or overtly hostile, the less likely the companies were to have taken initiative. In addition, the sampled companies with a designated person who was responsible for environmental protection were more likely to take compliant or over-compliant actions.

A hostile attitude fell short of protecting the environment, which was exemplified by the owner of a large, family-own company[107]. The delocalized facility was still operating with equipment purchased by the founder in the late 1970s[108]. The entrepreneur, who threatened to move the business out of the region, had decided to spend years meeting environmental

[105] Q10
[106] Based on field notes
[107] Company sampled #6, based on a conversation off-record during an on-site visit
[108] Based on information provided by an external expert working in cleaner production.

requirements. According to this owner, increasingly stringent regulations would cause the disappearance of industrial activities in the PRD, just like had already occurred in neighboring countries and regions. Such a position was diametrically opposed to that of several engaged executives who thought that stricter regulatory requirements were favourable for an equitable marketplace. They were willing to tackle environmental issues with coordinated government policies[109]. As a matter of fact, environmental regulations and government policies were identified by the respondents as a key factor [110] driving environmental decision-making and implementation. The last section explains the reasons why the surveyed firms implemented environmental measures.

4. Reasons for actions

4.1. Stricter regulations and enforcement

The top three reasons for implementing environmental measures, as cited by the respondents, were regulations/goals of government policies (68), return on investment (ROI)/implementation cost/cost saving/efficiency (57), and strategy/risk avoidance/image and reputation (52). The rest of the reasons included top management decisions (44), corporate social responsibility (CSR) (31), customer requirements (18), technology support (9), human resources (HR) (3), public pressures (3), and other reasons (2). According to the OECD's Environmental Policy Stringency (EPS) proxy indicator, China's environmental policy has become more stringent. This policy converged with OECD standards after 2010 (OECD, 2016b). The country established environmental courts and regional, environmental supervision centres (Wang and Yan, 2011; Xinhua News Agency, 2013). The revised Criminal Law (2011) held those with polluting behaviours criminally liable. Moreover, the Civil Procedure Law (2012) stipulated a legal foundation for public interest lawsuits (Brettell, 2013). According to news reports (Chen, 2015; GDDJ.Chinanews.com, 2014; Liu, 2003; Sun, 2015), law enforcement at national and local levels had been strengthened, thanks to the creation of a central inspectorate and local environmental police forces. Moreover, the use

[109] Companies sampled #14, 46
[110] Q1

of technologies (e.g., drones and online monitor systems) have enhanced inspection and evaluation.

Companies that failed to meet legal obligations were exposed to suspension of permits (i.e., pollution-emission), delocalization, and partial closure. According to some owners with plants located inside and outside the province, Guangdong imposed stricter requirements than other provincial jurisdictions. Enforcement officials acted in accordance with environmental laws more frequently than their counterparts (Yee, 2012). Guangzhou, the provincial capital, was associated with stringent regulations and strong enforcement (Stalley, 2010), and rejected 3,200 projects that failed to meet environmental requirements (Gao, 2011). Other municipal administrations such as one district in Foshan (Nanzhuang) closed a number of polluting facilities (City of Foshan, 2007). In addition, specific circumstances, such as hosting the Asian Games in 2010, served to tighten measures. Over 70 firms were subject to a temporary emissions reduction requirement. More than 140 enterprises were inspected before the games' opening and closing ceremonies, and ten chemical firms were ordered to temporarily suspend their activities before and during the games (Mou, 2010).

The 11th and 12th FYP specified binding targets[111] related to industrial pollution. Pollutant intensive industries were subject to numerous standards such as point source pollution control (i.e., chemical and heavy metal industries), wastewater prevention and treatment improvement guidelines, and wastewater concentration standards with load-based discharge criteria (i.e., pulp and paper). There have been deadlines imposed to phase out obsolete technologies and production processes, according to industry specific catalogs. In Guangdong, cement facilities using heavily polluted burners with an annual production of less than 20,000 tons were shut down as of 1998. The minimum production requirements were subsequently raised[112]. Nearly 58 million tons of cement production was eliminated (Xie, 2011). Hundreds of cement manufacturers were closed, including those in Dongguan (48) (Gdzxb.gov.cn, 2005) and Guangzhou (90) (Gao, 2011).

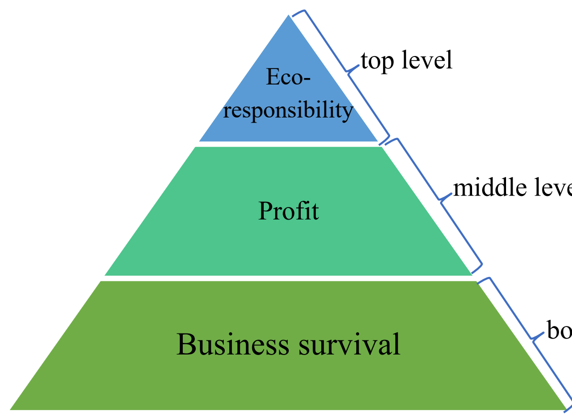
[111] Energy consumption reduction per unit of GDP (11th and 12th FYPs: 16% and 20%), CO_2 (12th FYP: 17%), COD (11th and 12th FYPs: 8% and 10%), SO_2 (11th and 12th FYPs: 8% and 10%), ammonium nitrogen (12th FYP: 10%), and NOx (12th FYP: 10%)

[112] From 60,000 tons in 2004 and 88,000 tons in 2005, Xie. (2011).

4.2. Strategic management decisions

Confronting stricter environmental requirements, the surveyed firms made different choices. Corporate environmental efforts were driven by business survival, profit, and ecological responsibility. There is a hierarchy of drivers (Figure 4.9) which had implications when forming strategic orientations and choices, as well as the means taken to act on them.

Figure 4.9: Hierarchy of drivers



Business survival depended on compliance for most surveyed facilities. There were numerous possible negative consequences for non-compliance, including increased control and inspections, monetary penalties, production disruption due to power supply cut offs, suspended export permits, suspension of participation in trade fairs[113], banned registration for new production licenses, revocation of emission permits or business registration, suspension of business activities, and closure. Moreover, collaborations between the environmental protection bureau (EPB) and China People's Bank in Foshan, by uploading corporate environmental enforcement and compliance histories to the bank's credit database, enabled the bank to halt loan application nationwide in cases of environmental violation (City of Foshan, 2007). A few surveyed entrepreneurs chose an exit strategy and decided to outsource production or delocalize activities to less industrialized regions. Others considered implementing compliance-only or beyond-compliance initiatives, as they could no longer maintain polluting operations in the name of creating jobs and economic growth.

[113] Circular on enhancing environmental monitoring over export enterprises, Ministry of Finance (2007, 2008).

Profit was derived from reducing cost and increasing revenue. A study found that material and energy costs accounted for 40 – 65% of total production costs (UNIDO, 2008). A majority of the surveyed firms engaged in energy and/or resource conservation (70%) and anti-pollution related activities (emissions/wastewater/waste) (65%). They adopted eco-efficiency strategies by engaging in energy and waste management to reduce production costs. Some used CP as an environmental strategy, like their counterparts in Australia and USA (Huisingh, 1993; Norgate, Jahanshahi, and Rankin, 2007), to achieve economic and environmental objectives (Miller, Burke, McComas, et al., 2008; van Berkel, 2007), while they developed new technologies or green products for the generation of new sources of revenue.

Strongly influenced by financial metrics, such as return on investment (ROI)[114], most surveyed executives favoured increasing revenue rather than cutting costs. ROI, comparisons, and weighted scoring methods[115] determined environmental investment and its perceived worthiness. Eco-responsibility, the highest level of driver, referred to the concern for initiating environmental good. By being ethically motivated, firms would act from a sense of responsibility that went beyond legal obligations and economic interest. Very few sampled companies took environmental action based on the fact it was the right thing to do. However, some executives agreed with an opinion expressed by the chief executive officer (CEO) of a multinational jeans manufacturing firm who said, "if you do it right, it can be financially beneficial as well" (Wrenn, 2019). All of the top management personnel surveyed emphasized that they must ensure profitable environmental improvements, survival, and the success of businesses[116].

Top managers' favourable environmental attitudes had positive effects on the perceived advantages of environmental initiatives, which were important elements when taking decisive action. Such attitudes influenced strategic decision-making, such as thinking through environmental initiatives correlated to competitive strategies, deciding whether to

[114] Ibid.
[115] A general examination that compares details such as levels of pollution, amount of energy/raw material consumption, and maximum potential for CP, while weighted scoring methods investigate the overall performance by identifying attributes including waste volume, energy/raw material consumption, toxicity of waste, cost, market development potential, and worker initiative. Hong and Li. (2013)
[116] Based on interviews and observations of business decisions

pursue the possible choices, and the selection of one or more options. We found that a higher level of environmental awareness had a positive influence on environmental management, which is in line with prior research (Huber, 2000). The more active the attitude toward environmental protection, the more rapid the establishment of EMS. Moreover, the surveyed EMS adopters tended to take into account the environment more than non-adopters. More certified firms (23) than non-certified ones (4) fixed objectives of lowering costs and increasing efficiency. The former outnumbered the latter by four to one in setting targets to reduce energy consumption and increase energy conservation [117] (22), differentiating products, improving image, entering into new markets, maintaining market share, and enhancing competitiveness[118] (28). These differences, related to strategic orientations, are explained in the next part of this section.

4.3. Competitive positioning

The sampled companies exhibited passive, reactive, active, and proactive strategic orientations toward environmental protection. Companies with a passive strategy orientation were resistant to acting or delayed action, as exemplified by those without any environmental measure. Firms with a reactive orientation focus were threat averse and followed existing practices. They positioned themselves as policy-takers and complied with regulations reluctantly. For example, some surveyed firms waited for requirements before taking part in programmes such as CPA. Companies with an active orientation were characterized by a willingness and preparedness. They were "interested" compliers who acted voluntarily. For instance, these firms applied voluntarily CP practices. Firms having a proactive strategy orientation were industry leaders. They pursued potential markets and developed innovative solutions. The sampled firms having active and proactive orientations adopted different strategic positioning to improve or maintain competitiveness.

The companies choosing to be low-cost producers altered or reduced costs savings. They may have improved efficiency in organizational processes by using in-house or certified EMS and increasing resource productivity to acquire environmental cost leadership. Those

[117] Q5b
[118] Q5a3 & a4

selecting differentiation offered unique products. These firms could differentiate their products through quality by enhancing image, generating positive customer opinion, or providing value for client organizations in industrial markets. For example, the surveyed textile mills that viewed European regulations on textiles as opportunities developed CT and eco-products, and attempted to become more competitive in European markets by shifting to make high-end fabrics and garments. Businesses opting for both cost leadership and differentiation targeted niche markets with reasonable pricing and raised their level of differentiation through resource-efficient practices and eco-design. They deployed a competitive strategy and chose to engage in activities that offered a unique mix of value, as stated by Porter (1996).

Using the value chain method, our study found that interrelated activities (e.g., operations, technological development, and human resource management) contributed to changing business practices, such as training, design, fabrication, maintenance, inspecting, and monitoring. Such changes created added values, such as cleaner products in predominately private firms. Facing stricter environmental regulations and tightened law enforcement, most surveyed companies took at least one environmental measure, and a majority of the compliant and over-compliant measures were associated with written corporate policies. Our study found that the adoption of common standards (i.e., ISO 14001) led to convergences in practices, whereas different environmental attitudes were linked to divergences in strategies. Through the lens of management, this chapter reveals the similarities and dissimilarities of environmental responses that are intricately linked to activities at a firm level. Chapter 5 analyzes environmental actions in implementation processes from a sociological point of view.

Chapter 5 Steering industry action for change

This chapter analyzes environmental implementation as dynamic social processes, with a focus on understanding how practices changed in urban, industrial environmental management. Section 1 addresses policy shifts in industrial management systems, from deploying nonregulatory approaches and enacting new regulations to strengthening law enforcement. The section discusses environmental responsibility and accountability and examines policy arrangements. Section 2 illustrates environmental initiatives and the triad-network model. The section analyzes the adoption process for CPA, presents nonregulatory initiatives as implemented by the sampled firms, and describes the network implementation model. Section 3 applies the model to analyze the dynamics of environmental implementation and the roles and relationships between actors in "policy, economic, and societal" networks. Section 4 identifies the driving forces behind the environmental initiatives undertaken by the sampled firms, including multi-stakeholder support, potential business opportunities, perceived obligations and impacts, and favourable regional contexts.

1. Shifts in policy and management systems

   1.1. Multi-pronged approach

The environmental impact assessments (EIA) system, three synchronizations system (3S), and the pollution levy system were the policies cited most frequently by the respondents. They are part of the schemes governing industrial organizations at the national level, as shown on Table 5.1 below. The subdivided sections highlight different policy focuses. The EIA Law (2002)[119] required that project proposals meet pollution emission standards (Ding and Gao, 2017). All of the surveyed EIA applicants (21), except for one, obtained EIA approval. The rate was in accordance with the trend of rising approval rates, from 61% in 1991 to 99.8% in 2009. The results of EIA were recorded in social credit files and disclosed publicly (Ding and Gao, 2017). One sampled firm complained to us about the complicated

[119] The law codified the 3S system, stipulating simultaneous implementation of pollution control measures in the design, construction, and operation of projects.

process of obtaining approval[120]. The recent amendments in EIA (2017) were to simplify the process.

Large, pollutant intensive firms were required to provide detailed environmental information (environmental quality, environmental monitoring, incidents, licensing, penalties, and fees), and to indicate principal pollutant discharges (names of pollutants, method, concentration and amount of discharge, and construction/operation of control technologies) (Schroeck, 2016; State Council, 2016). Under the pollutant emission permit system, regulated enterprises must have installed online self-monitoring equipment and connected to the MEP's environmental information network (State Council, 2016). Previously, the biggest polluters (over 15,000 facilities) had been required to release real-time air and water data[121].

The revised Environmental Protection Law (EPL) (2014) imposed a stricter emission quota system, a more stringent application of EIA, consecutive penalties, and criminal prosecution (Xinhua News Agency, 2014). The focus of industrial environmental management changed from EOP and pollution control (1972 – 1991), pollution prevention and process control (1992 – 2001), to energy conservation and emissions reduction (Lu and He, 2009). Industrial pollution control switched from concentrated to mass-based standards (Ma and Ortolano, 2000). Total emission control was enforced in almost all counties and cities (Lu and He, 2009).

More recently, the Environmental Protection Tax Law (EPTL) replaced pollution levy systems with a mechanism that provided leverage for emitters. Tax payable amounts were reduced by half if the pollutant discharge was 50% less than the emission standard (Wu, 2018). Higher tax rates were imposed on more toxic pollutants. For instance, the rate for Formaldehyde was 24 times higher than that of smoke and dust (Yu, 2018). Emission reduction was turned into tax breaks (Wang, 2021). Similar to the OECD countries, the tax

[120] Company sampled #13, during our site visit in the Bai Yun Technological Park, Guangzhou

[121] 国家重点监控企业自行监测及信息公开办法(试行) [Measures for the Self-Monitoring and Information Disclosure by the Enterprises subject to Intensive Monitoring and Control of the State (for Trial Implementation)], art. 20(3) (promulgated by the MEP, July 30, 2013, effective Jan. 1, 2014), State Council Gazette. July 30, 2013, translated in pkulaw.cn (requiring firms to engage in "real-time" (实时) disclosure of continuous monitoring information (企业自行监测信息) for air (hourly) and water (every two hours) pollutants), http://en.pkulaw.cn/display.aspx?cgid=207735 &lib=law

base was dominated by transport and energy (DRC and OECD, 2017). In 2014, environmental tax revenue generated 1.3% of GDP, nearly reaching the OECD average. Despite a growing share of total tax revenue (DRC and OECD, 2017), environmental tax accounted for a fraction of government revenue, according to Cai Zili, Director of the Treasury Department, the State Administration of Taxation (Wu, 2018).

Table 5.1: National industrial environmental schemes			
Year	Regulations	Nonregulatory policies	Economic instruments
		General protection	
1989	EPL, revised in 2014		
2016			Ecological damage compensation system
		Pollution control and prevention	
1979	Pollution discharge limits, EIA, 3S		Pollution levy system (replaced by tax)
1988	Total pollutant control		
1989			Pilot SO_2 emission fee
1996	Double attainments policy		
1999			Emission trading
2002	CP Promotion Law		
2016	Pollutant Emission Permit System		
2017			Carbon ETS
2018	EPTL		
		Green financing	
2007			Green credit
2008			Green trade
			Green stock
			Green insurance
2020			Green development fund
		Information disclosures	
2007		Measures on open environmental information	

2008	Opening governmental information regulation and environmental information disclosure decree	
2010		Guide to the disclosure of environmental information
		Labelling, EMS
1989		Minimum energy performance standards
1994		Environmental labeling scheme
1996		Introduction of ISO 14000
1999		Voluntary energy efficiency label
2003		Voluntary energy conservation label
2005		Mandatory energy information label
2015		Environmental frontrunner scheme
		Industry ecology
2003		Pilot eco-industrial park

Source: MEE. (n.d.); Xinhuanet.

Besides enacting new laws, the central government urged subnational governments to launch green development funds[122] (State Council, 2016). To improve implementation of the Paris Agreement, five provinces intended to build structures and form partnerships (People's Daily, 2017) within a newly established, green financial system. For example, Shanghai municipality, the Ministry of Finance, and the Ministry of Ecology and Environment launched a national green development fund Co., Ltd.[123] to finance pollution control, ecological restoration, afforestation, green transportation, clean energy, and energy and

[122] Guiding Opinions on Establishing the Green Financial System, 七部委印发《关于构建绿色金融体系的指导意见》, State Council. (2016).
[123] With capitalization of 88.5Bn yuan ($12.7Bn US), Xinhuanet. (2020); Reuters. (2020).

resource conservation (Reuters, 2020; Xinhuanet, 2020). The earlier green credit policy (2007) was designed to promote green finance and impose environmental criteria in order to gain access to commercial credit. Joint policies, implemented through a standardized management system for public listing/refinancing, along with strengthened environmental verification[124] and evaluation[125] were designed to move pollutant intensive enterprises toward environmentally friendly practices[126] (MEP, 2007, 2008).

Compliance with national standards became required in order to receive bank loans (State Council, 2016; Wang and Wheeler, 2000). Such requirements have been strengthened by China's securities regulatory commission[127]. Loans could be refused or called, in cases of environmental violations. Moreover, banks reduced the amount of credit available for pollutant and energy intensive projects (Aizawa and Yang, 2010). Pollutant and energy intensive enterprises had to pass an environmental assessment prior to refinancing or listing on a stock exchange. Those failing to meet green listing requirements were rejected for initial public offering (chinaenvironmentallaw.com cited by PRI and UNEP, 2011; Wang, Yang, Reisner, et al., 2019). In addition, several measures (i.e., the 2007 Measures on environmental information and 2010 Guide to environmental disclosure) required that companies exceeding emission standards (at local, regional, and national levels) and firms in target pollutant intensive industries (16) implement mandatory disclosures and release annual environment information reports. Policies were adopted[128] to improve the quality and frequency of disclosure. Both stock exchanges in Shenzhen and Shanghai encouraged listed companies to disclose environmental information (Johnson, 2011; Weber, 2014).

[124] Such as Circular on environmental protection verification of highly polluting industries
[125] Such as Guiding opinions regarding strengthening environmental protection supervision and management of listing companies and the public company environmental protection examination industry classification management directory
[126] For example, the introduction of green credit management marked by the Circular on the implementation of environmental protection policy and regulations to prevent credit and loan risk, MEP, People's Bank of China, and China Banking Regulation Commission. (2007).
[127] Guiding opinions on strengthening the supervision and management of environmental protection of listed companies. SEPA. (2008).
[128] Circular on taking steps to strengthen environmental open government information work. MEE. (2012) and measures on open environment information based on regulations on open government information. State Council. (2007)

Companies at risk of pollution incidents were required to acquire compulsory environmental liability insurance (State Council, 2016; Wang, Yang, Reisner, et al., 2019). Such insurance was established after pilot testing[129] (Turiel, Ding, and Liu, 2017), and has been used to roll out national policy implementation. In past decades, pilots were conducted in various areas, ranging from ISO 14001 certification, eco-labelling system, and carbon ETS covering eight energy intensive industries (petrochemical, chemicals, construction materials, iron and steel, nonferrous metals, paper, power generation, and aviation) (DRC and OECD, 2017), to standards and norms for green product and manufacturing system, factory, enterprise, park, and supply chain management (electronic, chemical, construction materials, furniture, and pulp and paper) (Xie, 2018b).

To evaluate the environmental performance of target enterprises, Guangdong established an environmental protection credit evaluation system based on indicators, compliance, and fulfilment of environmental responsibilities. The evaluation system classified the regulated firms as "alarming, bad, good, excellent," according to the scores obtained, and corresponding to an established colour coding system (red, yellow, blue, and green). Green coded enterprises benefited from credit access, refinancing, and other advantages, whereas yellow and red coded firms were subject to frequent inspection, ran the risk of being penalised financially, paid higher environmental risk insurance premiums, had environmental funding suspended, and were unable to obtain credit renewal for loans (Yue, 2020).

1.2. Increased responsibility and accountability

The EPL (1989) codified the environmental protection contract target responsibility, and stipulated local governments' responsibility for environmental quality (NPC, 1989). Political leaders were required to meet targets according to the environment quality administrative leadership responsibility system (1996). Guangdong was among the first to implement this system in 1997. Failing to meet such targets for three consecutive years meant they were ineligible for promotion over the following five years (OECD, 2007). Moreover,

[129] Guiding opinion about pollution liability insurance in 2007, initiation of pilot programmes and implementation nationwide by 2015; Guiding opinions regarding launching pilot work on compulsory environmental pollution liability insurance.

environmental criteria weighed more heavily in the performance and evaluation of management systems (OECD, 2007; Yang, 2016). To increase accountability (Burns and Zho, 2010) and public trust (MEP, 2008a; State Council, 2011a; Xinhuanet.com, 2009), public assessment and expert evaluation were also included in the party and government leadership accountability system (2011). Evaluation results were reported in the media, which heightened political leaders' concerns about negative publicity on environmental problems (Jiao, Su, Ji, et al., 2019).

The responsibility evaluation standards and index classified regions into different categories (Feng, 2012). Provinces, autonomous regions, and sectors negotiated and divided up overall national targets. More developed regions were allocated higher emission reduction targets, ranging from 10% to 18% (Yuan and Feng, 2011). However, subnational authorities did not take binding targets as a given. Sources revealed that provincial governors bargained for the total quantity of energy consumption. Eastern regions monitored their energy consumption, in order to make an economic transition (Feng, 2012). Some attempted a carbon shift by implementing low-carbon pilot provinces (Guangdong, Hubei, Liaoning, Shaanxi, and Yunnan) and cities (Baoding, Chongqing, Guiyang, Hangzhou, Nanchang, Shenzhen, Tianjin, and Xiamen) (NDRC, 2010).

Cities have been ranked annually according to their environmental performance, information disclosure, and the composite scores of 21 indicators. Their rankings and scores have been publicly released (Rock, 2009). In three decades (1988 – 2008), the number of cities subject to environmental targets increased from 113 to 629 (MEP, 2008b). Both our research and a previous study (Geng, Wang, Zhu, et al., 2010) found that municipal government used indicators (energy efficiency, wastewater, emissions, and recycled/reused industrial solid waste) to set quantitative objectives and signed agreements with provincial governments.

Sectoral environmental objectives were allocated to key emitters. For instance, target enterprises' CO_2 emissions were monitored by national, provincial and local governments (Song, Yang, Fang, et al., 2012), municipal industry energy conservation, industry transformation, and locations such as low-carbon industry parks (Climate organization, 2010, as cited in Qi, 2013). Individual enterprises and each level of government (prefecture,

prefecture-level city, district, county, county-level city, town, township) were required to sign contracts and achieve the goals within time limits (Yang, 2016). Moreover, the central government required large, energy intensive industrial firms to cut carbon intensity (emissions per unit of GDP) by 40 – 45% by 2020, as compared with 2005[130]. Those consuming energy at a rate of 180,000 tce or more (baseline 2004) had to meet conservation objectives (100 million tce) between 2006 and 2010, through the national "top-1000 energy consuming enterprises energy efficiency programme" (NDRC, 2006).

1.3. Policy arrangements

A fee collection system administered by local finance bureaus was implemented to decouple the pollution levy from the EPB's source of revenue (Tsui and Wang, 2004). Consequently, local EPBs became more financially dependent on local governments since they must obtain legislative approval for funding. This system worked better in more economically developed jurisdictions thanks to environmental leadership, stringent oversight, and integrated management of finance bureaus (Zhan, Lo, and Tang, 2014). For example, the financial situation in Guangzhou EPBs remained stable, allowing local agents to concentrate on law enforcement (Lo and Tang, 2007). However, the situation was different for regulated companies. Instead of getting a refund from pollution fees, they have had to submit pollution control project proposals, undergo evaluation, obtain approval, participate in open bids, and report quarterly project progress to receive grants. A study found that many firms did not have the capacities to manage such requirements (Zhan, Lo, and Tang, 2014).

Ministries, agencies, and financial institutions engaged in joint environmental efforts, and each had specified tasks. In the case of pollution control related to industrial boilers, the Economic and Information Committee (EIC) promoted technology, whereas the NDRC coordinated centralized heating projects and ensured a clean energy supply. Local governments were mandated to eliminate energy and pollution intensive boilers, to conduct energy surveys, and to test and monitor the boilers[131]. The Treasury Department was

[130] Under the 1000-enterprise energy conservation programme initiated by the NDRC, *China's Top-1000 Energy-Consuming Enterprises Program: Reducing Energy Consumption of the 1000 Largest Industrial Enterprises in China*. Price, Wang, and Yun. (2005).
[131] Implementation plan for preventing and controlling boilers' pollution (2016 – 2018), Guangdong 广东省锅炉污染整治实施方案（2016－2018 年）》. n.d.

responsible for funding (GDPTO, 2012). As a result, over 80% of highly polluting boilers (below 10 steam ton/hour) were eliminated in the PRD. Target enterprises installed an online monitoring system for boilers[132], connected it to the local monitoring centre and national city energy quantification centre (Guangdong), and released their data on the public platform (GDPTO, 2012). To elucidate how initiatives were carried out, the following section identifies environmental implementation using the triad-network model.

2. Environmental initiatives and the implementation model

2.1. CPA: from promotion to implementation

The Chinese government stipulated cleaner production (CP) as a national strategy for sustainable development (Government of PRC, 1994; Shi, 2003; Zhang and Chen, 2003; Zhao, 2001) in response to the UN Conference on Environment and Development (OECD, 1995a). In 1994, China introduced CPA demonstration projects, and became the first country to promulgate law on CP (UNIDO, 2008). The notion of CP was defined as "the continuous application of measures" for design improvement, enhanced management, advanced process implementation, and utilization of clean energy and resource, according to the Clean Production Promotion Law.

Fifty-three companies implemented CPA, including 16 mandatory adopters which were regulated enterprises that exceeded local/national discharge standards and norms, used toxic/harmful materials, or discharged toxic/harmful substances[133]. All firms undertaking compulsory implementation had to prepare plans for reduction (emission, discharges, and hazards), and to specify the amount of investments and time required to meet discharge standards and norms (Hong and Li, 2013; NDRC and SEPA, 2004). They were also required to submit a report on the outcomes (measures taken, associated energy savings, and pollution reduction) to local authorities (Hong and Li, 2013; NDRC and SEPA, 2004).

Voluntary CPA adopters needed to fix goals under an agreement, commit to fulfill tasks, sign a binding document, and deliver the agreement to the Economic and Trade Commission

[132] 20 steam ton /hour above steam 14 (MW) hot water boilers
[133] Refers to the lists prescribed: the lists of dangerous good (GB12268), hazardous chemicals, hazardous wastes, highly toxic, corrosive, and strong irritants, and radioactive substances. NDRC and SEPA. (2004).

(ETC). They abided by the obligations stipulated by the CP Promotion Law (NDRC and SEPA, 2004) and a seven-stage standard procedure (preparation, pre-assessment, assessment, screening, selection, implementation, reporting, and ongoing CP) (GZCPC, 2013). According to our on-site visits and the CPA reports dated from 2004 to 2014, the adopters followed the prescribed procedure[134], from online registration[135] to auditing/on-site evaluations.

Voluntary and mandatory CPA adopters were rated differently in terms of graded items and categories (Appendix D). For example, the evaluation criteria for voluntary CPA emphasized meeting industry standards and undertaking initiatives (i.e., resource efficiency, environmental technology development, environmental management, eco-labeling), whereas those requiring mandatory implementation focused on compliance with directives. The grades were determined by a committee responsible for evaluating reports, conducting on-site inspections, and assessing implemented measures according to the grading systems. The committee consisted of two representatives from the local EPB, the ETC, and at least three experts specializing in CP, energy-saving, and sectoral activity, as selected randomly from the database.

2.2. Nonregulatory initiatives adopted

Voluntary CPA (37) ranked as the second most adopted voluntary measure, after ISO 14001 (43), and before in-house EMS (34). We employed interchangeably, the terms voluntary measures and nonregulatory initiatives. The less commonly adopted measures included eco-labelling (7), public CSR/sustainable development report publication (5), carbon inventory management (4), carbon trade (4), and industrial eco-park operations (3). The least adopted initiatives (energy audit, in-house resource consumption assessment, circular economy initiative, product lifecycle management, and "Green Factory" designation) were only implemented by one firm. The high number of ISO 14001 certifications reported by the surveyed firms confirmed a higher percentage of certification in firms located in more

[134] 《广东省清洁生产审核及验收办法》. 粤经贸法规〔2009〕35 号. Guangdong CPA evaluation methods GDEIC 广东省经济贸易委员会, Department of S&T of GD 广东省科学技术厅, and GDEPB 广东省环境保护局. (2009).
[135] www.gzcpc.org

developed or coastal areas, such as Guangdong (Cushing, McGray, and Lu, 2008; Li, 2012). It also reflected the rapidly growing tendency of ISO 14001 adoption in China (Cushing, McGray, and Lu, 2005; McGuire and Sheldon, 2012; Mol and Carter, 2007), which rose from a few hundred to almost 70,000 over one decade (from 1999 to 2010) (McGuire and Sheldon, 2012).

In contrast to ISO 14001 certification, the adoption rate of eco-labelling (8%) in the surveyed firms was lower than those of prior studies (Cushing, McGray, and Lu, 2008; Li, 2012). Less than 5% of the sampled firms published CSR/sustainable development reports, which was a much lower rate of adoption than that of Canadian facilities (Henriques and Sadorsky, 2004). The result was in line with prior research in China that found few companies engaged in environmental disclosure (CREJ, 2018; Tang and Li, 2013), and even fewer using international reporting standards (such as the UN global compact principles) to publish CSR reports (Cai, Pan, and Statman, 2016). Our result also suggested that little progress was made in environmental disclosure over the past decades, by comparing it with previous findings (Guo, 2005; Li, Xiong, and Xu, 2008; Lu and Abeysekera, 2014a; Zhou, 2010b). In terms of the quality of information disclosed, one study found that a majority of the publicly traded firms (70%) provided unbalanced information (Noronha, Tou, Cynthia, et al., 2013). But research indicated that larger companies tended to have the highest level of report compliance[136] and provided better quality of information (Lu and Abeysekera, 2014b).

2.3. Implementation model

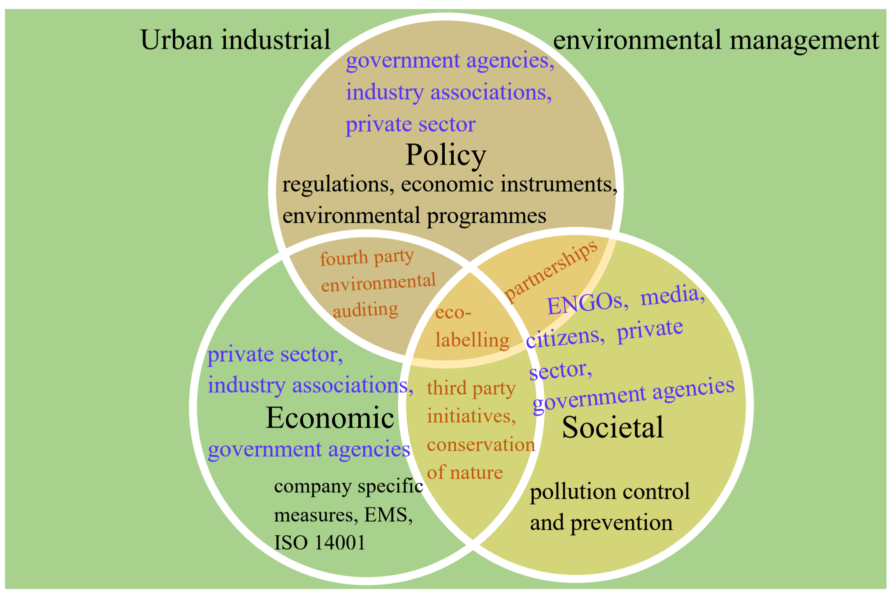
The abovementioned nonregulatory initiatives can be represented in a triad-network implementation model. The model illustrates environmental measures according to implementation, with respect to institutional arrangements and interactions among actors involved in networks. Compared with the value chain model, the triad-network model proposes analyzing environmental actions in a broader social context. The networks are interconnected by concentric circles embedded in urban industrial environmental management (Figure 5.1).

[136] World Economic Forum & Boston Consulting Group. (2012).

Each network is comprised of actors, organizations, practices, and arrangements:

- The policy network emphasizes environmental regulations, economic instruments, and government initiatives;
- The economic network focuses on practices when implemented by economic actors, including company-specific and industry-initiated measures such as in-house EMS, ISO 14001;
- The societal network pays attention to civil society's role in implementing environmental initiatives.

Figure 5.1: Triad-network implementation model



The actors and organizations involved in networks may vary and depend on the environmental issues. For instance, private sector actors in the economic network include firms, consultants, suppliers, and vendors of equipment in the implementation of CPA, whereas private auditors are key actors in ISO 14001 adoption. The measures across networks are represented in three overlapping areas of two circles and one common intersection.

- The policy - economic networks: state-initiated programme, industrial eco-park, fourth party environmental auditing such as CPA, government-industry partnership, government-industry agreement;
- The economic - societal networks: third party initiative, conservation of nature;
- The societal - policy networks: partnership;
- The policy - economic - societal networks: eco-labelling.

For instance, to promote energy labels and standards, as well as low-carbon product certifications, a number of government agencies (i.e., MEP, NDRC, the State Forestry Administration, Ministry of Finance, State Administration of Quality, Supervision, Inspection, and Quarantine) coordinated across networks (CEC, 2018).

The voluntary initiatives adopted by the sampled firms ranged from company-specific individual measures (in-house EMS and public CSR/sustainable development report publication), industry self-initiatives (ISO 14001), partnerships between government and industry (industrial eco-parks) and across networks (eco-labelling), to state-initiated programmes (CPA). The next section applies the triad-network to identify the actors involved in networks and to examine the roles they played and the influence of different actors in implementations, particularly CPA implementation in the sampled firms.

3. Triad-network analysis

3.1. Policy networks: sources of support

The triad-network model for analyzing environmental implementation in the surveyed firms comprised the basic spheres (policy, economic, and societal) advanced by Mol (1995). Each network was conceptualized as a broad category that may include multiple networks and subnetworks. These networks and subnetworks were distinguished by issues and business activities, for example, eco-innovation and environmental learning. Different actors interacted in these interrelated networks, whereas actors (e.g., industry associations) may be simultaneously involved in multiple networks (e.g., economic and policy networks), as depicted in the triad-network model. The policy networks related to CPA implementation comprised state actors, companies, and institutional arrangements. Nationally, environmental plans, regulations, and socioeconomic policies incorporated CP[137] to make industry sectors more competitive, maintain high level of economic growth, and pursue development (Fussler and James, 1997). In Guangdong, CPA implementation focused on guiding industries to low pollution and high value-added production (GDEIC, 2011).

Nearly 90% of the sampled firms had contacts in government agencies related to environmental protection. Seventy-five firms cited the EPB, followed by the ETC (20), "others" such as industrial park authorities and local governments (20)[138], the Technology and Communication Bureau (TCB) (9), and the Development and Reform Committee (DRC) (7) as points of contact. Seven companies maintained relations with more than two government agencies. All firms having contacts with multiple government agencies had EPBs included in their range of connections. The ETC succeeded the MEP and took over primary responsibility for implementing cleaner production. Local ETCs supervised voluntary CPA, whereas EPBs were in charge of compulsory CPA. Local governments identified the firms subject to mandated CPA. Government at different levels stipulated measures[139] and documents[140] for implementation and evaluation processes.

Over 60% of the firms surveyed (54) were incentivised by governments toward environmental implementation[141]. Forty-four companies benefited from financial incentives such as subsidies, loans, credits, and tax reduction. Thirty-five firms obtained consulting services or training along with other measures. Twenty-seven received both pecuniary and non-pecuniary incentives through various programmes at the national and provincial levels. For instance, the Ministry of Science and Technology and the MEP allocated environmental

[137] Including Law on Solid Waste Pollution Prevention and Control (1995), Law on Water Pollution and Control (1996), Regulation on Environmental Protection of Development Projects (1998), Law on Air Pollution and Prevention Control (2000), and 10th FYP for National Economic & Social Development (2001)
[138] Q3a
[139] Opinion about acceleration of CP, GD CP audit and acceptance methods, CP auditing Report template, CP technology service management methods
[140] CP auditing method (2004), Examination and evaluation method (2003), and Revised procedures and evaluation criteria (2009)
[141] Q3c

science funding for R&D and support for technology diffusion, respectively (OECD, 2010). With the provisions of tax credits for utilization through ETS, clean energy funding was available for low carbon production technology adoption (Lü, Geng, and He, 2015). Guangdong incorporated energy conservation, pollution reduction, and renewable energy into its Scientific and Technological Special Programme (2008), establishing a special fund of 100M yuans for research (OECD, 2010). Technology support and monetary awards were provided by the Guangdong EPB to replace small boilers and generator boilers that met emission standards[142] (GDPTO, 2012).

In addition, the former State Environmental Protection Agency (SEPA) and the World Bank (WB) created a national CP centre (NCPC) (Wang, 1999) devoted to CP policymaking, technical and institutional capacity development, the formation of information networks, and links among institutions. The UNIDO and UNEP formed partnerships with the NCPC (UNIDO, 2008). The WB funded CP demonstration projects, the publication of manuals and materials, and training for policy makers, industrial actors, and experts (UNEP, 1994). The WB also co-provided funding with the UNEP for China’s first EST projects (Zhang and Chen, 2003), established over 160 technology research centres, and developed and transferred know-how (Rakesh, 2000, as cited in Luken and van Rompaey, 2007). All levels of government cooperated with international organizations or signed bilateral agreements with numerous countries[143] (Geng, Wang, Zhu, et al., 2010; Zhang and Chen, 2003). Bilateral and multilateral assistance contributed to strengthening institutional capacities. The European Union played an important role in policymaking (Geng, Wang, Zhu, et al., 2010), while the Sino-Canadian cooperation project supported the implementation of China’s Agenda 21, and increased capacity building (Geng, Wang, Zhu, et al., 2010; Luken and Navratil, 2004, as cited in Ashford and Hall, 2011).

The Asian Development Bank (ADB) set up a centre for EST transfer and provided technical assistance to industries and businesses, especially for SMEs. Joint UNIDO-UNEP funding promoted CP and CT in industrial firms (Luken and Navratil, 2004, as cited in Ashford and Hall, 2011). The US Environmental Protection Agency, Canadian International

[142] According to the boiler gas emission standard GB13271-2014
[143] Japan, Australia, the United Kingdom, Germany, Netherlands, Norway, Sweden, Canada, and the USA

Development Agency, and the Norway Engineers Association developed CT by training, creating an information system and database through facility visits, assessments, and demonstration projects (Fussler and James, 1997; Luken and Van Rompaey, 2007). The UNEP created a Network of Industrial Environmental Management to support CPA and environmental management (Fussler and James, 1997; Luken and Van Rompaey, 2007; Shi, Peng, Liu, et al., 2008). Thanks to foreign technology and public funding[144], an air conditioning manufacturer in Zhongshan converted a production line, with an annual capacity of 200,000 units, from hydrochlorofluorocarbon (HCFC)-22 to propane refrigerant[145]. Technology transfer phased out HCFC-22[146] and contributed to compliance with the freeze target for HCFC consumption under the Montreal Protocol (UNIDO, 2015).

3.2. Economic networks: horizontal relationships

International collaboration went beyond government programmes. For example, a few enterprises worked with private sector actors, such as globally innovative firms[147] and manufacturers[148], for product development related to environmental protection. Inter-firm collaboration facilitated eco-products, which entered high-end markets, increasing sales and market share[149]. Fifty-five surveyed companies (64%) collaborated with one or more organizations when addressing environmental issues. Twenty-nine firms indicated the absence of external collaboration. The most cited external collaborator was consulting firms (46), followed by research institutes and/or universities (17), NGOs (5), and "others."[150] Most surveyed companies worked with consulting firms to deal with multiple issues. All firms collaborating with two or more organizations, with a few exceptions (3), engaged in several fields of activities (Appendix E). Production management enhancement was combined with energy savings and emission reduction in all companies, with one exception.

[144] Under the contracts signed with the Foreign Economic Cooperation Office and MEP
[145] A benign, ozone and climate friendly natural gas
[146] 240 metric tons of HCFC-22, the quantity equals 13.2 ozone-depleting potential (ODP) tons leading to an estimated 967,490 metric tons of CO_2 equivalent annual GHG emission reductions.
[147] Companies sampled #5, 14, P9
[148] Companies sampled #P2, 10
[149] Company sampled #14
[150] Q4a

Consulting firms offered general environmental services, technical and technological assistance, provided regulatory support, facilitated the application for subsidies, and organized formal site training, seminars, and conferences in which participants shared information about policies, environmental technologies, and their application. They helped the sampled firms enhance environmental awareness, incorporate the environment into organization-wide practices, facilitate pollution prevention technology transfer, and optimize internal environmental assessments. For example, energy service companies (ESCOs) conducted energy audits, identified potential savings, offered financing for upgrades, and executed upgrades. ESCOs paid off capital investments, shared savings with clients, and created mutual benefits. The number of ESCOs increased by nine times, and their revenue grew 16 times within five years (between 2006 and 2010) (Qi, 2013).

The consultants working in CPA were required to undergo an examination, demonstrate environmental know-how, have a proven track record and industrial experience. Our collaborators obtained academic credentials in science, undertook training in CP, and acquired knowledge in industrial production. They used real case examples, benchmarking, cost analysis indicators, and financial and environmental metrics to elucidate the potentialities and feasibilities, weigh pros and cons of different options, and help their clients select appropriate options. Other external experts included individuals who were involved in law making processes or were knowledgeable about policies and procedures. Outside consultants and experts disseminated experiences, helped managers and entrepreneurs identify opportunities, understood the bigger picture of environmental protection, and measured and enhanced environment-oriented management.

Senior management commitment, inter-departmental cooperation, and employee participation played an important role in carrying out CPA in the surveyed firms. Our data showed that a cross-functional team was formed with one leader, a deputy leader, eight to ten members of senior and middle management, and employees. A majority of the team members were engineers in charge of operations, technology development, quality control, and environmental protection. The others were accountants and staff responsible for logistics and communications. The team examined pollution and emissions data, determined a focused area of implementing CPA, tracked energy and water usage flows in the area, established the balance of materials, quantified sources, and extent of waste generation, set targets, and proposed measures.

Evidence from the field revealed that the cross-functional team members in the sampled firms screened, evaluated, and classified all propositions, as well as selected the most appropriate options. The team leaders were found to communicate the benefits of such solutions, mobilize employees, and solicitate the support of all functionaries for implementation of the measures. For instance, the financial department authorized adequate resources and the engineering department directed its efforts toward developing technologies and products. Training was key to building awareness and soliciting employee participation. Management and staff attended seminar training and continued to learn as day-to-day implementation moved forward. The sampled CPA implementers also established employee reward schemes including bonuses, incentive pay, training opportunities, and internal promotion rewards for those making suggestions.

3.3. Societal networks: direct and indirect interactions

The societal networks focused on looking at how private sector actors and civil society interacted in addressing environmental issues. Energy conservation and emission reduction (43), along with pollution treatment and prevention (33), were the most popular fields of cooperation between the surveyed firms, NGOs, research institutes, and/or universities. The rest of the fields included production management enhancement (28), technology procedure, infrastructure, and equipment upgrade (27), training (26), product R&D (14), and "others" (5). For instance, one firm established long-term relationships with a national laboratory and testing centre[151]. The surveyed pulp and paper mills obtained technological advice and followed up with commercialization of innovation from research institutes and universities specialized in pulp and paper, under which a national laboratory and testing centres were set up in the early 2000s (EPB, 2008). Furthermore, some sampled enterprises formed partnerships with universities and research institutions via "production-learning-research bases"[152] founded according to the principle of co-development. Trilateral partnership

[151] Company sampled #4
[152] Companies sampled #11, P6, P11,14

enabled the firms to develop product-oriented technologies, commercialize R&D results, and improve and disseminate CT development. A few surveyed hi-tech enterprises collaborated in R&D[153], others pursued greener products and CP[154], and launched R&D centres and automated production lines[155].

The government affiliated and organized environmental NGOs (GENGOs) provided assistance for the ETCs and the EPBs to promote and follow through CP. The GENGOs had been assigned nonregulatory tasks and offered services (i.e., EIA reports, provision for environmental planning), shared information, and coordinated with associations and firms. Some organizations were partially or fully self-financed, others were attached to government agencies with appointed, fixed term directors. For instance, our key collaborator worked with a self-financed association which coordinated site visits, compiled a directory of target firms, made appointments with executives, and confirmed the visiting time with all potential participants (environmental service providers, implementing agents, local EPB staff, and members of the CP centre). The transfer of responsibility to GENGOs for planning and organising policy implementation resulted from administrative decentralization, which may stem from reduced administrative staff due to civil service reforms or organizational restructuring. For example, the number of staff was reduced from 65 to 48 in Guangzhou EPB (Tang, Tang, and Lo, 2005).

The Guangzhou CP centre, a registered GENGO under the supervision of ETC, was responsible for CPA implementation. Like other CP centres, it conducted workshops, cooperative projects, training, consultation, cleaner technologies evaluation and dissemination, eco-design, R&D, and lifecycle assessment (Zhang and Chen, 2003). Its members included firms, science and research institutes, universities, scholars, experts, and other organizations. The centre became a hub for disseminating information, fostering exchange among members and government agencies (ETC, EPB, DRC, Sciences and Information Bureau). Intermediary organizations (e.g., the China Business Council for Sustainable Development, the China Council for Industrial Environmental Protection, and

[153] Companies sampled #4, 11, 14, P6, P9, P11, 60
[154] Companies sampled #10, 48
[155] Company sampled #60

the Guangdong Environmental Protection Industry Association) provided platforms to share information, exchange experiences, and trade and coordinate activities. Such organizations served as contact points for information dissemination on regulations, standards, and technology options in ad-hoc networking activities (i.e., training workshops, seminars, and conferences). Relationships were formed among creators of information and knowledge, and services helped the sampled CPA adopters achieve targets. Our findings reflected the GENGOs' claims, which stated that knowledge-sharing and peer learning influenced corporate environmental action, improved practices such as reusing and reclaiming hazardous solid waste[156] (Xie, 2018a), and facilitated cooperation in sustainable development among enterprises, governments, and communities[157].

Only a few large and resourceful grassroots ENGOs, for example, IPE, Green Peace, and Friends of Nature, directly affected corporate environmental practices through naming and shaming, disclosure of air and water pollution data, publication of investigative reports, and creation of "green pages" for products carrying eco-labels. They built awareness, encouraged citizen engagement, named and shamed bad corporate behaviours, and accrued media attention regarding pollution, as in the case of heavy metal pollution caused by MNCs (Dayoo.com, 2010b). Local media published firms' environmental protection credit evaluation results (Dayoo.com, 2010a; Yang, 2014). For example, major newspapers based in Guangzhou (*Yangcheng Evening News, Nanfang Daily, Guangzhou Daily, Xin Kuai Bao*) released detailed performance information (e.g., Dayoo, 2010c; Huang, 2014; Liu, Huang, and Deng, 2010; Ou, 2010). They published the names and emissions of mandated CPA adopters and of offenders. Also, citizens brought their complaints to the media, used social media to conduct online petitioning and coordinate protests, and could appear as witnesses in public hearings and consultations or complete surveys for EIAs.

[156] The China Council for Industrial Environmental Protection and Guangdong Environmental Protection Industry Association – Solid Waste Branch
[157] For instance, an organization (CBCSD) was established in 2003 by the China Enterprise Confederation and the World Business Council for Sustainable Development. http://english.cbcsd.org.cn/

3.4. Roles and relationships

The respondents had different perceptions of policy implementation, government actions, and company-government relationships related to environmental protection. They characterized government environmental actions as monitoring (56), command (6), intervention (4), assistance (36), promotion (21), and "other" (2) [158]. One respondent overtly criticized regulatory red tape. Some companies considered government actions as a combination of monitoring and assistance (11), promotion (3), intervention (3), and command (2). To several respondents (4), there was a mix of command, intervention, monitoring, assistance, and promotion. More sampled companies receiving incentives regarded such actions as assistance (25), monitoring (24), and promotion (18), rather than intervention (4) or command (4). Company-government relationships were described as frequent (16), occasional (10), collaborative (6), and non-existent (2)[159].

Many surveyed companies, such as those based in Guangzhou and Foshan[160], stated that participation in CPA was to help maintain the status of the national environmental protection model city. Guangzhou CP centre and a local ETC bureau jointly launched a campaign of promotion and introduced voluntary CPA to firms[161]. Based on our experiences as a participant in scheduled tours during the promotion of CP at facilities in Guangzhou (Baiyun district) (2013 – 2014), only a few manufacturers declined the proposed visits, either over the phone or at the factory gates. The majority of the discussions were cordial, although a couple of executives lashed out at government representatives[162]. Most firms welcomed the opportunity to receive first-hand information and networking. Those interested in implementing CPA had been kept informed about activities, such as free training workshops

[158] Q3d
[159] Q3b
[160] Companies sampled #48, 7, 51
[161] Guangzhou 1000-enterprise CP green action 广州市政府"千家企业清洁生产"绿色行动
[162] Based on notes taken during our onsite visit in the Bai Yun Technological Park of privately-owned companies, Bai Yun district, Guangzhou, September 2013

related to the implementation. Target companies were provided with a toolkit containing a declaration of intent for voluntary CPA, along with a set of informative documents[163].

Corporate representatives, local government officials, consultants, experts, and researchers held different perspectives on implementation. Civil servants tended to focus on policy issues, whereas firms paid more attention to financial aspects. A few surveyed executives called for clarity and stability in policy making, in order to help harness innovation. "Set the direction, no need to intervene. We will explore the best means to arrive at the destination," said an executive of an eco-innovative firm[164]. Consultants, experts, and researchers were more likely to address the challenges from perspectives encompassing policy, market, management, and technology. Our finding was consistent with those of an earlier study (Shi, Peng, Liu, et al., 2008). Firms were found to stress financial, technological, and informational barriers, and downplay managerial and organizational factors, whereas experts had more balanced views when compared to government and corporate representatives (Shi, Peng, Liu, et al., 2008).

Local implementing agencies depended on target firms' efforts for achieving objectives. Based on the number of signed contracts with target firms in CPA, civil servants maximized the opportunities for fulfillment. An ETC officer attempted to recruit more participating firms through increasing site visits with key collaborators. Bargaining over implementation occurred between target firms and local industrial bureaus, in line with prior research (Liberthal, 1992; Rock, 2009). The implementing agencies deployed a gradual approach with diminished incentives and cost-effective strategies to urge firms to sign agreements for implementing CPA. We found that ETC officers solicitated voluntary participation through persuasion, exchanges with executives, providing one-on-one assistance to prospective companies by responding to immediate inquiries, and updating information via social media applications[165]. E-government initiatives, such as websites, were used to provide detailed policy documents. The enforcement agents provided advice and assistance to the facilities

[163] Include official announcements, notifications, and guidelines for on site evaluation and CPA procedure, a contact list of accredited CP service providers operating in Guangzhou, a presentation of Guangzhou CPC, and an invitation to join the center, GZETC and GZCPC. (2013)
[164] Company sampled #14
[165] Such as "QQ" and "Wechat"

having difficulties in meeting requirements, and issued warnings to recalcitrant companies. Such finding supports that of prior research showing the reliance on the Guangzhou EPB for raising the levels of awareness and education (Zhan, Lo, and Tang, 2014).

Although outside experts contributed to promote CPA, inadequate external advice could cause negative impacts. For example, one sampled and ill-advised CPA adopter[166] selected an option that heightened financial risks due to a longer payback period than expected. Such experience led to suspicion and a mistrust of external expertise. Certain firms only relied on internal experts to design and implement environmental projects. Having insider views allowed an in-depth understanding of the issue. For instance, a senior manager with a strong engineering background undertook certified training in CP and was responsible for implementing a number of initiatives (e.g., ISO 14001, voluntary CPA, internal EMS, and eco-label)[167]. Expertise and experience were not limited to high-ranking employees. Lower tier workers with knowledge and skills played crucial roles in fulfilling tasks on the front line. The next section identifies the main forces driving initiatives for change.

4. Forces driving environmental initiatives

4.1. Multi-stakeholder support

The majority of the sampled companies who had relationships with government agencies adopted ISO 14001, voluntary CPA, and in-house EMS. Those maintaining contacts with the ETC were more likely to implement such measures. Among firms that had relationships with "others," more took obligatory CPA (Appendix F.1). Collaborative and frequent company-government relationships were associated with more voluntary measures (Appendix F.2). The pollutant/energy intensive sectors and the sectors targeted by CPA had maintained contacts with government agencies, whereas other sectors were overrepresented in firms that had no company-government relationship. Proportionally, more firms perceiving government actions as "assistance" and "promotion" implemented voluntary

[166] Company sampled #1, based on information provided by our key informant
[167] Company sampled #47

initiatives and other measures. Those characterizing the actions as "commands" took few measures (Appendix F.3). Such a result was in line with that of previous research that found collaboration between businesses and funding agencies helped to form partnerships which produced tangible environmental benefits and created leverage (Esty and Winston, 2006).

All sampled firms undertaking carbon trade and carbon inventory had collaborators. The firms working with organizations significantly outnumbered those who did not, when considering those taking voluntary initiatives such as other environmental measures (nine-fold more), voluntary CPA (eight-fold more), ISO 14001 (five-fold more), and in-house EMS (four-fold more). The implementation of voluntary initiatives was also positively associated with the presence of collaborators. Such finding suggested that the surveyed firms collaborating with stakeholders tended to look in new directions, kept a close eye on unchartered opportunities, identified the circumstances, and deployed resources for environmental adoption. Moreover, collaboration between external and internal experts improved their capability in conducting R&D, feasibility studies, and specific projects. Our findings supported a prior study that found external assistance enhanced firms' capability to explore opportunities for environmental improvement and to influence decision-making (Murphy and Gouldson, 2000).

4.2. Potential business opportunities

There are more voluntary CPA and ISO 14001 adopters who identified customer demand, strategy, cost, CSR, technical support, and public pressures as drivers of environmental implementation than other surveyed companies. To in-house EMS implementers, human resources (HR) was a determinant, along with other factors (technical support, CSR, and public pressures) (Appendix G.1). A majority of the certified firms (60%) indicated management decision, and over one third of them considered customer demands, as key to implementing environmental actions. They perceived foreign customers to be more "environmentally conscious"[168] than domestic customers. The same was true for firms serving MNCs, original equipment manufacturers (OEMs), firms using their own brands (OBMs), and exporters to various markets (Appendix G.2). For example, the sampled firms

[168] Q1c

exporting to European markets complied with a multitude of requirements such as the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), the Restriction of Hazardous Substances (RoHS) Directives for electrical and electronic equipment, and the End of Life Vehicles' Directive. Those serving the Japanese market who perceived foreign customers as paying more attention to the environment were outnumbered by 5:1, and up to three-fold more for the USA and Canada region, more than two-fold for Australia and New Zealand, Africa, and Latin America, and nearly twice the rate for Europe (Appendix G.3). In fact, one surveyed exporter serving numerous foreign markets[169] pointed out that Japan imposed the most stringent requirements.

Six out of ten sampled companies without environmental measures served the national market exclusively. At the other extreme, all firms obtaining eco-labels were large exporters serving multiple foreign markets. The firms serving European countries had the highest percentage of CPA adoption (85%), followed by those serving the USA and Canada (75%), and Asian markets except Japan (72%). The suppliers catering to MNCs had the highest percentages of ISO 14001 certification (92%), followed by exporters to Japan, and OEMs. The surveyed electromechanical industry and special equipment was the most ISO 14001 certified, while four surveyed industries (food and beverage, pulp and paper, pharmaceutical industry, and printing industry) were non-certified.

A number of the sampled exporters applied certifications to satisfy customer demands and to circumvent "green barriers" such as environmental indication systems and carbon tariffs. For example, garment manufacturers were required to be certified in order to have access to European markets, according to regulations on textiles. Our findings supported those of previous research (Christmann and Taylor, 2001; McGuire, 2012; Nishitani, 2009). Demand-side incentives from foreign customers (Neumayer and Perkins, 2004) and pressures exerted by the market drove certification (Delmas and Montiel, 2009; Jiang and Bansal, 2003). Two-thirds of the surveyed ISO 14001 adopters served foreign markets, and almost all of them (except for three) served multiple international buyers. Europe was their top export destination (19), followed by the USA and Canada (16), Asian markets except

[169] Company sampled #47

Japan (12), Japan (11), Australia and New Zealand (5), and Latin America (4). The result confirmed the positively corelated relationship between ISO 14001 certifications and international markets found in American companies (Bansal and Hunter, 2003), and Chinese firms (Fryxell, Chung, and Lo, 2004). Evidence showed that ISO 14001 certification provided access to global production supply chains (Nishitani, 2009, 2010; Prakash and Potoski, 2007), overcame a de facto trade barrier (Eriksson, 2004), and provided environmental legitimacy (Bansal and Hunter, 2003; Heras-Saizarbitoria and Boiral, 2013).

Moreover, certification could serve as a "gold standard" (Bansal and Hunter, 2003; Delmas, 2002; Potoski and Prakash, 2005b), signalling sound environmental management (Jiang and Bansal, 2003; King, Lenox, and Terlaak, 2005) and visible commitment (Neumayer and Perkins, 2004). But few surveyed ISO 14001 adopters communicated environmental information publicly. Although some studies found that environmental disclosures signaled corporate environmental responsibility (CER), attracted green stakeholders (i.e., investors and customers) (Dhaliwal, Li, Tsang, et al., 2011), and impacted positively on financial performance (Yusoff, Mohamad, and Darus, 2013) and on corporate risk (Chang, Du, and Zeng, 2021; Yu, Jian, and He, 2011), most sampled firms were reluctant to disclose information unless they were obligated. Our finding confirmed that of a survey conducted in China, which found that obligation was key to disclosure of environmental information for most listed companies (Chiu, Zhang, Li, et al., 2020).

4.3. Perceived obligations and impacts

Almost all adopters of nonregulatory initiatives cited regulations as a key factor influencing environmental implementation. The adopters of ISO 14001, voluntary CPA, in-house EMS, and other measures figured among the sampled companies (41) that perceived positive impacts from current regulations (Appendix H.1). More certified companies perceived positive impacts than others. CPA adopters (19) outnumbered (over four-fold) non-adopters (4), and indicated such impacts. Positive perceptions of current regulations were associated with more and greater variety of voluntary initiatives, whereas negative perceptions (11), neutral (6), and uncertain (28) responses were linked to fewer measures. "We embrace stringent environmental laws, because our competitors, especially those sell products with low price won't survive," said one manager[170].

Fifty-eight respondents thought that their firms would be influenced by more stringent environmental policies. Most of these corporations pointed out the increasing cost of compliance (40) and over a third indicated enhancing competitiveness (21) as effects of stronger policy implementation. A majority of the adopters of voluntary (68%) and mandatory (57%) CPA, in-house EMS (60%), ISO 14001 (52%), and public report publication (4/5) did not mention cost increase as a factor. Firms that perceived enhancing competitiveness were large, privately owned, less pollutant intensive, and serving domestic and international markets. A majority of them had adopted ISO 14001 (18), voluntary CPA (15), in-house EMS (14), and other measures. Facing more stringent laws, large private firms increased R&D (15), and private companies with mainland Chinese investment established or enhanced EMS (20) (Appendix H.2). Four firms that stated decreased competitiveness were private and non-publicly traded companies.

The surveyed pollutant and/or energy intensive sectors accounted for over 80% of the mandatory CPA adopters and half of the voluntary CPA adopters. All surveyed chemical firms and a majority of automobile manufacturers (80%) and cement manufacturers (60%) adopted CPA. According to provincial and municipal action plans[171], big, energy intensive enterprises were required to implement CPA (GZETC, 2010). Target industries (i.e., chemical, mechanical, textile and dyeing, food processing, paper)[172] were to reduce energy consumption. A number of municipal governments implemented policies[173] to accelerate CPA. Some pollutant intensive firms were ordered to move out of cities in the PRD (Mou, 2010), whereas others were allowed[174] to stay if they fulfilled stricter requirements. Several surveyed facilities undertook CPA, met the requirements, and avoided being relocated.

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170 Company sampled #46
171 Guangdong 1000-enterprise scheme, GDEIC. (2013).
172 GDEIC. (2011).
173 GDEIC. (2011); Guangzhou: accelerated CP implementation plan, 1000-enterprise CP action plan (2015); Shenzhen: opinion about CP implementation (2003); CP audit implementation rules (2007); joint action system, municipal, district and street three-level joint action plan; Foshan: accelerated CP implementation plan (2008), classified directive.
174 Such as company sampled #9

The threat of sanctioning motivated some surveyed firms in Zhongshan to implement CPA. All enterprises were evaluated and color coded[175]. Yellow and red coded firms and VOC emitters [176] were required to implement CPA (ZSEPB, 2014) and complete the implementation before deadlines based on national, provincial and local requirements[177], in accordance with provincial and municipal environmental protection credit evaluation[178]. Failing to complete obligatory CPA within deadlines resulted in the target facilities being penalised. Implementation progress was published biannually[179]. Three quarters of the surveyed firms headquartered in Zhongshan undertook CPA, and all mandatory adopters[180] were textile mills. Moreover, the greater the perceived urgency of requirements, the faster actions were undertaken. For instance, one surveyed firm[181] conducted CPA immediately, another[182] suspended its production and passed the audit ahead of schedule. Such findings confirmed the result of an earlier study (Zhan, Lo, and Tang, 2014).

The sampled firms considered pollution (i.e., air, water, solid waste, and soil contamination) as the most serious environmental problem. Like their western counterparts, the surveyed senior management recognized the problem as having universal effects (Gittsham, 2015). However, only one respondent indicated GHG emissions reduction, and no respondent mentioned biodiversity protection, as key environmental issues. Some respondents raised their eyebrows over “biology conservation” and “climate change” when these phrases were

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[175] According to provincial environmental protection credit regulatory rules on target pollution sources

[176] Official notice 中山市第三批应依法实施清洁生产审核的重点企业名单的通知中环办[2014]53 号 EPB, Zhongshan. (2014a).

[177] National level: CP Law《中华人民共和国清洁生产促进法》; CPA regulations《清洁生产审核暂行办法》; Acceleration CPA in target enterprises《关于深入推进重点企业清洁生产的通知》（环发〔2010〕54 号）, Provincial level: Strengthening CPA in target enterprises 《广东省环境保护厅关于加强重点企业清洁生产管理工作的通知》（粤环函〔2012〕880 号）; Heavy metal integrated pollution prevention and treatment 《广东省环境保护厅关于印发广东省重金属污染综合防治 2015 年度行动计划的通知》（粤环〔2015〕52 号）; Municipal level: e.g., lists of obligatory CPA 第四批应依法实施清洁生产审核重点企业名单,中环[2015]41 号, EPB, Zhongshan. (2014b). 中山市第五批应实施清洁生产审核的重点企业名单, 中环函[2015]419 号, EPB, Zhongshan. (2014c).

[178] Selection criteria of obligatory CPA: environmental evaluations 《中山市环保信用管理评价警示、严管企业纳入强制性清洁生产审核名单的筛选原则》（中环[2015]68 号）, EPB, Zhongshan. (2015a).

[179] Notice of CPA implementation progress 中山市环境保护局关于公布 2015 年下半年中山市第二批应依法实施清洁生产审核企业完成情况的通知: 2015 年下半中山市年第二批应依法实施清洁生产审核企业完成情况表,中山市环境保护局, 2015 年 12 月 29 日. EPB, Zhongshan. (2015b).

[180] Companies sampled #8, P2, P12

[181] Company sampled #P5

[182] Company sampled #P3

used in conversations or questionnaires. Our findings were in line with prior research that found public awareness regarding the protection of biodiversity was insufficient[183] and that overall concern about climate change was less intense in China when compared with a global median[184]. Indeed, the sampled firms took more actions to address issues causing visible or audible impacts (e.g., pollution, noise, and the disposal of waste) rather than measuring carbon emission or publishing CSR/sustainable development reports.

Most surveyed firms underestimated the invisible environmental impacts of production (i.e., electricity consumption). Such perceptions reflected those of residents. For example, chemical industry accounted for nearly a quarter of the total number of complaints submitted over the phone during the first half of 2015 (Jiang, 2015). Even children were aware of the issue. For example, a national environmental cartoon contest received a number of children's drawings that displayed the industry as a facility emitting pollutant[185]. Environmental complaints and petitions focused on pollution, but less easily observed problems were ignored (Warwick and Ortolano, 2007; Yang and Zhang, 2011). Moreover, companies that took few actions tended to believe that their impacts were minor compared to the most polluting industries. Such findings supported an earlier study conducted in Europe (Batenburg, 2006).

4.4. Favourable regional contexts

Firms in coastal regions invested the most in environmental protection, as compared to their counterparts in central and western regions (Li, 2012). Over 70% of the adopters of nonregulatory initiatives indicated that costs drove environmental implementation. Provincial and local governments offered green incentives for businesses. These incentives included provincial energy efficient equipment upgrade subsidies (amount ranged from 100 to 140 yuan/kilowatt-hour) in over ten industries, including six surveyed sectors (electro-mechanical and special equipment, textiles and clothing, food and beverage construction materials, pulp and paper, and plastics) (Guangdong Treasury and ETC, 2013), municipal

[183] According to research conducted by Yale University and Columbia University in 2011
[184] According to surveys conducted in 40 nations among 45,435 respondents from March 25 to May 27, 2015. Pew Research Center. (2015)
[185] 中国环境污染统计图. (2013). Source: http://xjz.k618.cn/tongji/2013zx/201503/t20150328_5906031.htm

subsidies for energy audit, energy saving, interest free loan grants for energy conservation projects (3-6 million), and district grants for voluntary CPA adopters (50,000 yuans) (City of Shenzhen, 2011). More surveyed firms in Guangzhou obtained incentives than other areas. According to two environmental consulting firms, district grants helped almost all firms located in an industrial park in Guangzhou completed CPA, and funding provided by a district in Foshan (Shiwan) enabled all target plants to install desulfurization equipment (City of Foshan, 2007).

More sampled enterprises in industrial parks had relationships with multiple government agencies. A majority of them worked with organizations and obtained incentives (Appendix I.1). Businesses were provided with incentives to relocate to industrial parks (OECD, 2010). Between 2011 and 2015, enterprises located in industrial zones increased from 20 to 34%. Over 90% of industrial zones built centralized water treatment facilities (94%), installed automatic online monitoring equipment (91%) (Liu, 2018), and other projects (i.e., centralized heating and use of cleaner energy)[186]. All surveyed firms based in Guangzhou, except for four, worked with external organizations (Appendix I.2). By eight-fold, these companies outnumbered those headquartered in Foshan in maintaining contacts with the ETC. Proportionally, more surveyed firms based in Dongguan and Zhongshan had relationships with governments. All companies headquartered in Zhongshan worked with external organizations, and seven out of nine received incentives (Appendix I.3).

Zhongshan (Sanjiao) provided incentives to accelerate environmental technology development, to build innovation centres, and to construct an industrial ecological park, all of which contributed to a shift to manufacturing high-end electronics and equipment (Zhao and Li, 2016). The township signed agreements with over 100 enterprises that were held accountable for investing in environmental prevention (Li, Zhang, and Wu, 2017). Dongguan closed dyeing mills (9) and paper mills (12) to eliminate obsolete production capacities[187] (Gdzxb.gov.cn, 2005) and became a low-carbon CP pilot city (Climate group and Nanfang media, 2011). The city stipulated the most stringent regulations to protect

[186] 重点工业园区集中供热改造工程, 清洁能源利用工程. List of key project 重点项目清单. Action plan of air pollution control and prevention (2014-2017), Guangdong 广东省大气污染防治行动方案 (2014-2017 年）.

[187] Gdzxb.gov.cn. (2005).

fauna, looked to build a low-carbon ecological town, and piloted a national production and R&D innovation base (Huang, 2016). The municipal government provided over 100M to subsidize CPA (Gdzxb.gov.cn, 2005), offered training programmes to industrial enterprises (Huang, 2016), and accelerated transformations in the pulp and paper industry toward hi-tech and greener development (He, 2016).

The PRD was a spot for outsourcing and relocation of industry from Taiwan and Hong Kong (Henry, 1992; Liang, 2008). Until the early 1990s, most industrial firms were relocated from Hong Kong (HKTDC, 2016). The sheer number (56,000[188]) of these firms (electronics, information, technology and communication, textiles, chemicals, printing, and plastic) caused serious environmental problems (OECD, 2010). Some of them breached environmental regulations (Yu and Wong, 2011, as cited in Stalley, 2012). In 2008, the Hong Kong Productivity Council injected over HK$13M to initiate the Cleaner Production Partnership Programme, to assist Hong Kong-owned factories to adopt CP. Target sectors (textiles, non-metallic mineral products, metal and metal products, food and beverage, chemical products, printing and publishing, furniture, and paper/paper product manufacturing) obtained training and financial support for on-site improvement assessment, demonstration projects, and technological accreditation (CGCC Vision, 2010).

Guangdong partnered with Hong Kong and Macau in the “Greater PRD Greening,” aimed at establishing liveable cities and clean energy supply while enhancing CP standards and promoting a recycling economy (CGCC Vision, 2010). The province prioritized green industry development and environmental infrastructure upgrades by reducing environmental impacts, for example, through reusing 80% of industrial water (He, 2016; OECD, 2010). Government programmes were launched to lower NOx combustion, and implement desulphurization and de-NOx technologies (OECD, 2010). For example, nearly 60 industrial firms in Guangzhou desulfurized and decreased SO_2 emissions by 55% (Gao, 2011).

Provincial policymakers designed plans for a low-carbon city and promoted the ETS under an international low-carbon industry framework (Qi, 2013). Foshan and Dongguan have initiated paths toward low-carbon green economy development by funding high value-added

[188] According to the estimation from the Hong Kong Environmental Protection Department in 2007

production and environmental protection (Guo and Zhang, 2016; Wu and Zhao, 2016). Shenzhen has developed low-carbon industries, established GHG data management systems (NDRC, 2010), and advocated low-carbon marketization (NDRC, 2010; Qi, 2013). The province increased environmental investment from less than 1% of its GDP in 1995 to nearly 3% over one decade (OECD, 2010).

To move up the value chain and increase emerging and potential industries[189], Guangdong invested in infrastructure and subsidized firms (OECD, 2010), through providing financing and technology support to help Original Equipment Manufacturers (OEMs) toward Original Design Manufacturers (ODMs) and Original Brand Manufacturers (OBMs) (Climate group and Nanfang media, 2011). Guangdong's 11th FYP focused on industrial upgrades, and the establishment of high-tech industries and high value-added manufacturing systems (He, 2016). The province set up engineering laboratories (12), national industry R&D centres (10), and high-tech development zones (9). It ranked first in terms of the number of invention intellectual property rights in the country (Xie, 2011). HNTEs might benefit from preferential corporate income tax assessments under certain conditions[190]. A few sampled HNTEs obtained funding, such as provincial special funding for commercialisation of innovation through a "production-learning-research base"[191]. Companies based in Shenzhen have received 70% of the Guangdong Technology awards issued (Nanfang Daily, 2017).

Industries have been developed in clusters along the east bank (electronics and IT products)[192] and west bank (household appliance products)[193] of the delta. For instance, Shenzhen produced 20% of China's computers, and 15% of its semiconductor integrated circuits (OECD, 2010), becoming the "most competitive city" (HKTDC, 2017)[194]. The surveyed cluster facilities benefited from a high concentration of firms. The ease of visits facilitated the maintenance of relationships with other cluster entities, the sharing of information, and technological learning, as compared with facilities at other locations. Some

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189 According to the development plan for nine pillar industries 2005 – 2010

190 Those earning over 60% of their revenues from high technology products and acquiring proprietary intellectual property rights in the last three years

191 Company sampled #20

192 Dongguan, Huizhou, and Shenzhen

193 Foshan, Jiangmen, Zhaoqing, Zhongshan, and Zhuhai

194 According to "overall economic competitiveness" ranked by *2016 Report on China's Urban Competitiveness*. Chinese Academy of Social Sciences. (2016).

sampled cluster firms established common infrastructure, attracted specialized personnel, and obtained expert advice from local universities and institutions. These firms tended to perceive technological opportunities and to involve local partners to source the components needed for innovation. Such advantages were comparable to those of their western counterparts (Porter, 1996). Moreover, they attracted FDI. For instance, Dongguan alone was home to 9,000 foreign-invested industrial enterprises and its manufacturing accounted for almost 20% of Guangdong's exports (HKTDC, 2018).

Embedded in international trade and production chain, a number of the sampled firms in the PRD implemented environmental initiatives to meet customer demand and comply with the more stringent requirements emanating from export markets. They were also supported by multiple stakeholder actions in efforts to steer away from pollutant and energy intensive manufacturing. The radical political and economic decentralization and established autonomous powers in villages and towns in the PRD (OECD, 2010), left more room for environmental policy implementation. Such finding does not support prior research that suggested local autonomy was a major barrier to implementation in China (He, Lu, Mol, et al., 2012; Zeng and Eastin, 2011). However, it confirmed that decentralization increased powers and strengthened environmental protection in large firms and richer coastal cities (Rock, 2009).

Statistics from SEPA and MEP (1999 – 2011) showed that wealthier regions (van Rooij, Zhu, Li, et al, 2017) and those with higher levels of income tended to initiate complaints (van Rooij and Lo, 2010). The rate of complaints in a region was positively correlated with sanctions against illegal polluters (van Rooij and Lo, 2010). For instance, the total number of complaints (696) submitted through an environmental hotline ("12369") in the first half of 2015 remained unchanged compared with the same period in 2014, while complaints in Guangdong (59) increased by over 90% during the same timeframe. Almost 80% of the calls were related to air pollution and more than 70% of the complaints involved environmental violations (Jiang, 2015). However, our study found that media exposure, shaming lists, and negative perceptions had not directly affected environmental practices in most of the sampled firms. Only a couple of the surveyed ISO 14001 adopters cited pressures from the public or the media as a key factor in influencing their environmental actions[195]. This result was contradictory to prior research (Castka and Prajogo, 2013) that found local communities, social groups, and NGOs were influential in motivating firms to adopt ISO 14001. It is likely that firms perceived less pressure if they had already undertaken environmental measures, as shown in prior research (Lo, Fryxell, and Tang, 2010).

This chapter illustrates recent development in environmental governance systems and, more particularly, shifts in legislations and law enforcement, as well as the introduction of policy instruments and arrangements. Effort made by the central government, from amending regulations (e.g., EPL) to creating new systems and green financial institutions are described. The latter appears to rely on imposition of restrictive measures that target specific enterprises (i.e., listed firms and pollution or energy intensive industries). Similarly, top-down, binding environmental target-based systems put environmental protection on the local policy agenda, and generated the joint environmental initiatives shown in our triad-network model. At the same time, cooperation and partnership contributes to the development of solutions and changes in implementation. The state strived to integrate nonregulatory environmental programmes like CPA into urban industrial management in order to drive environmental changes. The surveyed CPA implementors were driven by carrot and stick policies, which supported previous finding (Geng, Wang, Zhu, et al., 2010).

The initiatives most adopted by the sampled companies were in-house EMS, ISO 14001, and CPA, indicating that the practice of meeting standards and requirements became part of the agenda for some business and political leaders. We found that government authorities worked with network members to meet environmental targets. However, only a selected group of actors specializing in subject areas shared responsibility with the government in facilitating the adoption of practices. With the exception of GENGOs, environmental organizations play circumscribed roles, as shown by recent research (Zhang, 2021). Besides multi-stakeholder involvement, Chapter 5 identifies business opportunities beyond the immediate financial benefits, green supply chain, perceived obligations, and environmental impacts related to regional law enforcement trends, and local government support being the

[195] Q1

major forces that influence the implementation of environmental initiatives, especially nonregulatory measures. Such finding helps us to understand the importance of regional variations and international institutional pressures exerted through supply chains. The next chapter summarizes comparative analyses, highlighting regularities and patterns in the data, the effects of corporate environmental actions, and the key challenges for broad implementation.

Chapter 6 Diverse and uneven paths toward adoption

Chapter 6 identifies regularities and implementation patterns by comparing and contrasting various environmental practices. Section 1 examines the links between firm characteristics and environmental efforts, from complying with regulations and going beyond compliance to developing resources for implementation. Section 2 presents ideal-typical analysis and outlines the top-performing CPA adopters. Based on the environmental performance of ISO 14001 and CPA implementers, we categorize firms into two groups of ISO 14001 adopters and four types of CPA implementers. The section describes a classification of four configurational profiles, illustrates a typology of enterprise in terms of environmental strategy and technological solutions deployed, and portrays eco-innovative firms. Section 3 evaluates the joint effects of implementations, the impacts of stricter laws on eco-innovation and firm performance, and the overall outcomes from using self-evaluated effects and audited results. The last section discusses the major barriers to spreading environmental initiatives, including particular difficulties for SMEs, effectiveness of government intervention, and the limits of market-based initiatives.

1. Firm characteristics and environmental efforts

1.1. Compliance

Twenty-eight large enterprises (LEs) accounted for 64% of the sampled companies that undertook measures in compliance within industry standards. Eight out ten firms without measures were SMEs. Only one out of nine micro-enterprises (IEs) implemented compliant measures (Table 6.1).

Table 6.1: Size, measures and compliance

Size (quantity)	No measure	With measures	Compliant
IE (9)	3	5	1
SE (13)	4	1	8
ME (10)	1	2	7
LE (34)	2	4	28
Total	10	12	44

All firms in pollutant and/or energy intensive sectors (except for one) took environmental action, whereas seven out of ten firms without measures were in other sectors (Appendix J.1). More than two-thirds of the pollutant and/or energy intensive firms (19), and half of the companies targeted by CPA (12) undertook measures meeting industry standards (Appendix J.2). Our data indicated that the more polluting intensive the sampled sectors were, such as the largest emitters of BOD (pulp and paper)[196] and COD (pulp and paper, food and beverage, chemical industry)[197], the more likely that the firm complied with industry standards.

Nearly 80% of the sampled firms cited regulations as a key factor in driving environmental implementation. The SOEs (100%), Taiwan and Hong Kong invested companies (100%), listed firms (all except for one), joint ventures (JVs) (nine out of 11), and large or pollutant/energy intensive firms (24 out of 28) were more likely to consider regulatory requirements as a key driver of action. The exporters serving only international markets (all except for one), and a vast majority of the SOEs and HNTEs identified costs as their implementation catalyst, as compared to the rest of the sampled companies. Proportionally, more large, private, Chinese-invested firms, and non-HNTEs considered CSR and top management decision-making as a determinant. Eight out of ten firms indicating customer demand and technology support as core factors were large enterprises. All companies mentioning human resources (HR) were private and non-HNTEs, while all firms citing public pressures were large companies (Appendix K).

Being more visible than SMEs, larger firms were susceptible to additional pressure and negative publicity, according to several respondents. Our finding confirms those of prior research (Gonzalez-Benito and Gonzalez-Benito, 2006; Neumayer and Perkins, 2004; Welch, Mori, and Aoyagi-Usui, 2002). The sampled LEs were more aware of CSR, and their actions were more likely to be affected by decisions from top management, customer demand, and technology. The regulations had been widely accepted by the sampled SOEs and firms with outside investments. Stringent regulations had significant impacts on the implementation of measures by the pollutant/energy intensive firms. The fact that there were fewer human resources in the private firms and non-HNTEs surveyed, as compared to the

[196] World Bank. (2004).
[197] World Bank. (2001).

SOEs and HNTEs, might explain the relative importance of HR in taking action. All HNTEs were supposed to have at least 10% of their skilled personnel reserved for R&D activities (State Council, 2020). Prior studies showed that these employees had a favorable position regarding CT adoption (Adeoti, 2002; Blackman and Kildegaard, 2003).

1.2. Beyond compliance

The surveyed firms that published their reports were large companies and listed firms, which supports prior information indicating that larger enterprises tend to disclose environmental information (Zeng, Xu, Dong, et al., 2010). LEs accounted for over 75% of ISO 14001 certifications and over 70% of CPA adoptions. All the Hong Kong invested companies had EMS, and they had the highest percentage in ISO 14001 certification[198]. All the Hong Kong and Taiwan invested companies, except for one, conducted CPA. All JVs, except for one, implemented measures and a majority of them adopted CPA. The SOEs and JVs had a relatively high ISO 14001 certification rate (over 40%).

The surveyed enterprises that indicated regulations as a key determinant were more inclined to engage in voluntary environmental programmes. Four pollutant and/or energy intensive sectors (chemical industry, automobile industry, information technology, and electrical equipment) had high ISO 14001 certification rates. Such a finding was in line with prior research showing that electrical/electronic/optical equipment and chemicals/chemical products were among the top five sectors certified (Cushing, McGray, and Lu, 2005). Our finding confirmed that larger firms, SOEs, and companies with outside investments had higher ISO 14001 certification rates (Cushing, McGray, and Lu, 2008; Li, 2012). Three quarters of the sampled SOEs undertook CPA. Although this finding confirmed that SOEs invested more in environmental financing (Li, 2012), it was in contradiction to previous studies that found that they invested less in PAT (Luken and Van Rompaey, 2007) or technology and production equipment upgrades (Jahiel, 1997; Ma and Ortolano, 2000).

[198] Six out of seven companies surveyed

1.3. Resource development

A majority of the large and medium firms worked with organizations, while only a few small companies had collaborative organization connections (Appendix L.1). All the SOEs, except for two, most JVs, and Hong Kong and Taiwan invested firms, collaborated with external organizations. Four surveyed industries (electromechanical industry and special equipment, information technology and electronics, automobile industry, and chemical industry), representing 75% of those implementing measures beyond compliance, were also leading industrial producers and exporters in growing sectors (HKTDC, 2016). Proportionally, more pollutant/energy intensive firms worked with organizations. All sectors working with external organizations (automobile industry, food and beverage, construction materials, and petrochemistry) were pollutant/energy intensive or caused significant environmental impact. Electro-mechanical and special equipment were overrepresented in the companies having collaborations with organization (Appendix L.2).

Government incentives were associated with more voluntary measures (Appendix M.1). Proportionally, the sampled recipients of incentives took more measures. By contrast, the non-recipients undertook few measures. Most "other measures" were linked to non-pecuniary incentives. The ISO 14001 certified firms were top recipients of incentives. Twenty-six out of 37 companies across four sectors that obtaining monetary incentives (Appendix M.2) had the highest certification rates. Most large firms, all Taiwan invested firms, and ten out of 12 SOEs received incentives. The data suggested a correlation between firm size (larger), better access to government incentives, and support from stakeholders. This finding was consistent with a prior study that indicated all large firms received commercial loan credit for CPA (Geng, Wang, Zhu, et al., 2010).

The surveyed firms' characteristics were significant predictors of environmental practices. Bigger enterprises and pollutant and/or energy intensive companies tended to implement environmental measures and comply with industry standards. Moreover, the beneficiaries of subsidies, companies that have external assistance, and growing sectors were likely to adopt measures beyond compliance. Resource-rich firms such as the HNTEs, SOEs, firms with outside investment, and publicly traded firms were associated with voluntary initiatives. For example, HNTEs, listed companies, and those undertaking renovation or expansion had higher CPA adoption percentages (over 65%) than the other sampled companies. The variation in the form of environmental responses reflected that the surveyed firms are not unitary actors, nor a monolithic group. The next section presents different enterprise profiles that help better understand regularities in adopting environmental initiatives.

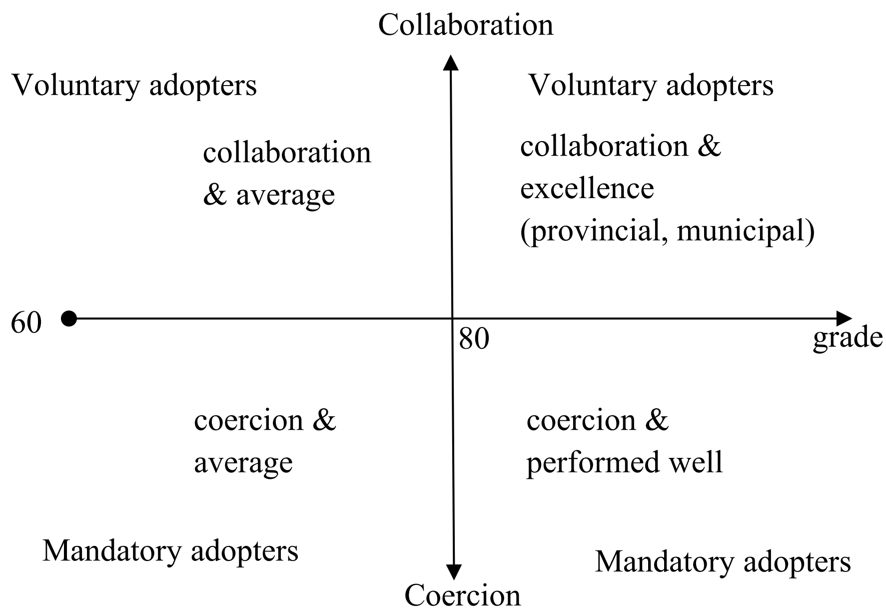
2. Typological profiles

2.1. Categories: ISO 14001 and CPA implementers

Some of the certified companies in our sample "genuinely" adopted ISO 14001, whereas others "symbolically" acquired certification. The "genuine" adopters applied more measures than the "symbolic" ones. ISO 14001 adopters were supposed to comply with standards based on the Plan-Do-Check-Act principle of continuous improvement ensured by an accredited third party (ISO, 2004, 2012; Welch, Mori, and Aoyagi-Usui, 2002). Following the principle would enable them to enhance strategic, managerial, and operational effectiveness and efficiency (Bansal and Hunter, 2003; Jiang and Bansal, 2003; Strasser, 2011). However, self-reported responses from questionnaires revealed that a few certified companies did not fix environmental objectives nor designate persons responsible for environmental protection.

There were four types of sampled CPA adopters, in terms of performance and type of implementation: "average" voluntary adopters (16); "excellent" voluntary adopters (21); "average" mandatory adopters (13); and mandatory adopters that "performed well (3)." All "average" implementers had passing marks (60), whereas the "excellent" voluntary adopters obtained scores of 80 or above. An ideal-typical representation (Figure 6.1) situated the sampled CPA adopters in a two-dimension quadrant including coercion-collaboration and average-excellence. The collaboration-coercion axis indicated the means undertaken to get firms involved in CPA. The highest degree of coercion under the law involved closure and immediate adoption. The degree of collaboration was related to the number and variety of collaborators and projects. The continuous average-excellence axis indicated the relative level, from a passing grade to the highest possible assessment.

Figure 6.1: Ideal-typical representation



Most "average" voluntary adopters were large, privately owned, domestic-invested companies. A majority of the "average" mandatory adopters were SMEs[199] located in industrial parks in Zhongshan. All mandatory adopters that "performed well" were domestic-invested firms maintaining their facilities in urban area. Mandated implementors were not qualified to acquire the status of "Excellent CP Enterprise." By contrast, voluntary adopters benefited from performance award programmes, automatically obtaining the municipal status of "Excellent CP Enterprise" for scores of 80 or above. They could apply for further evaluation in order to acquire the same status at a provincial level. Thirteen implementers obtained the provincial status, including one that achieved "remarkable performance" within the "Hong Kong-Guangdong Cleaner Production Partners Recognition Scheme."

A majority of the "Excellent CP Enterprise" recipients (15) reported positive impacts on environmental implementation from current environmental policies and regulations.

[199] Companies sampled #11, 27, 40, P6

Proportionally, more provincially recognized "Excellent CP Enterprises" took advanced environmental measures[200], and they affirmed the positive effects of such measures[201]. By contrast, none of the mandatory adopters initiated advanced practices or stated positive effects. More sampled enterprises previously or concurrently adopting government-led initiatives had implemented CP practices. This finding was consistent with prior research (Hicks and Dietmar, 2007).

2.2. "Excellent" CPA adopters

Two thirds of the "excellent" adopters were domestic-invested firms that completed renovation or expansion. A majority of them were large, private companies and HNTEs, which were located in industrial parks. All textile mills that performed at the excellent level were non-HNTEs serving European, American, and Canadian markets, whereas most "excellent" chemical firms were HNTEs. All "excellent" electro-mechanical and special equipment manufacturers, except for one, were large businesses serving national and international markets. Growing companies, large, private, HNTEs, exporters to the OECD countries, and firms located in industrial parks tended to achieve good performance. The electro-mechanical and special equipment sector was overrepresented in "excellent" adopters, followed by chemical and textile industries.

The "excellent" companies were publicly awarded prize money. For instance, 5M yuans was allocated for performance achievements in a pilot study. Provincial "Excellent CP Enterprises" were rewarded with 50,000 yuans and were granted access to a simplified procedure for project approval (GDEIC, 2011). Over the past decades, several cities in the PRD (Guangzhou, Foshan, Shenzhen, Dongguan, Zhongshan) have established financial reward systems which offer between 50,000 – 300,000 yuans to implementers (GDEIC, 2011). Most provincial "Excellent CP Enterprises" sampled had obtained government pecuniary incentives and tended to perceive government actions as "monitoring". For instance, one private enterprise chose to "maintain neutral, remain cautious, and not be too

[200] Q6a:5; Q8c:7, Q9a:7
[201] Q1a: 3 & 1b

close to officials," said one of its founders. With a few exceptions, they had maintained "frequent" relationships with government agencies.

The **"**excellent**"** adopters[202] collected a swathe of honours, awards, and prizes from governments, industries, and suppliers in recognition of their outstanding performance in various areas (i.e., environmental protection, corporate citizenship, productivity and quality, tax contribution, and economic impact). Their staff and executives exhibited great pride when showing us the CP excellence honour plaques, among other awards and certificates displayed at the factory entrance gates or in their office buildings. A strong will to win seemed to motivate these companies to achieve a good performance in CPA, like other leading adopters in the PRD (GDCP, 2010; GZETC, 2010).

In addition, company cultures have been shaped to support environmental commitments by instilling a sense of belonging and a bonding point for employees. "Our culture is very strong, and we are capable to execute [environmental implementation]," said one corporate Vice President (VP). A number of staff, mostly young migrant workers, told us that they were proud of being part of the company[203]. Several provincial "Excellent CP Enterprises" used visible culture codes, including posters, banners, and internal print magazines, to share the company's commitment to preserving the environment[204]. One company hung posters in the meeting room displaying a mission statement that said, "striving for sustainable development," along with core values to "[…] maintain better environment for future generations" with "mutual respect, equal opportunity, sharing of success, persistence, and customer satisfaction"[205]. By making their mission statement and values accessible, these companies connected their employees and helped the employees to understand how their work impacts the environment[206].

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[202] Companies sampled #14, 51; GDCP. (2010); GZETC. (2010).
[203] Based on informal conversations during lunch at the factory cafeteria
[204] Companies sampled #14, 51
[205] Company sampled #14
[206] Based on an interview and discussions with an executive, middle-level management, and staff

2.3. Profile and typology

Based on the patterns of environmental considerations and practices in managerial, operational, and technological activities, we created four configurational profiles (Table 6.2).

Table 6.2: Configurational profile

Profile	Consideration	Management	Operation	Technology
Absentee	none	none	none	none
Minimalist	few	none/a few	a few	minimum
Complier	legal	systemic	some	some
Integrator	strategic	integrated	a wide range	multiple

The "absentee" designation included companies that did not implement any environmental measure. They avoided taking into consideration environmental issues. The second configuration was comprised of firms that took at least one measure. Having few considerations for environmental protection, these "minimalists" had not included the environment in their business plan. They were slow to take action and preferred to "wait and see," in order to buy time. The "complier" designation referred to enterprises that had legal considerations, acted in accordance with industry standards, and took compliance-only measures. The "integrator" considered the environment as a strategic component of their business success. Compared with "compliers," the "integrator" incorporated environmental goals into business activities, took more measures in operations, and deployed multiple environmental technologies.

In terms of the environmental strategy and technological solution deployed, the surveyed companies were grouped into four types (Table 6.3).

Table 6.3: Typology of enterprises

Type of company	Environmental strategy	Technological solution
Laggard	none	none
Taker	reactive	end-of-pipe (EOP)
Follower	adaptive	EOP & clean technology (CT)
Eco-innovator	proactive	EOP, CT, eco-innovation

The "laggard" had neither an environmental strategy nor environmental technology. They attempted to avoid policy constraints and resisted changes. The higher the environmental standards, the more disadvantages the "laggard" faced. The technology "taker" adopted a reactive environmental strategy and made changes reluctantly. They deployed conventional technologies and the least-cost options (e.g., resource conservation) to pick low-hanging fruits. The "followers" made changes with an environmental strategy. They were prone to adopt EOP and proven CT. The "eco-innovator" employed a proactive environmental strategy, used a number of technologies (more particularly CT), and engaged in eco-innovations. The "followers" tended to be more adaptable and have stronger technological capabilities than the "takers." The "eco-innovators" had the strongest capabilities as described in the next subsection.

2.4. Portrait of eco-innovators

Fourteen surveyed firms developed new products and production processes that reduced negative environmental impacts. With a few exceptions, they were large medium size enterprises (12) and HNTEs (11). Fifty percent of these firms were in the pollutant and/or energy intensive sector, and the other half were in other sectors. Eco-innovative responses came from electro-mechanic equipment industries (6) and chemical industry (3), textiles and clothing (2), petrochemistry (1), cement industry (1), and plastic industry (1). They were recipients of government incentives, such as subsidies on R&D, which were valued between 100,000 and 1.7M[207] yuans per annum. All "eco-innovators" (except for two) collaborated with stakeholders including environmental services providers (12), universities and research institutes (8), and other organizations (3). They accounted for nearly half of the sampled firms cooperating with universities and research institutes. Having greater access to environmental technological knowledge from a broad range of sources, the "eco-innovators" formed and strengthened collaborations that developed learning-by-doing and problem-solving cultures, while staying current with technological advances. High levels of environmental knowledge enabled them to enhance their technology development and

[207] Companies sampled #60, 11

differentiate their products from competitors. Our finding confirmed that innovative firms were resourceful (Khanna and Anton, 2002).

The surveyed "eco-innovators" integrated environmental protection, low carbon, and greening[208] into their agenda. They were capable of identifying emerging customer demand, forecasting future markets, making environmental investments, and taking on the risks of demand uncertainty. In addition, these firms managed to deploy resources and transform them into sources of innovation. Such capability was referred to as an "integrative" ability that improved in combination with innovative responses (Teece, Pisano, and Shuen, 1997). Thanks to such ability, the sampled "eco-innovators" built and reconfigured organizational skills, resources, and competencies, and created new opportunities, achieved environment-related competitive advantage, as well as enhanced their business value.

All "eco-innovators," except for three, established incentive systems and provided training to employees. Focusing on having an "innovative mind-set, management, products and green technology,"[209] an eco-innovative company[210] was founded by people sharing a vision for environmental protection. They have created new product lines by delivering quality products and services via the "internationalization of products, market, and talent"[211]. Since its establishment, monthly training and an "employee dream" plan were implemented[212]. Each year, employees provided between 1,000 – 2,000 suggestions. On average, a dozen suggestions were partially implemented and a few (3 – 5) were fully implemented. "Rewards range from hundreds to tens of thousands yuans," said the VP. Another sampled firm emphasized on inculcating a sense of responsibility that enabled to lower production reject rate and ensure a high quality of raw materials and final products[213]. These examples showed that environmental awareness enhanced the overall quality of products and reduced waste loss.

[208] Company sampled #3
[209] Our translation of company mission and vision
[210] Company sampled #14
[211] Ibid.
[212] Ibid.
[213] Company sampled #46

Nine out of ten "eco-innovators" that adopted CPA obtained a status of "Excellent CP Enterprise." Most of them integrated CP measures into their activities. Open to new approaches, these firms seized opportunities through integrating environmental protection into business activities. The staff had well-defined roles and were encouraged to enhance their capacities through individual performance bonuses. The "eco-innovators" also tended to pursue continuous improvement. Half of them indicated they would continue to develop environmentally friendly products and increase environmental investments. Over one third of the sampled "eco-innovators" planned to use highly efficient electric generators, and/or undertake energy efficiency upgrades in the next five years. Such responses were in line with prior studies that found innovative firms were forward looking and had the ability to absorb associated costs and undertake organizational change (Khanna and Anton, 2002). The next section looks at the overall outcomes and impacts of environmental actions.

3. Implementation outcomes and impacts

3.1. Concurrent adoptions and implications

Twenty surveyed companies implemented joint EMS and voluntary CPA. The ISO 14001 adopters accounted for nearly 85% the voluntary CPA implementations. Nearly one third of these companies took various nonregulatory initiatives including carbon inventory and carbon trade[214]. EMS adopters accounted for two thirds of the companies with measures going beyond compliance. The latter implemented twice as many measures than those only adopting ISO 14001, in terms of reducing pollution, recycling paper, managing waste, and improving products and production processes (Appendix N). All in-house EMS implementers, except for one, undertook measures to comply or go beyond compliance. They outperformed ISO 14001-only adopters in the total number of measures taken and performance. Such result confirmed those of previous studies (King, Lenox, and Terlaak, 2005; Yin and Schmeidler, 2009). These findings suggested that home-made systems were more likely to help in-house EMS adopters achieve better performance.

[214] Q6a

The surveyed "genuine" ISO 14001 adopters created paper trails, defined environmental responsibilities, and provided training to raise environmental awareness. The finding was consistent with those of previous research (Prakash and Potoski, 2006). The "symbolic" adopters carried out only a few actions that delivered minimum performance. Such result was in concordance with prior findings (King, Lenox, and Terlaak, 2005; Yin and Schmeidler, 2009). On the contrary, a few sampled non-certified firms applied ISO 14001 operational instructions to establish the organization and content of an EMS (i.e., identifying environmental impacts, outlining communication structures, and formulating procedures for evaluating environmental compliance). Similar practices were also found in companies elsewhere (Rondinnelli and Vastage, 2000). Explicit[215] or implicit[216] use of ISO 14001 documentation (environmental procedural documents and operating guidelines), serving as templates, resulted in convergences of environmental policymaking, planning, and monitoring among the sampled "genuine" adopters.

The surveyed implementers that "performed well" adopted a multitude of measures, which distinguish them from other firms. All "eco-innovators" were in-house EMS adopters, which were ISO 14001 certified (except for two companies). They adopted advanced management practices, which is in line with previous studies (Florida, 1996; Florida and Davidson, 2001). Also, the sampled EMS adopters integrated environmental activities with other management systems, like their Canadian counterparts (Henriques and Sadorsky, 2004). Implementation of various measures stimulated changes from learning, developing coordination, and adapting management styles (i.e., cross-functional work). Teamwork and cross-departmental collaboration facilitated disseminating environmental information and knowledge, and contributed to high performance in CPA, on par with other Chinese firms (Hicks and Dietmar, 2007; GZETC, 2010; Wang, 1999).

Moreover, the implementers that "performed well" shared common attributes and practices, including adequately trained personnel, strong management support, and applying up-to-date management approaches, methods, and procedures. Some of them[217] acquired triple

[215] Companies sampled #6, P4
[216] Company sampled #51
[217] Companies sampled #10, 46

certifications[218], adopted total quality management (TQM), and ISO 9001[219]. They developed structured processes, from setting environmental objectives, planning, and allocating resources, to monitoring and evaluating results. For example, adopting OHSAS 18001 improved working conditions, reduced environmental risks, and lowered waste treatment fees[220]. Previous research found a positive relationship between adoptions of ISO 9001 and ISO 14001 (Christmann and Taylor, 2001; Henriques and Sadorsky, 2004; McGuire, 2012), as ISO 9001 adopters tended to be familiar with ISO standards and the types of paperwork involved (McGuire, 2012).

A few companies that performed well in environmental protection had implemented application systems to improve planning and control of internal resources[221], as well as management and operational efficiencies such as supply chain management, customer relationship management, product life cycle management[222], and six-sigma (6S)[223] rooted in TQM. Companies achieving a 6S level of performance could avoid waste losses and decreased the costs of waste management. A life-cycle perspective enabled firms to extend the TQM process beyond eco-efficiency. They enhanced their ability to perform analysis for forecasting and established a framework for internal and external communication that facilitated their ability to accomplish multiple environmental implementations.

Both CPA and EMS implementations could allow for optimization of resource efficiency, enhanced reuse and recycling, improved product quality, reduction of costs, and profitability. Being early movers, as was the case with four surveyed firms that acquired provincial "Excellent CP Enterprise" status among the first 300 CPA implementers in Guangdong, created positive media attention, enhanced corporate image, and established credibility. They showcased practices, acquired knowledge, and improved capabilities by sharing with stakeholders via pilot projects (i.e., energy saving and emission reducing technology[224] and

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[218] Quality, Security, Environment: including Occupational Health and Safety Management Certification (OHSAS 18001)/ISO9001/ISO 14001), ISO 9001 and ISO14001

[219] Companies sampled #3, 4, 5, 10, 11, 14, 46, P6, P9, P11

[220] Company sampled #46

[221] Such as Enterprise Resource Planning applications implemented by companies sampled #4, 14, 15, P2

[222] Company sampled #14

[223] Systems rooted in TQM, GDCP. (2010).

[224] Company sampled #3: an expert platform for integrating design and production of customized elevators, 广东省信息化与工业化融合 4 个 100 示范工程标杆企业、节能减排信息技术应用标杆示范企业

CP information application[225]) (GDEIC, 2011). Most surveyed EMS adopters improved management capabilities and working relationships within and between firms. In addition, these firms reduced production rejects, recycled packaging and containers, avoided disposal of raw materials, and reduced loss of input. The EMS and CPA adopters surveyed may have enhanced their managerial and technological capabilities, as demonstrated by prior studies (Blind, 2012; Rennings, Ziegler, and Ankele, 2006; Wagner, 2008).

3.2. Stricter law, eco-innovation, and performance

Banning or severely restricting chemicals[226] forced the surveyed manufacturers to use alternatives. Moreover, stricter standards drove the paint industry to develop new technologies, in order to lessen the use of volatile compounds in manufacturing. Such evidence supported that more stringent laws produced "greater innovation" than lax regulations, and that the regulated firms would make incremental product and process changes or reconfigure products and processes advanced by Porter and van der Linde (1995a, 1995b). The surveyed firms that made product and process changes increased their sales, thanks to their ability to meet customer demands. For instance, more customers demanded water-based paint and pigment because they became conscious of the toxicity of solvent-based products. In fact, a sampled eco-innovative paint manufacturer[227] acquired 70% and 50% of product market share in national and international markets, respectively.

Stronger management capabilities enabled the sampled "eco-innovators" to improve approaches for measurement and assessment that determined costs and benefits. The approaches helped them identify opportunities for innovative solutions. This finding supported Porter and van der Linde's claim (1995a, 1995b). In addition, their management capabilities facilitated the execution of eco-innovations. The finding was in line with that of prior research (Kammerer, 2009). The "eco-innovators" accounted for 100% of the surveyed firms using ecolabels. Most sampled "eco-innovators" were industry leaders that have

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[225] Companies sampled #51, 18: 2011 GD integration of Information and Industrialization: 100 pilot project candidates. 广东省信息化与工业化融合“4 个 100”示范工程序号地区项目名称/行业/应用领域工业企业生产流程数字化改造示范. GDEIC. (2011).
[226] Such as cyanide
[227] Company sampled #P11

propelled themselves into international markets. They obtained national (i.e., CCC[228] and CELP[229] and international product certifications (i.e., CE[230], TUV[231], UL[232], ETL[233], and triple certifications[234]). Certifications and ecolabels served to differentiate their products, contributing to higher profits because buyers were willing to pay premiums. Therefore, eco-innovations created product stewardship traits that satisfied environmental demands, kept one step ahead of competitors, enhanced/maintained market share, and opened up opportunities to extend markets to jurisdictions where environmental standards were higher.

The trajectories taken by the surveyed "eco-innovators" turned environmental challenges into opportunities, and created environmental leadership, a strong cohesive culture, and continuous improvement. A couple of the sampled early movers set industry standards, including sectoral CP technology standards[235], which was considered "exceptional"[236]. The surveyed forerunners moved up the value chain and became more capable competitors by serving a broader geographic scope and offering products at prices that outcompeted other global companies. For example, a chemical firm made products with recycled waste that decreased energy consumption and production costs. Their costs were only half of its international competitors. As a result, the firm held a 40% product share of world exports (Gdzxb.gov.cn, 2005).

CPA enabled the sampled adopters to phase out obsolete production capacities, improve bad environmental records/credits, minimize liabilities, and maintain a license to operate. Eco-innovations contributed to reducing negative environmental effects (i.e., toxic chemicals and volatile matter) and increasing product value. Such results are in line with previous reporting (Gdzxb.gov.cn, 2005; Wrenn, 2019). The surveyed implementers of EMS, eco-innovations, and voluntary CPA gained efficiency by integrating environmental protection efforts into organizational process. Our finding was in accordance with those of prior studies (Morrison

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228 Companies sampled #P9, 4, 14
229 Company sampled #11
230 Companies sampled #3, 4, 14
231 Company sampled #4
232 Companies sampled #4, 14
233 Ibid.
234 Companies sampled #4, 46, P9
235 Companies sampled #47, P11
236 According to a VP working for an eco-innovative firm

et al., 2000, as cited in Cushing, McGray, and Lu, 2008). Concurrently undertaking environmental initiatives (i.e., CPA and EMS) could have improved capabilities for coordination, cooperation, and collaboration among business units and functions. Such improvement in turn ameliorated the ability to fulfill customer needs and improved competitive advantage, as suggested by prior research (Delmas, 2001; Russo, 2009). According to one study, resources and skills developed during the process were complex and difficult to imitate (Delmas, 2001).

The sampled "eco-innovators" indeed secured a competitive edge and achieved/maintained their leadership position by making changes faster and/or better. Such finding confirmed that technological change, innovation, and cleaner production systems improved eco-efficiency (Gunningham, Kagan, and Thoronton, 2003; Mol, 1995), productivity, and competitiveness (Huber, 1991, as cited in Mol and Jänicke, 2009). Enhanced eco-efficiency and resource productivity enabled these eco-innovative companies to lower input costs, reduce expenses associated with liability, and generate financial gains. As well, green image, cost leadership, and product differentiation allowed them achieving first mover advantage. The result was consistent with previous findings (Bansal and Roth, 2000; Esty and Porter, 1998; Gunningham, Kagan, and Thoronton, 2003; Huber, 2009; Jänicke, 2008; Kallio and Nordberg, 2006; Porter, 1990; Porter and van der Linde, 1995a, 1995b; Reinhardt, 1998; Roome, 1998).

3.3. Self-evaluation effects

Self-reported results from questionnaires showed that environmental implementation increased revenue and/or reduced expenses (30), or increased expenses and/or reduced revenue (31). The effects varied and depended on the markets served and the number and type of measures taken. A majority of the adopters of voluntary initiatives (i.e., eco-label, CPA, ISO 14001, and "other measures") increased revenue or decreased expenses, whereas the firms taking few measures indicated a neutral (16) or uncertain (6) effect. Most firms participating in carbon trade indicated decreased revenue and/or increased expenses. The companies applying voluntary measures (e.g., firms undertaking "other measures") increased revenue and/or decrease expenses (Appendix O.1).

The sampled firms adopting eco-label, EMS, and eco-innovation were the most profitable. Our finding was comparable to those of prior studies. EMS adoptions were associated with benefits, for example, improved image and reputation (Prakash, 2000) and increased market share (Christensen, 2013). Previous research suggested a positive relationship between ISO 14001 adoption, increasing revenue (Eriksson, 2004), and cost savings (Chen, 2002; Morrison et al., 2000, as cited in Cushing, McGray, and Lu, 2008). One study found that certified firms had greater long-term profits than non-certified ones publicly traded on the Tokyo Stock Exchange (Nishitani, 2007). However, our study could not attribute a dollar amount to benefits that were derived from ISO 14001 certification, similarly to another survey of more than 1,400 American companies (McGray and Lu, 2008).

A minority of the surveyed companies indicated that environmental implementation enhanced competitiveness in domestic markets (44%) and international markets (35%). In-house EMS adopters were more inclined to report enhanced competitiveness. More firms taking mandated CPA and voluntary measures (i.e., CPA, ISO 14001, and "other measures") indicated improved competitiveness in domestic markets (38) than were reported in international markets (30). Proportionally, more exporters to Europe, USA and Canada, and Asia including Japan stated enhanced competitiveness in international markets than domestic markets. However, a majority of the firms only serving domestic markets (i.e., suppliers to MNCs and OEMs) affirmed the opposite. A majority of the companies serving national and international markets, suppliers to MNCs, and the exporters to other markets (i.e., Africa, Latin America, Australia and New Zealand) indicated enhanced competitiveness in both markets (Appendix O.2).

The surveyed firms subject to more stringent environmental requirements tended to perceive relations between market demands, competitiveness, and environmental implementation, and enhanced competitiveness, as demonstrated by exporters serving markets with stricter regulations (European, American, Canadian, and Asian markets including Japan). Double the number of firms stated the neutral effects of environmental implementation on competitiveness in domestic markets (17) than international markets (8). Domestic markets were more likely to be associated with the neutral effect of implementation. More OEMs, companies serving both markets, exporters to Asia except Japan (8), and USA and Canada (5) indicated such effect in domestic markets than in international ones (Appendix P).

A few surveyed firms linked environmental implementation to decreased competitiveness. Only two exporters (one firm serving both markets and the another serving only international markets) reported decreased competitiveness in international markets. According to a couple of entrepreneurs interviewed, intense retail price competition prevented their firms from improving competitiveness in international markets. Double the number of exporters (i.e., serving Europe, Asia except Japan, and USA and Canada) stating decreased competitiveness in domestic markets (4) (Appendix P).

Nearly 60% of the surveyed firms complied with environmental standards (i.e., pollution emissions, energy, and water consumption) (51). A majority of them reduced waste, air, and water pollutants (44), reduced resource consumption (paper, raw materials) (41), and increased energy efficiency (37). Only 20% of the companies reported direct carbon emissions reduction (17). Self-evaluated performance revealed that in-house EMS only adopters, “eco-innovators,” and joint EMS adopters were top achievers. In-house EMS only adopters had the highest percentages in compliance (100%), reduction of waste and pollutants (88%), and resource consumption (88%), as well as higher percentages for improving energy efficiency (75%) and reducing carbon emissions (38%). These percentages were 30%, 20% nearly 20% higher than those of ISO 14001 only adopters, respectively. Joint EMS adopters had the highest percentage in carbon emission reduction (47%), which was nearly 30% higher than the lowest percentage (ISO 14001 only adopters). Joint adopters had between 10 – 20% higher reductions in resource consumption and compliance as well as increasing energy efficiency than those of ISO 14001 only adopters. The “eco-innovators” had the highest percentage of increasing energy efficiency (86%), higher percentages of compliance (93%) and other improvements including waste and pollutants reduction (79%), decreased resource consumption (71%), and lowered carbon emissions (43%).

The surveyed CPA adopters accounted for over 85% of firms with increased energy efficiency and reduced carbon emissions, lowered waste and pollutants, increased compliance, and over 75% of decreased resource consumption. The sampled voluntary CPA adopters had higher percentages than the mandated ones in compliance (30%), waste and pollutant reduction (20%), and energy efficiency and reduced resource consumption (10%). Mandated adopters had the lowest percentage of compliance (56%), at slightly below the average of the sampled firms. EMS implementers were more likely to comply and to reduce waste and pollutants, whereas CPA adopters tended to reduce carbon emissions. A majority of the respondents thought that their firms' environmental performance was either superior to their industry counterparts (37) or the same as others (30). The surveyed CPA adopters comprised over 75% of those evaluating their performance as superior. Fifteen firms, predominantly non-adopters, were uncertain about their comparative performance (Appendix Q).

EMS adopters accounted for more than 90% sampled firms that reduced waste and pollutants and increased energy efficiency, and nearly 85% of companies that undertook compliant measures. This finding confirmed the results of prior research. For example, EMS adopters mitigated environmental risks (Morrison et al., 2000, as cited in Cushing, McGray, and Lu, 2008) or had lower toxic releases (Dasgupta, Hettige, and Wheeler, 2000); ISO 14001 adopters reduced pollution and resource consumption, developed new procedures (Castka and Prajogo, 2013; Chen, 2002; Potoski and Prakash, 2005b; Rondinelly and Vastag, 2000; Russo, 2009; Yee, 2012), and contributed to regulatory compliance in China (Chen, 2002) and elsewhere (Dasgupta, Hettige, and Wheeler, 2000; Potoski and Prakash, 2005b). However, our research also showed that firms applying only ISO 14001 certification was associated with less positive effects. The last subsection describes the impacts of the surveyed CPA adopters using audited CP reports.

3.4. Audited results

A majority of the "excellent" CPA adopters and "average" implementers provided their reports that specified the outcomes of CPA implementations in terms of social, environmental, and economic impacts. The "eco-innovators" were the most represented (11), whereas the "average" non-eco-innovative voluntary adopters (6) were the least represented. None of these companies conducted carbon inventory or published reports publicly. Only one provincial "excellent" implementer participated in carbon trade. Several provincial “excellent” eco-innovative implementers and “average” non-eco-innovative voluntary adopters adopted “others” (i.e., OHSAS 18001 adoptions[237] and moved toward building or relocating to more energy efficient facilities). The following tables (Table 6.4a & 4b) illustrate voluntary measures taken by “excellent” voluntary CPA adopters, as well as voluntary and mandatory adopters. All the illustrated provincial “excellent” “eco-innovators” (Table 6.4a) adopted joint EMS and eco-labels, whereas all the municipal “excellent” companies implemented ISO 14001. In terms of quantity of measures undertaken, the former ranked as the top performing adopter followed by provincial “excellent” non-eco-innovative companies and municipal “excellent” “eco-innovators.” All “average” voluntary adopters (except for one) were joint EMS implementers, more than doubling the number of mandatory ones. Both eco-innovative firms that undertook mandatory CPA had implemented in-house EMS, applied eco-label, and “others.” A couple of “average” “eco-innovators” were ISO 14001 certified.

<table>
<tr><th colspan="5">Table 6.4a: “Excellent” voluntary adopters</th></tr>
<tr><th rowspan="2">Measures</th><th colspan="2">Provincial</th><th colspan="2">Municipal</th></tr>
<tr><th>eco-innovator</th><th>non-eco-innovative</th><th>eco-innovator</th><th>non-eco-innovative</th></tr>
<tr><td>ISO 14001</td><td>4</td><td>3</td><td>3</td><td>4</td></tr>
<tr><td>In-house EMS</td><td>4</td><td>2</td><td>1</td><td rowspan="7">N/A</td></tr>
<tr><td>Carbon trade</td><td rowspan="2">0</td><td>1</td><td rowspan="6">0</td></tr>
<tr><td>Carbon inventory</td><td rowspan="4">0</td></tr>
<tr><td>Eco-labelling</td><td>4</td></tr>
<tr><td>Public report publication</td><td>0</td></tr>
<tr><td>Others</td><td>3</td></tr>
<tr><td>Total number</td><td>4</td><td>4</td><td>4</td><td>4</td></tr>
</table>

[237] Companies sampled #46, 15

The mandatory adopters that performed well did not take any voluntary measures (Table 6.4b).

<table>
<tr><th colspan="6">Table 6.4b: Voluntary and mandatory adopters</th></tr>
<tr><th rowspan="3">Measures</th><th colspan="2">Voluntary adopters</th><th colspan="3">Mandatory adopters</th></tr>
<tr><th colspan="2">average performance</th><th>well-performed</th><th colspan="2">average performance</th></tr>
<tr><th>non-eco-innovative</th><th>eco-innovator</th><th>non-eco-innovative</th><th>non-eco-innovative</th><th>eco-innovator</th></tr>
<tr><td>Voluntary CPA</td><td>6</td><td>1(*)</td><td colspan="3">N/A</td></tr>
<tr><td>Mandatory CPA</td><td colspan="2">N/A</td><td>1</td><td>6</td><td>2</td></tr>
<tr><td>ISO 14001</td><td>5</td><td>1</td><td rowspan="7">0</td><td>2</td><td>1</td></tr>
<tr><td>In-house EMS</td><td>5</td><td rowspan="6">0</td><td>2</td><td>2</td></tr>
<tr><td>Carbon trade</td><td rowspan="4">0</td><td rowspan="4">0</td><td rowspan="2">0</td></tr>
<tr><td>Carbon inventory</td></tr>
<tr><td>Eco-labelling</td><td>2</td></tr>
<tr><td>Public report publication</td><td>0</td></tr>
<tr><td>Others</td><td>4</td><td>3</td><td>2</td></tr>
<tr><td>Total number</td><td>6</td><td>1</td><td>1</td><td>6</td><td>2</td></tr>
</table>

All provincial "excellent" CPA adopters, except for three, invested less than the average in low-cost options. Half of them generated above average savings, including one significant spender that injected six times more than the average investment with eight times more in savings. All municipal "excellent" adopters, except for two, injected less than the average investment in low-cost options. Their spending ranged from less than one fifth of the average investment (with 8% of the average savings) to double the average investment (resulting in nearly twice the average savings). Only a couple of "average" voluntary adopters had above average investment levels and savings. The smallest spender invested 2% of the average investment with 4% of the average savings, whereas the biggest spender invested 2.4 times more than the average investment with 3.5 times more savings. Three mandatory adopters injected above average investments and one generated more than average savings. Investment and savings are positively associated with performance in voluntary CPA. Well-performed voluntary adopters generated more savings and invested less in low-cost options. The mandatory adopters tended to spend more, with less savings than "average" voluntary adopters.

In total, the aforementioned firms invested over ¥CNY1.35Bn in 926 CP options, including 137 complex options that brought more than half a billion yuans in savings per annum, and nearly ¥4.3M within the CPA audited period (Appendix R). They injected between ¥3,000 – ¥700,000 in low-cost measures and spent from ¥1400, 000 – ¥33M in high-cost ones. The adopters implemented almost 800 low or no cost measures amounted ¥4M and brought over ¥10M in savings per year and ¥600,000 in benefits during the audited period. With 33 times more spending, high-cost options generated quadruple the benefits of low-cost measures.

Over 60% of the high-cost measures were to replace, modify, or introduce equipment. The rest varied from technology modification, product reformulation, and better process control to pollution treatment, energy source replacement, input material change, certification, application system adoption, maintenance, renovation, moving, and relocation of equipment/workshop. More than half of the equipment modifications aimed to save energy (e.g., reduction of steam, coal and electricity). Good housekeeping practices (i.e., adjusting machines, monitoring chemical dosage, and regular maintenance) optimized and improved environmental efficiency (e.g., preventing or minimizing leakage, enhancing raw material efficiency, and reducing emissions and wastes). Both low and high-cost measures generated positive environmental outcomes, including decreased resource use, lowered energy consumption, and reduced emissions, effluent, and waste.

The major outcomes illustrated below (Table 6.5) shows that high-cost options delivered significantly better outcomes than low-cost measures with a few exceptions. High-cost measures contributed to the greatest reduction in energy consumption, carbon emissions, dust, and ash; whereas low-cost ones conserved wood pallet packaging, office and lab supplies, and two-thirds of the raw materials consumption. For example, deploying smart devices to collect dust, as well as tracking and monitoring operations enabled to enhance process control and reduce pollution. Improving the design of processes and using new machinery and filter systems[238] cut chemical, energy, and raw material use, reduced discharge, and re-channelled substances into production processes[239]. Furthermore, reusing

[238] Companies sampled #5, P2, 15
[239] Company sampled #46

and recycling wood pallet packaging[240] and cardboard saved wood, and reduced the consumption of forest products. Information stored, displayed, and transferred in electronic form replaced paper and paper-based material and reduced material consumption[241]. Turning down heating, cooling, and lighting levels during non-working hours conserved energy, as did investing in compact fluorescent lightbulbs, using devices (steam traps, or designed sensors and control systems)[242], employing more efficient cooling towers or generators, and retrofitting equipment[243].

Table 6.5: Positive environmental outcomes			
	Total	Low-cost option	High-cost option
Decreased resource use per annum			
Electricity 10,000 kw/h	412	121	291
Coal (ton)	6,557	692	5,865
Steam (ton)	4,016	416	3,600
Freshwater (ton)	220,829	110,094	110,735
Raw materials (ton)	3,052	2,041	1,011
Wood pallet packaging (ton/m3/km)	368/10/47	368/10/47	0
Paper	129	0	129
Others (less than 100 tons): cardboard, steel, copper, office and lab supplies, paint, fuel, cast iron, chemicals, denim, detergent, toxic substance (cyanide)			
Reduced emissions, effluent, and waste			
Atmospheric emission (ton)	230	101	129
CO_2 (ton)*	16,298	9	16,289
Effluent (ton)	134,871	87,107	47,764
Dust/ash (ton)	636	0.0003	636
Solid waste (ton)	3,537	947	2,590
Others (less than 100 tons): SO_2, NOx, VOC, COD, ammonia nitrogen, chromium, silver, copper, nickel, zinc ash, toxic waste (cyanide)			

Key indicators (i.e., resource intensity of production) revealed that a vast majority of the adopters minimised environmental impacts while producing positive economic benefits before and after implementations. Resource-efficient practices reduced, concomitantly, production costs and negative environmental impacts, and brought immediate or near-term

[240] Companies sampled #3, 46, 4, 14
[241] Companies sampled #14, 5, 15
[242] Company sampled #5
[243] Companies sampled #6, 46, 5

quantifiable financial outcomes. The overall benefits outweighed the costs. Consuming less electricity cut energy bills and curbed indirect carbon emissions, while saving water and chemicals reduced wastewater and pollution. Decreasing the consumption of energy and raw materials enhanced product competitiveness and the ability to obtain more overseas orders[244], as well as government incentives (i.e., provincial energy efficient incentives)[245]. Replacing toxic chemicals with alternatives[246] eliminated hazardous ingredients and reduced toxic waste and health risks, which also improved working conditions. Such finding confirmed those of prior studies (Gdzxb.gov.cn, 2005; Lü, Geng, and He, 2015; Technology Daily, 2019). The sampled voluntary implementers achieved the triple benefits of CP by maximizing resource productivity, improving social benefits and financial bottom line. Our results were consistent with prior findings across industries and countries (CGCC Vision, 2010; Cushing, Wise, and Hawes-Davis, 1999; Fussler and James, 1997; Warren, 1996, as cited in Cushing, McGray, and Lu, 2008; Vietnamnet, 2019).

Such improvement had positive impacts on the surrounding geographic areas. According to monitoring results[247] and a joint report[248], air quality improved (Government of the Hong Kong SAR, 2017; Xie, 2017a, 2017b; Xie, Chen, and Zhong, 2017), as did water quality. Eighty percent of the surface water quality was assessed as being superior to Grade III[249] (Xie, Huang, and Zhong, 2016). The total amount of substances[250] causing pollution in the major rivers in Guangdong decreased, exceeding national objectives (Xie, 2018a). All of the deltaic cities surveyed had improved their environmental quality, achieved development targets, and obtained or maintained the status of "environmental protection model city"[251].

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[244] Company sampled #14

[245] For saving 1,000 – 10,000 tons of standard coal equivalent (200 yuan/tce), Xie. (2011).

[246] Companies sampled #46, P2

[247] Results released by the provincial MEP and Meteorological Bureau

[248] Results released by the Guangdong-Hong Kong-Macao Pearl River Delta Regional Air Quality Monitoring Network

[249] According to Environmental Quality Standard GB3838-2002, Environmental quality standard for surface water, June 1st, MEE. (2002). https://english.mee.gov.cn/Resources/standards/water_environment/quality_standard/200710/t20071024_111792.shtml

[250] Including COD, ammonia nitrogen, SO_2, NOx

[251] Status obtained: Shenzhen and Zhongshan (in the late 1990s); Guangzhou, Foshan, Jiangmen, Dongguan, and Zhaoqing (in the 21st century)

Meanwhile, Guangzhou and Shenzhen figured among 14 cities[252] whose GDP exceeded one trillion yuans, accounting for nearly a third of China's GDP[1] (China Daily, 2018).

Stringent law enforcement and compliance enabled the PRD to reduce pollution (MEE, 2019), reap benefits, and step ahead in wealth and development (OECD, 2010). The most current results of the annual, provincial environmental protection credit evaluation (2019) (Yue, 2020) showed that nearly 95% of the regulated enterprises (1,044) were attributed to blue (766) or green codes (215), indicating good or excellent environmental behaviours. The enterprises being assessed as "environmentally conscious" accounted for over 73% of the total number, between 2017 and 2019. Compared with 2017, the percentage of firms with "excellent performance" increased by 7%, whereas those with "alarming and bad performance" decreased by 6% and 0.7%, respectively. Despite improvements in environmental protection, some firms (including manufacturers in our sample) did not initiate environmental measures. The last section addresses the barriers to spreading environmental action.

4. Obstacles to broad participation

4.1. Difficulties and different implications

The surveyed firms encountered some difficulties in environmental implementation. According to the responses from predominately large, private, and domestic-invested companies adopting various measures, they lacked financial resources (56), encountered technological problems (45), and confronted management issues (33), overly stringent environmental standards (19), as well as other problems (5). The degree of difficulty was associated with the type of measures undertaken and the firm's characteristics. All mandatory CPA adopters (except for one), most firms implementing "other measures" (85%), a majority of the ISO 14001 certified companies (73%), the adopters of voluntary CPA (68%), and in-house EMS (60%), cited financial constraints. Over 30% more

[252] Shanghai, Beijing, Shenzhen, Guangzhou, Chongqing, Tianjin, Suzhou, Chengdu, Wuhan, Hangzhou, Nanjing, Qingdao, Wuxi, and Changsha

mandatory CPA adopters and nearly 25% of ISO 14001 adopters indicated the lack of financial resource than technological problem. Almost all adopters of eco-labels enumerated multiple issues (financial resource**,** technological problem, mindset challenges, and management issues), while the implementers of "other measures" encountered similar difficulties with much higher percentages regarding financial resource (85%), technological problem (75%), management issues (70%), and mindset challenges (70%).

"Mindset" was not mentioned by the firms who participated in carbon trade or published public reports. The Taiwan invested firms, Hong Kong-owned firms, and large-medium size companies had percentages above the average among those citing financial resource. Those below average included JVs and private, domestic-invested companies. The percentages of JVs and Taiwan invested firms were above average in indicating technological problem. Proportionally, more SOEs stated overly stringent environmental standards than mindset problems. Their responses were similar to those of some Taiwan invested firms.

4.2. Challenges for SME

Only five surveyed SMEs adopted CPA. None of the "micro-firms" had either adopted EMS or implemented CPA. However, the aggregated impact of SMEs on the environment, in terms of emissions and the effects on health, were significant, given the sheer number of SMEs operating in the PRD. For example, there were nearly 1.5 million SMEs based in Shenzhen (Wang, 2016). Confronting stricter legislation and enforcement, smaller surveyed firms were in a disadvantaged position vis-à-vis their larger counterparts. For example, they faced difficulties in obtaining "environmental protection entrance permits" due to a lack of access to treatment facilities (Sun, 2018). In addition, the costs related to EOP, CT, and ISO 14001 certification were exorbitant. For example, the average investment in CPA amounted nearly ¥20M per annum (Gdzxb.gov.cn, 2005). The average expense of simple and complex options undertaken by the sampled implementers was ¥13,000 and 4M, respectively. The latter was 1M higher than the sales revenue of a "micro-firm". The costs associated with ISO certifications were high. Each certification fee paid by a surveyed company[253] was ¥150,000

[253] Company sampled #46: ISO 14001 and OHSAS 18001 implemented between 2004 – 2005

(including initial registration fees[254]), before considering the resources required for maintenance, recertification, and the potential costs related to changes in technologies (Potoski and Prakash, 2005b), production processes, organizational structures, and responsibilities (Melnyk, Sroufe, and Calantone, 2003; Neumayer and Perkins, 2004).

The surveyed SMEs were less capable of shouldering environmental investments, phasing out outdated technologies, or introducing innovative solutions. Our finding was in line with those of a public report published by the Federation of Hong Kong industries. The latter found restraints on financial and human resources figured among the main barriers (i.e., environmental consciousness, a lack in strategic planning, the ability to identify adequate environmental technology, and the means of responding to global supply chain demands). Furthermore, the surveyed small firms lacked environmental record keeping, maintenance, and monitoring that prevented them from developing managerial, technological, and innovative capabilities. This finding confirmed those of prior research conducted in Chinese (GZETC, 2010) and Brazilian firms (de Barros, de Paiva, and Sisinno, 2003). The sampled SMEs had lower environmental awareness than large companies, with a couple of exceptions (i.e., articulations of environmental interest and concerns about workers' health and safety).

Smaller sampled firms, for example, private, Chinese invested companies, were less likely to be networked as they did not have staff available to attend training, obtain information, and put knowledge into practice. In fact, their American and Canadian counterparts had similar problems (Windatt, 1999). The sampled SMEs accounted for 100% of the firms that did not establish a relationship with government agencies. The lack of connections and networking posed negative implications in terms of information and support. The smaller the size, the less likely firms are to obtain green incentives. For instance, only one "micro-firm" obtained monetary incentives. The reasons for a lack of support provided by a handful of respondents were ineligibility (7), a lack of information (5), absence of internal policies (3), complicated administrative application procedures (2), and "others." (2) The surveyed SMEs, like their counterparts operating in another province (Geng, Wang, Zhu, et al., 2010), did not receive adequate government support for environmental implementation.

[254] Fees may vary and depend on the size of the firm, industry, and country.

4.3. Effectiveness of state intervention

Since the late 1990s, initiatives have been undertaken by national and local governments to assist SMEs in fulfilling the environmental requirements[255] such as funding technological development and building shared facilities (Sun, 2018). The ETC was not the only agency that had effectiveness issues. Most SMEs were not under the radar of local EPBs. For example, we visited a facility that violated regulations while clandestinely manufacturing batteries. In fact, more than half of the lead-battery manufacturers were not registered officially (Moser, 2013). Although only one respondent mentioned corruption[256], there were 15 "serious corruption cases" involving environmental governance systems between 2012 and 2014 in Guangdong (Ren, 2014). Some EPBs lacked manpower, expertise, and monitoring capacity to ensure compliance (Shi and Zhang, 2006). Furthermore, lawmakers and upper levels of government were criticized for addressing problems in an unrealistic manner (van Rooij, 2006) or imposing impossible targets. For example, the central government set goals to clear over 2,000 polluted water bodies within three to five years. Local governments were left with one to two years to achieve goals being characterized as "unreasonable, unrealistic, and impossible" by one expert, who said it would take six decades to achieve similar goals in other countries (Liu, Yuan, and Luo, 2018).

Regarding personnel support related to implementation, a civil servant admitted that he had struggled with conflicting demands for environmental protection and economic growth. "Environmental protection is not really a priority for my boss, who aims at prioritizing the pursuit of economic growth." The agent scrambled to get more firms to sign agreements, in order to meet targets[257]. Another civil servant who was responsible for CPA promotion for over a decade, believed that her team had exhausted all possible means to persuade potential target companies to implement CPA. "The firms that are willing to get involved (in CPA) already did," she said. During a lunch meeting, she announced her job transfer, in order to "move on" rather than being stuck with companies that would not "back down"[258]. To deal

[255] Such as Guiding opinions about strengthening energy conservation and emission reduction in SMSs 关于进一步加强中小企业节能减排工作的指导意见. 工信部办〔2010〕173 号. Ministry of Industry and Information Technology. (2010). http://www.gov.cn/zwgk/2010-04/26/content_1592469.htm
[256] Company sampled #21
[257] Based on our translation of informal conversations which took place during a number of site visits
[258] Based on our translation of informal conversations at a lunch which took place during one site visit in 2013

with the impasse, local implementing agencies settled for an opt-out auditing alternative, which "watered down" CP rather than providing "a real solution" according to an environmental consultant. Our finding illustrated conflicting priorities within implementing agencies, as shown by a prior study (Kostka, 2014).

4.4. Limits of market-based initiatives

Our results also indicated difficulties in the development of markets for environmental services. For example, low-rate CP service providers dominated the market in the PRD and low-price competition significantly impacted the businesses. One of our collaborators stated that the market price of consulting fees was too low to deliver high service quality. "Here, clients do not see the value of the quality of our service," said an owner of a consulting firm. Rules have been promulgated for improving the quality of service and encouraging value-base service providers. For instance, service providers could not work with enterprises over a period of five years unless they both meet appraisal requirements. In Foshan, a couple of permits were revoked by the EPB. To our informants who found their way out of the CP business, such policy changes were too little, too late.

During an interview, the owner of a sampled manufacturer serving only international markets explained how environmental improvements at manufacturers' expense reduced even more profit margins for a mature industry. The entrepreneur told us that the facility was accepted based on supplier-selection criteria (i.e., quality and price), records (i.e., penalty, maintenance and inspection), and compliance (i.e., pollutant discharge, wastewater treatment and solid waste disposal). It was also inspected for "environment, health and safety" performance according to auditing policies (site inspections ranged between two and five years in intervals). He pointed out that some competitors used cheap raw materials which are hazardous to workers' health, despite inspections. Hence, buyers exerted limited pressure on suppliers despite their adherence to pro forma regulations, as suggested by prior research (Lam, 2011). Moreover, reports showed that businesses including MNCs had committed environmental violations (Friends of Nature, IPE, and Green Beagle, 2010, 2011; Ma, Collins, Wu, et al., 2012).

Moreover, ISO 14001 certification neither required verifiable commitment (Prakash and Potoski, 2006), nor accountability in mandatory external reporting (Krut and Gleckman, 1996, 1998, as cited in Parto, 1999). Certification targeted procedural improvements on paper (Krut and Gleckman, 1998, as cited in Parto, 1999; Potoski and Prakash, 2005a), rather than results (Bansal and Hunter, 2003; Delmas, 2001) based on efficiency or performance (Krut and Gleckman, 1996, 1998, as cited in Parto, 1999). According to our collaborators and an environmental manager of a Swiss firm, auditors only focused on procedures and documented processes (Hamschmidt and Dyllick, 2006). Site-specific certification compliance with existing national law varies, as regulations differ from region to region (Potoski and Prakash, 2005a). In addition, eco-labelling incurred major problems in China, such as bad press linked to falsified labelled products (Wang, 2003, as cited in Stalley, 2010; Wu and Pan, 2002) and "chaotic" green product markets (Wu and Pan, 2002). Few companies improved their environmental reporting, in spite of measures[259] adopted by the Stock Exchange in Shenzhen and Shanghai to encourage disclosure (Johnson, 2011; Weber, 2014). However, more enterprises adopted eco-labels on construction materials and sanitary porcelain products, thanks to a requirement to use green construction materials in renovation (80%) and new construction (30%)[260] (Xie, 2016).

This chapter shows that firm size (larger), disposal of financial and human resources (resource-rich), sector (growing, pollutant and/or energy intensive), and stakeholder network engagement correlate with complying environmental actions beyond compliance. It is noted that variances were found in the measures taken by the sampled firms. Significant gaps existed between large and small industrial firms in environmental implementation. The surveyed firms that performed well shared similar attributes and traits (i.e., pro-environmental company cultures, strong will to win, enhanced managerial and technological capabilities). The implementation of multiple measures enabled them to create sources of distinctiveness, which generated more tangible and intangible positive outcomes for the environment, economy, and society. For example, international green supply chain

[259] Circular on taking steps to strengthen environmental open government information work. MEE. (2012); Measures on open environment information based on Regulations on open government information. State Council. (2007).
[260] According to a plan released jointly by the Ministry of Construction and Ministry of Industry and Information Technology

requirements (e.g., RoHS) incentivised export-oriented manufacturers to initiate action (e.g., branding products) and improve performance. Chapter 6 draws distinctions between the factors of environmental action that reduced the negative impacts and forces behind a range of initiatives beyond remediation. It highlights that environmental implementation was dependent upon firm-specific determinants, sectoral characteristics, internal and external resources. The last chapter summarizes the main findings, followed by the implications derived from the overall study, and outlines recommendations for future research.

Conclusion : changes and continuities

Key findings

We delineate the recent state of China's major environmental challenges by focusing on the associated causes and consequences, as well as government, civil society, and business responses in chapter 1. The first chapter illustrates that environmental degradation and its impact on health have become great concerns for Chinese people and authorities. Moreover, the country is under increasing pressure to mitigate climate change. Over recent decades, the central government has changed its approach, from denouncing industrialized countries for causing environmental problems, to acknowledging issues and taking measures to protect the environment through the development and enforcement of environmental policies. The effort to respond to the challenges went beyond exhibiting a different tone by officials, which included stipulating public policies illustrated by legislation and action plans, as well as establishing pro-environment evaluation systems. In the area of global climate protection, China played a more active role in post-Kyoto processes, for example, through establishment of a South-South cooperation fund on climate change as part of its climate action pledge under the Paris Agreement (NDRC, 2015). Despite some positive signs, the implementation of environmental policy remains a key challenge. Therefore, our research proposed understanding of why and how institutions, state and non-state actors implement environmental measures, and assessing the results of implementation.

After describing an interdisciplinary theoretical framework that combines EMT and the Porter hypothesis (page 40), we present the operationalization of hypotheses and the use of mixed-methods in data collection and processing. The combination of meso and micro approaches is complementary, as EMT describes corporate environmental action in networks of actors and institutions, and the Porter hypothesis focuses on business logic at the individual firm level. Then, we illustrate the results of our investigation, beginning with a description of the sampled Chinese industrial firms. In this concluding chapter, we summarize our principal findings, present the limitations of the study, and outline its implications. In light of a new understanding, derived from the analyses, we identify some new questions and propose a set of ideas for future studies.

Four major findings emerged from our study. First, divergences and convergences were found in environmental responsiveness. A vast majority of the surveyed companies took action, although the two groupings of firms either did not implement measures ("absentees") or undertook few measures ("minimalists"). The grouping labeled "compliers" engaged in compliance-only implementations, whereas the category referred to as "integrators" initiated comprehensive measures. Marked convergences resulted from adopting standards and certifications (e.g., ISO 14001), whereas divergences were due to environmental attitudes associated with different strategic orientations and choices such as hierarchical determinants (business survival, profit and ecological responsibility). The "integrators" were affected by the type of markets (i.e., industrial and consumer markets, domestic and international markets) and industries (i.e., energy and/or pollution intensive sectors, industrial firms generating more waste and/or by-products).

Driven by business survival, profit, and ecological responsibility, the surveyed firms chose strategies (exit, eco-efficient, and innovative) that resonated with their competitive positioning (cost leadership and/or differentiation). In addition, they handled each issue based on their own circumstances. Investments in CT were shaped by company-specific factors, such as timing and economic scale of production. A preponderance of the surveyed companies adopted eco-efficiency strategies that increased the productivity of organizational processes and generated concomitant savings and environmental benefits. We elaborated a typology of enterprises to illustrate various environmental strategies and technological adoptions. The "laggards" resisted taking action, whereas the "takers" reluctantly changed their behaviours and tended to use EOP technologies. The "followers" were inclined to adopt proven CT, and the "eco-innovators" made new products or production processes.

All "eco-innovators" surveyed used eco-labels. This result was in line with prior multivariate model analysis that showed a positive association between eco-labelling and environmental product innovations in European manufacturing firms (Wagner, 2008). The surveyed "eco-innovators" developed a creative way of differentiating products, and they marketed environmental differentiation in order to increase the potential of obtaining a price premium. Most of them engaged in product innovations, rather than process innovations, which would not be paid by buyers or end-users. Incorporating eco-innovations and eco-labels into activities required the knowledge and skills to develop strategies, align changes with corporate vision, and overcome alignment problems across different systems. The sampled companies that thrived in green markets pivoted purposefully, analyzed competitive environmental management, and found opportunities beyond the "low hanging fruit." Furthermore, they were able to retain older, niche end-users and identify and attract new environmentally conscious customers.

Secondly, our study confirmed that stricter environmental regulations, economic interests, and competition were key factors driving environmental actions. The sampled firms subjected to more stringent requirements, including bigger enterprises, exporters, and pollutant and/or energy intensive companies, were inclined to implement measures and comply with environmental standards. Despite inter-industry and inter-firm variations in corporate responses to climate change in similar socio-political-economic contexts, large, energy intensive companies and export-oriented firms tended to make more efforts to reduce their carbon emissions. Most surveyed CPA implementers were propelled by regulations and market demands, took eco-efficient measures, and tended to obtain cost savings. Mandated CP processes pushed imperatives for action, whereas demands from corporate buyers created incentives that fostered voluntary implementation.

In addition, the surveyed firms made different strategic choices while confronting stricter environmental requirements. Our result supports that stricter regulations played a key role in environmental change, as shown by previous studies (Jänicke, 1997; Jänicke and Weidner, 1995; OECD, 1996). More specifically, the exporters and industry suppliers tended to improve environmental performance and progress toward CP (Sonnenfeld, 2000; Zhu and Sarkis, 2006). The surveyed companies serving competitive markets, such as suppliers to MNCs and exporters to the OECD countries, were most likely to be industry leaders that engaged in eco-innovative activities and excelled in environmental performance. The finding suggests that competition pushed sound management (Buttel, 2003), and spurred technological development and innovations (Porter and van der Linde, 1995a, 1995b).

Most sampled implementers benefited from government green incentives. Voluntary agreements provided them with the flexibility to pick the implementation methods that fit business goals and strategies, in order to improve corporate environmental performance. Economic incentives and disincentives (fines) were deployed to underpin implementations. The combination of coercion and encouragement created favourable conditions for changing strategies through self-regulation, as advanced by Mol (1995, 1997). Profitable measures, such as efficient energy and material usage, were the most common practices among the sampled firms. Such finding indicates that increased revenue and cost reductions were key to action (Aden and Rock, 1999; Huber, 2000).

Ecological criteria were applied in production, product design, and performance, and this was in line with prior research (Mol, 1995). Nonetheless, sustainability did not rank within the top buying motivations for consumer products (Wrenn, 2019). When compared with multinational manufacturers and retailers, individual consumers exerted less influence. Buyer pressures were insignificant for a majority of the sampled firms. Environmental technologies did not pay for themselves, as demonstrated by the absence of economic viability. Although environmentally friendly products began to occupy a market niche, demand alone was not sufficiently important for triggering eco-innovation. Our finding confirms that eco-innovation was not self-enforcing (like telecommunication technologies) because technology push and market pull factors were not strong enough (Rennings, 2000).

Many sampled companies were not predisposed toward environmental investment. The higher the costs, the less likely the corporation was to make potential investments. They tended to pace their efforts based on what was prudent to implement, according to potential additional expense or compensatory financial gain. For example, an over-emphasis on profit, combined with unwillingness to retrofit/upgrade equipment, led to underperformance in a large mandatory CPA adopter in a declining industry[261]. Comparatively, this situation was not unique to Chinese companies. For instance, less than 10% of Canadian firms[262] and only 6% of firms in Quebec applied green technologies during a similar period. The adoption rate in Quebec was higher in the petrol and pulp and paper sectors (over 20%). Weak ROI and the long period required for the recovery of expenses were perceived as key obstacles, according to Institut de la statistique du Québec (Rettino-Parazelli, 2016). Prior research also

[261] Company sampled #6, according to an expert in cleaner production
[262] With more than 10 employees

suggested that a lack confidence in financial analysis made corporate decisions-makers reluctant to invest in environmental measures (Cushing, Wise, and Hawes-Davis, 1999).

Our third finding showed that mixed results were found in the effects of stricter environmental regulations on eco-innovation and on the financial outcome of environmental improvements. Our study showed a stronger business case for big businesses going green because environmental protection is good for the bottom line. Environmental protection has become a key competitive component for export-oriented firms serving markets where standards are stricter than domestic requirements. Firms with high capabilities and substantial resources were more likely to confront stringent requirements by taking a variety of initiatives that were immediately profitable or strategically advantageous. Specifically, the "integrators" innovated, renewed, and reinvented themselves to seek growth and created value so that their businesses could survive and thrive. Compared to their western counterparts, the sampled companies in our study, except for "eco-innovators," were less likely to influence consumer behaviour through environmental communication and marketing. This finding suggests that the green market still remains a niche.

Eco-innovative responses came from the surveyed firms that sold products to the markets where regulations were more stringent, demands for green products were stronger, and/or competition was fiercer. All "eco-innovators" improved product quality for products that were the source of their competitive advantage. Stricter environmental regulations prevented competitors that avoided environmental investment from accessing markets and gaining competitiveness. Such evidence confirms that stringent regulations reshaped the playfield and made the pursuit of green production more rational (Buttel, 2003). It also supports the conclusion that stricter regulations were favourable for innovation (Ashford, 1993; Ashford, Ayers, and Stone, 1985; Huber, 2008a; Jänicke, 2008; Porter and van der Linde, 1995a, 1995b) and market advantages (Ashford, 1993; Ashford, Ayers, and Stone, 1985; Berger, Flynn, Hines, et al., 2001; Huber, 2004, 2008a; Porter and van der Linde, 1995a, 1995b).

Despite these findings, it is noted that less than one fifth of the sampled firms engaged in eco-innovation. In response to stricter energy efficiency requirements at national, regional, and municipal levels, a majority of the surveyed companies looked at resource efficiency and chose to implement housekeeping measures and incremental technology improvements. Most of them overlooked opportunities for profit. According to prior research, less than 20% of the largest Chinese firms perceived a link between good environmental practices and cost saving (Lei, Long, and Pamlin, 2005). Our study shows that the situation has remained the same over the last decade. Most surveyed executives, entrepreneurs, and managers did not perceive a positive relationship between innovation and stricter regulations. Moreover, a lack of managerial and technological capabilities, as well as the limited impact of green consumerism on sales, prevented a majority of the sampled firms from joining the eco-innovation bandwagon.

Our study partially supports that regulations affected green product innovation (Chan, Yee, Dai, et al., 2016) and drove firms to make gains in their competitive performance (Jänicke, 2008; Leroy and van Tatenhove, 2009; Porter and van der Linde, 1995a, 1995b). These mixed results are in line with prior empirical studies on the effects of stringent regulations (Arimura, Hibiki, and Johnstone, 2007; Frondel, Horbach, and Rennings, 2007; Kammerer, 2009; Lanoie, Ambec, and Scott, 2007; Popp, 2006). Our evidence suggests that eco-innovation is driven by an interplay of factors, rather than one single determinant, confirming previous studies conducted in China and elsewhere (Cai and Zhou, 2014; Horbach, 2008). Our finding indicates that stricter environmental regulations are necessary, but that they are insufficient for triggering eco-innovation.

The surveyed firms that implemented in-house EMS, eco-innovators, and joint EMS adopters were top achievers. Capabilities and resources possessed by the sampled ISO 14001 adopters caused variances in levels of environmental improvement, supporting previous findings (Castka and Prajogo, 2013; Heras-Saizarbitoria, Boiral, and Arana, 2016; Yin and Schmeidler, 2009). The EMS implementers were predominantly firms that reduced waste and pollutants, increased energy efficiency, complied with standards, and reduced carbon emissions. Most firms that performed well had fully implemented EMSs along with systems for recognition and rewards. The combined systems enabled these firms to report and monitor the progress of implementations, such as CPA, while reinforcing environmental vision and strategies. By contrast, companies that implemented a go-it-alone ISO 14001 approach delivered inferior outcomes when compared to in-house EMS adopters surveyed.

The lack of integration caused efforts toward EMS certification to languish. This finding was consistent with prior studies that found well-implemented EMSs improved the management of environmental product innovation and firm performance (Bansal and Hunter, 2003; Horbach, Rammer, and Rennings, 2012), whereas isolated EMSs did not result in environmental improvement (Darnall and Edwards, 2008; Darnall, Henriques, and Sadorsky, 2008; Wagner, 2008).

Fully implemented EMSs helped the sampled firms to define responsibilities, establish corporate culture, and incorporate an incentive mechanism. Changes made in organizational structures were favourable for improved management capabilities, subsequently enhanced environmental performance, and eco-innovation. Such findings supports those of prior studies (King and Lenox, 2001; Rennings, 2000). Most surveyed "eco-innovators" gained resource productivity, cost savings, and competitive advantage thanks to reinforced capabilities and coordination mechanisms. To remain innovative and competitive, some companies deployed management system applications to administer corrections or adjustments, exploited complementarities between implementations, and drove continual improvement. They created competitive advantage by excelling in practices that are hard to match. In addition, ownership of intellectual property and the existence of innovative culture contributed to the communication of environmental credentials and the articulation of values.

Technological changes induced by CPA minimised environmental impacts and achieved positive economic benefits. Audited results indicated that all CPA adopters decreased per annum resource usage, energy consumption, and rates of emissions, effluent, and waste. The vast majority of voluntary CPA implementers obtained economic and environmental benefits, supporting the claim that technological change, innovation, and cleaner products and production processes were profitable and increased eco-efficiency (Gunningham, Kagan, and Thoronton, 2003; Mol, 1995). The surveyed CPA adopters that performed well had lowered input costs, reduced legal expenses associated with liability, and had improved eco-efficiency and resource productivity as well as social benefits. However, positive economic and environmental outcomes were primarily associated with the sampled voluntary CPA adopters who invested more on prevention. The mandatory adopters tended to spend more on environmental controls equipment, while achieving less savings than voluntary adopters surveyed.

Some sampled early CPA adopters created unique market positioning and achieved first-mover advantages. Such outcomes were in line with previous findings (Bansal and Roth, 2000; Esty and Porter, 1998; Gunningham, Kagan, and Thoronton, 2003; Huber, 2009; Jänicke, 2008; Kallio and Nordberg, 2006; Mol, 1995; Porter, 1990; Porter and van der Linde, 1995a, 1995b; Reinhardt, 1998; Roome, 1998). Corporate environmental efforts were not altruistic. For example, eco-labelling was exclusively used by the sampled "eco-innovators," whereas only one firm[263] applied for an international social certification standard (SA8000) for compliance with corporate responsibilities along with product certifications (VDE/PSE/BS KFI/RoHS). The strategic effects of environmental initiatives, including ISO 14001, changed over time. Such initiatives have become common practice as they were adopted by more firms. Certifications served as a strategic differentiator for early EMS adopters that were market leaders, as shown by prior research (Azzone and Manzini, 1994; Elkington, 1994). The latter companies applied ISO 14001 as a necessity or a "license" to access certain markets, according to the surveyed entrepreneurs.

A consistent pattern emerged from this study. Firms subject to stricter environmental regulatory requirements tended to comply and those with a green commitment were likely to adopt a greater number of measures. Bigger surveyed firms, including HNTEs, SOEs, firms with outside investment, and publicly traded companies, were more likely to invest in greening their practices, adopting voluntary initiatives, and turning environmental costs into profits. Predominantly, large companies made the transition from remediation to pollution prevention, along with cleaner products and production processes. Such findings support those of prior studies (Bansal and Hoffman, 2012; Hoffman and Woody, 2008; Mol and Jänicke, 2009;). Larger, profitable businesses introduced more environmental management measures (Neumayer and Perkins, 2004) and tended to adopt EMS (Porter and van der

[263] Company sampled #P9 that had previously obtained provincial certifications for good behaviour (AAA) and harmonious labor relations (AAAA)

Linde,1995a, 1995b), as they had more flexibility to finance programmes (Nakamura, Takahashi, and Vertinsky, 2001) such as certification (Nishitani, 2009).

Our finding show the differential effects of stricter environmental regulations on eco-innovation and the various financial outcomes resulting from environmental improvements. Environmental improvement at manufacturers' expense lowered profits in mature industries with thin margins. A majority of the surveyed manufacturers operating in price competitive markets, such as textile, clothing and footwear, shifted production to higher value-added apparel and footwear and relocated to regions/countries[264] where labour was cheaper. Moreover, the surveyed firms were unanimous about a cost surge as a consequence of stricter future regulations. A majority of these businesses indicated costs related to environmental investments and operational costs, a finding which is in line with previous traditional environmental economic studies (Jaffe, Peterson, Portney, et al., 1995; Palmer, Oates, and Portney, 1995). The relation between economic gain and environmental benefit is dynamic and depends on the type of environmental action, firm characteristics, and contextual factors. Such result supports previous findings (Schaltegger and Synnestvedt, 2002).

Finally, our study partially supports the claims made by EMT. Positive changes have happened on the ground. The most recent provincial environmental protection credit evaluations showed that more regulated firms had excellent performance, and fewer companies performed at the lowest levels. The deltaic cities improved environmental quality and achieved development targets. Such improvement was accompanied with productivity gains and manufacturing efficiencies (MEE, 2019). However, widespread environmental implementation, such as CPA, was stagnate. Our findings were consistent with earlier ecological modernization perspectives emphasizing technological innovations and market-based solutions as a means to generate economic growth while protecting the environment.

Relationships between business, society, the market, and the environment have changed and continue to evolve. Facing public scrutiny and discontent, the state exercised its coercive and persuasive power and demonstrated the capacity to steer the greening of industries.

[264] Interior regions in Guangdong, Bangladesh, Sri Lanka, Cambodia, and Vietnam

Governments also increased command-and-control by imposing stricter laws and more stringent enforcement. We found civil society played a circumscribed role in environmental improvements and policy reforms. Acting as watchdogs, ENGOs indirectly affected implementation within firms. This may explain the reasons why most surveyed entrepreneurs/managers/executives seemed to undermine the role of civil society.

Local grassroots ENGOs mobilised people to promote changes, whereas transnational and national organizations tended to attract media coverage and bring public attention to specific problems. By comparison, individual citizens were likely to use less organized ways of involvement. Besides lodging complaints, bringing lawsuits, and protesting environmental violations, citizens could engage in public exchange, as facilitated by the internet and the revisions to EIA Law. However, public participation remained limited within the political system. Such evidence stood in contrast to broadening participation in political processes, as suggested by ecological modernization theorists (Mol, Spaargaren, and Sonnenfeld, 2014).

Overall, our results suggest that companies played positive roles in environmental protection (Mol and Jänicke, 2009). A majority of the firms made changes in their environmental management (e.g., goals, planning, strategies), HR (i.e., training and motivation of personnel), operations (i.e., CPA) and technology development (i.e., R&D), consistent with previous findings (Bansal and Hoffman, 2012; Huber, 2004; Mol, 1995; Wright and Nyberg, 2012). Top management instituted policies and developed cultures that connected employees to a company's mission. The entrepreneurs and executives set objectives, built commitments, allocated resources, and provided support for training, in order to implement changes. They were major forces in environmental change processes, and their favourable attitudes had a positive influence on the implementation of advanced measures. These conclusions support prior findings (Huber, 2000, 2004; Mol, 1995, 2006).

The CPA adopters, especially "eco-innovators," took part in the "ecologization" of the economy by modifying the technological trajectory toward cleaner products and production processes. This action was designed to achieve the technological and material objectives of ecological modernisation, including dematerialization, waste reduction and elimination, resource recovery and reuse, and the reduction of water and chemicals (Hajer, 1995; Jänicke, Mönch, Ranneberg, et al., 1989; Simonis, 1989b; Sonnenfeld, 2000). But environmental implementations were limited to particular issues and areas that generated savings or solved visible or audible impacts. For example, the most frequently reported climate related measures were energy saving, waste management, and the use of renewable or clean energy. The most common technologies were related to waste management and atmospheric emissions, similar to the actions observed in Canadian firms (Rettino-Parazelli, 2016).

Most surveyed firms underestimated the invisible environmental impacts of production, such as electricity consumption. Underestimation of such impacts may link to local citizen complaints which focused on the most visible and audible problems (e.g., smoke and noise). Furthermore, firms taking few environmental actions tended to minimize their environmental impacts and emphasize those of pollutant intensive companies. Such behaviours resembled those of European companies (Batenburg, 2006). Improvements were unevenly distributed among the sampled companies. Large businesses made progress on pollution reduction and prevention. This finding is similar to that of a Canadian study (Windatt, 1999). Our study highlights a lack of monitoring of small businesses. SMEs were the least likely to adopt environmental practices and this fact is one of the key issues regarding the application of EMT analysis. In addition, climate change pose another problem, as most surveyed enterprises did not incorporate it into their strategic planning.

Additional requirements, to ensure environmental protection, represented the sword of Damocles hanging over regulated firms. State actors played the role as their "catalyst and challenger" (Porter and van der Linde, 1995a, 1995b), as well as "enablers" (Berger, Flynn, Hines, et al., 2001) when deploying complementarily regulatory and nonregulatory approaches. The application of a wide range of market-based mechanisms and instruments (i.e., taxes, levies, subsidies, tradable emissions, green credit policies, environmental taxes, and environmental liability insurance) indicates the tendency for the emergence of "economizing" ecology (Buttel, 2000b; Mol and Spaargaren, 2000; Mol, Spaargaren, and Sonnenfeld, 2013). Government interventions facilitated adoption, halted industrial activities harmful to the environment, promoted preventative measures, and provided incentives to CT investment, all of which were in line with previous findings (Sonnenfeld, 2000). Moreover, policies stimulated the development of new and more efficient industries in the PRD, as shown in prior studies elsewhere (Blowers, 1997; Huber, 2008a; Jänicke, 2008; Jänicke and Jacob, 2004; Mol and Sonnenfeld, 2000; Weale, 1998).

The use of nonregulatory initiatives favoured arrangements between initiators, promoters, and signatories to maintain objectives, monitor results, and fulfill targets. The state restructured public institutions, created organisations such as government affiliated/organized ENGOs (GENGOs), and shared resources and environmental responsibilities. GENGOs became legitimate actors, assuming administrative and managerial tasks, and operating in close proximity in order to coordinate concerted public-private efforts in environmental implementation. Implementing agencies were connected to industry associations which fostered collaboration and facilitated dissemination of information, best practices, and lessons learned. Such finding is consistent with prior research (Huber, 2004; Jänicke and Weidner, 1995; Kemp, Smith, and Becher, 2000).

Our finding supports that the transformation of key institutions contributed to solving environmental problems (Huber, 1982, as cited in Mol, 2000; Mol, 1995; Spaargaren, 1997). It also suggests that redefining roles (Bailey, Gouldson, and Newell, 2011; Blühdorn and Welsh, 2008; Buttel, 2000b; Mol and Spaargaren, 2000) and shifting government responsibilities (Economy, 2007; Leroy and van Tatenhove, 2009; Mol and Sonnenfeld, 2000) enabled the achievement of common environmental objectives (Mol, 1995). The state constituted the main source of grants, credits, loans, funding for environmental S&T research, and provision for special development funds. Governments solicited assistance and resources from foreign governments and international organizations, and they channeled resources to improve access to technology and enhance support for industrial environmental management. Working bilaterally and multilaterally with international partners helped resolve domestic and international environmental problems.

State actors remained central in planning and creating networks for environmental protection, in line with prior findings (Buttel, 2000b; Jänicke, 1997; Mol, 2006; Mol and Jänicke, 2009; Mol and Spaargaren, 2000; Sonnenfeld and Rock, 2009). They oversaw and guided eco-innovation through dynamic processes that were characterized by mutual learning and co-production of knowledge between the public and private sectors. The “eco-innovators” engaged in cross-sectoral exchanges to acquire tools, data, and insight that addressed knowledge gaps and enhanced organizational and technological capabilities. Research institutes and/or universities offered knowledge in R&D, furthered CT development, stimulated innovation, and followed up with commercialization. Economic actors gained leeway and played vital roles, consistent with previous findings (Berger, Flynn, Hines, et al., 2001; Gouldson and Murphy, 1997; Huber, 2008b; Mol, 2000; Mol and Sonnenfeld, 2000; Mol and Spaargaren, 2000; Seippel, 2000).

The surveyed large domestic companies, banks, and business associations articulated environmental interests, and this finding does not support previous research findings on China (Mol, 2006, 2010). In fact, financial institutions were responsible for applying environmental criteria in commercial credit under the green financing framework. Contradictory to prior research (Mol, 2006, 2010), threats of sanction were significantly more serious than simply being in conflict with administration. The regulated firms were motivated to improve their performance by stricter regulation and law enforcement, as well as a provincial environmental protection evaluation system. The stricter the local law enforcement present, the more likely the sampled firms were to comply with requirements. High rates of EIA implementation showed that the state has the capability to enforce regulations. Indications were that tightened law enforcement (at local, provincial, and national levels) drove corporate environmental actions, particularly in energy and/or pollution intensive firms.

Hierarchical and command-and-control did not move away from environmental governance systems, as stated by a previous study on China's governance (Mol, 2010). Environmental goal setting and target allocations are centrally planned, although the central government has been taking more consideration for local circumstances and subnational contexts in the allocation of environmental objectives (e.g., carbon emissions reduction). It relied on a range of top-down mechanisms to hold government officials personally accountable for achieving binding targets and for the commission of unlawful acts (i.e., "inaction" according to the new EPL). Lawmakers and upper levels of government were blamed for imposing impossible targets. Control over subnational government officials has strengthened via hierarchical responsibility and accountability systems and verification processes, despite bargaining among political and business leaders.

Processes of centralization and decentralization have created tensions between top-down and bottom-up, as well as with accountability and local autonomy. Some local governments chose to shirk responsibility (Zhou, 2010a). For instance, a few of them falsified certifications for enterprises that violated laws (People's Daily, 2017; Sun and Kou, 2017), and plagiarized "environmental rectification plans" (People's Daily, 2017). Conflicting priorities, overemphasis on economic gains (Ran, 2013), and neglect of environmental protection (Sun and Kou, 2017; Xinjing Journal, 2017; Zhou and Tian, 2017) were associated with law enforcement misconduct. Authorities did not have an iron fist in the protection of the environment. Our study found uneven implementation of measures across districts and cities, which may have been linked to local government discretion. For example, competing mandates between economic development and environmental protection constrained local implementing agents and rendered large scale CPA implementation difficult at one district where we conducted our fieldwork.

Our study shows that environmental governance in Mainland China, more particularly in the PRD, has evolved from the implementation of stringent environmental legislation, increasing market-based approaches, to the provision of more room for environmental advocacy. However, its social and political institutions, paths of development, government structures, and arrangements, which brought about changes, differ greatly from western democracies. For example, China's environmental policies are unaffected by election cycles. Moreover, the country has a large population and more people in poverty. Its per capita income continues to be a fraction of the level of developed economies in spite of the size of Chinese economy[265]. In the foreseeable future, the central government's priorities include raising the standard of living and continuing industrialization, urbanization, and infrastructure development.

We found that China shared more similarities in environmental issues with South Korea, Taiwan, and Singapore. Firstly, environmental problems have stemmed from high-speed

[265] The world's second largest, according to the World Bank. (2021).

industrialization and export-oriented, rapidly developing economies (Bello and Rosenfeld, 1990; Eder, 1996). Secondly, they have also encountered problems in common such as the weak organization of civil society (Bello and Rosenfeld, 1990) and inadequate environmental reporting (ACCA, 2002 cited by Lang, 2008; Lang, 2008). Thirdly, the state has played a key role in greening industrial production, with initiatives ranging from promoting technology (Lang, 2008; Yang, 2008) to building partnerships between industries and research centres, providing support for technology transfer, and ensuring the economic viability of projects (Lang, 2008).

Our research suggests that most surveyed Chinese firms have behaved similarly to businesses with comparable characteristics in other countries when making environmental technology investment and conducting certified EMS. Large profitable companies were most likely to reap both environmental and financial benefits. By contrast, SMEs tended to lag large firms in the adoption of green technologies and other environmental measures. Moreover, the globalized markets exerting environmental pressures on export-oriented companies seemed to harness environmentally friendly actions leading to isomorphism.

The study: implications and limits

Studying a leading innovation hub facing serious environmental degradation offers insights into rapid changes in urban environmental management. The research provides recent, empirical evidence and raises new questions about the adequacy of EMT and the Porter hypothesis in understanding environmental change in business, as well as its factors, processes, and implications. It sheds light on the complexities of change that unfold during implementation. The study uncovers the patterns of divergences and convergences in corporate environmental responses, key drivers and barriers to green technology investment, the nuanced effects of environmental regulations on innovations, and the mixed financial outcomes resulting from environmental improvements. In addition, it highlights commonalities and differences in measures undertaken by Chinese firms and their western counterparts.

Our study moves beyond a focus on large corporations and broadens the scope toward SMEs. It challenges the pertinence of EMT in explaining persistent problems such as SMEs faced (Mol, 1995; Sonnenfeld, 2002), climate change, and paradoxes and contradictions occurring in institutional development processes. Furthermore, the study highlights the selective approaches focusing on successes and improvements, as used in prior research (Mol, 2006), and how they failed to reflect the setbacks in China's environmental reform. For example, despite increased environmental investment (He, Lu, Mol, et al., 2012), the former MEP was faced with a shortage of resources (DRC and OECD, 2017). Our empirical evidence reveals that non-state actors and non-regulatory policies play key roles in inducing environmental innovation and that social benefits are part of the outcomes of stricter regulations. However, the Porter Hypothesis made no reference to such outcomes or took into consideration of the institutional context regarding environmental innovations. Similarly, issues raised by critics related to ecological modernisation studies such as the units of analysis used to demonstrate environmental improvements and evidence of de-materialisation that avoid rebound effects (York and Rosa, 2003) continue to exist and remain partial and contested.

Drawing on a wider range of methods, the study brings the investigation closer to the phenomena. Mixed methods expose multiple perspectives and permit insights into decision-making and changes in actions. Empirical work on the value chain is useful to view environmental activities and to understand their role in developing competencies related to environmental and generic strategies. We find that eco-innovations are key elements in the chain that leading firms adopted to achieve goals. Integrative systems are beneficial for meeting the objectives, through aligning decisions and allocating resources. Combining environmental sociology and strategic management overcomes the weakness of the value chain's consideration of linear relationships among the elements. The interdisciplinary approach identifies solutions, connects environmental issues to social and development challenges, and builds greater understanding of green transition. In addition, the research broadens analysis by incorporating knowledge from other disciplines, and clarifying the roles played by organizations and technology in environmental change processes.

Through comparing actions taken and actual performance, the study identifies firm characteristic and sectoral differences as key factors affecting variations in implementation and creating a typology of enterprises. Moreover, cross-industry comparisons enable us to expand the focus of activities to the national and international level. Multilevel analysis shows that individual corporate behavioural changes depend on the institutional contexts of the organization. It expands the scope of research in EMT from national activities to the local and international supply chains in which the companies are embedded. Nonetheless, the results are limited by the sample size and geography of the survey in a particular moment in time. Despite the limitations, conclusions maybe generalizable outside of the sampled firms. Moreover, this study has theoretical and practical implications beyond borders such as corporate decision-making process in green technology investment.

Future research suggestions

Our findings lend support to the importance of stringent regulations on environmental actions. Most surveyed companies changed their behaviours and improved environmental performance. A combination of mandatory-voluntary approaches offered both requirements-encouragements and flexibility-accountability. Maintaining regulatory pressures and threats related to obligations was found to be indispensable for reinforcing corporate responsibility, as nonregulatory initiatives risked the possibility of being limited to corporate priorities and what individual entrepreneurs and executives felt their firms were able to afford. The impacts of stricter regulations on eco-innovation were not as clear-cut. More stringent legislation was one of the key determinants of innovations; however, the majority of the sampled firms stopped at the level of reducing their environmental impact and accruing the cost savings that resulted. Future empirical work could analyze the impetus for the pursuit of continuous improvement, in order to better understand the efforts undertaken to further environmental initiative.

Furthermore, we conclude that firms are not focused on efforts to fight global warming and are inconsistent regarding their treatment of the issue. Many companies surveyed relied on energy efficiency, in combination with cleaner energy sources, to deal with climate change, without fixing low emission goals. Only a handful of the surveyed firms made offset trades. However, it is likely that industries may have caught up following the implementation of carbon ETS subsequent to our data collection timeframe. We recommend continuing the work of assessing corporate responses to climate change, in order to identify whether and how affected sectors modify their practices at the subnational level.

Our study analyzes the social dynamics and mechanisms through which firms have started to "ecologically modernise" and highlights the differences and similarities of institutional changes across countries. Prior comparative analysis, through opposing developed and developing economies, newly industrializing countries and industrialized countries, or the North and the South (Mol, 2006; Sonnenfeld, 2000), tended to draw comparisons in general terms, possibly omitting consideration of the major differences in political cultures, social structures, and institutions. As mentioned earlier, environmental changes in Mainland China have more in common with those in developmental states with a recent history of authoritarianism. They have adopted an entrepreneurial strategy to promote cleaner technology and green industrial production. To provide more accurate international comparisons, we suggest gathering contextual country information and refining the criteria for analysis.

Our research shows that a national-level study on environmental reforms might overlook regional contexts that have important implications on governance. For example, competition among mass media has existed for decades in the PRD, which is contradictory to prior finding (Mol, 2006, 2010). Since the late 1970s, local governments have accepted that residents received Hong Kong television signals (Chan, 2000; Factsanddetails.com, 2011) and channels with syndicated shows from Hong Kong (Zhu and Berry, 2009). To our knowledge, local stations rebroadcast these programmes albeit tight control. As our research showed, regional integration among the greater PRD contributed to transforming the "world factory" into a technology innovation centre. Paying attention to relationships between regional integration and environmental protection could provide further analysis of changes. Future research could look into regional dynamics to contextualize the social determinants of policy implementation.

Our work uncovers that private firms and SOEs in non-monopolistic sectors, along with other economic actors, have embarked on state-led, market-driven, and technology-oriented processes. To find solutions, the state explored the many means they could employ, from modifying the modus operandi of policy making to adopting multiple governance modes and mixed styles. The study shows that environmental policy arrangements are co-existent and multi-plural rather than transitional, as suggested by ecological modernization. Environmental policy making could be authoritarian, top-down, and state-initiated, even in democratic countries (Buttel, 2000b; Leroy and van Tatenhove, 2000). The notion of pragmatism seems to be useful in characterizing the situation of environmental change. Our finding supports a lack of manpower, expertise, and monitoring capacity prevented some EPBs from ensuring compliance (Shi and Zhang, 2006). Also, environmental inspection led by the central government pressured industrial upgrades and improved efficiency. Our research suggests command-and-control was not necessarily ineffective, as stated by some proponents of EMT (Mol, 2001; Spaargaren and Mol, 1992). In addition, it finds that coordination and cooperation could be improvised and confined to ad hoc agreements and coalitions among actors.

Our findings suggest that when the state and private actors converge around common interests, lines of action through projects can be mutually reinforced. Where their interests diverge, they are set to miss such goals. Both our study and prior research reveals that weak environmental disclosure has persisted across regions for decades (Liu and Anbumozhi, 2009; Lu and Abeysekera, 2014a). Our work highlights it is necessary to identify and understand the different interests of the actors, as suggested by Guay and Hamel (2018). To better comprehend the evolving, co-existent modes of governance and dynamics of change, we propose conceptualizing a hybrid model that analyzes a mixture of centralized, top-down, and hierarchical practices with new decentralized, flexible, and consensual elements. Furthermore, future studies might consider using the model in combination with a neo-institutional approach, in order to improve the understanding of social action with reference to specific institutional settings.

In conclusion, we also propose drawing on actor network theory (ANT) to complement EMT in the network study of social dynamics. Our study suggests that corporate environmental initiatives were manifested in diverse forms such as strategies, management, technological innovation, which have led to some environmental improvements. However, the changes occurred among certain sampled firms in the PRD region do not support generalised theory nor linear dualistic thinking about environmental protection and economic improvement. Conceptually, ANT may bring insights to make sense of environmental practices in new ways. For example, applying the concept of "translation" can further the analysis of eco-innovation processes as co-production of environmental knowledge (Callon, 1999; Latour, 1987). Uneven ecological modernisation shown in our results suggest the importance of paying more attention to local situations. ANT analysis can crosscut practices at all levels, unfold specific situations, circumstances, and negotiations that influence local solutions. Specifically, actor network lenses help examine how interests are translated in emerging networks, understand how social forces influence multi-stakeholder efforts to make improvement, and elucidate complexities of trajectories in the development and adoption of new instruments and governance modes.

Moreover, such approach move beyond framing questions around conceptual dualism between economy and environment, or viewing environmental protection as a threat and an opportunity, which may provide an understanding of relations as circulating that bypass oppositions, underpin and foster openness to socio-environmental change. In addition, applying non-dualistic analysis will attend to a range of scenarios and alternatives and highlight divergent interests. More particularly, ANT grasps emergent systems through the exploration of developing actors and organisations as they participate in processes of co-construction between assembled local and national interests. Hence, the perspective of ANT would enhance the explanatory power of EMT by improving our understanding of institutional hybridity, evolving multi-stakeholder systems, and tensions in hierarchical environmental governance systems towards more ecologically benign ends.

References

ADB. (2015). *Addressing Climate Change Risks, Disasters and Adaptation in the People's Republic of China*. The Asian Development Bank.

Adeoti, J. O. (2002). Technological capability. *Science and Public Policy*, *29*(2).

Ai, S. (2012). Factory Towns of South China: An Illustrated Guidebook. In S. Ai (Ed.), *Factory Towns of South China: An Illustrated Guidebook*, 1-4.

Ai, S. (2012). *Factory Towns of South China: An Illustrated Guidebook*. Hong Kong University Press, HKU.

Aizawa, M., & Yang, C. (2010). Green credit, green stimulus, green revolution? China's mobilization of banks for environmental cleanup. *The Journal of Environment & Development*, *19*(2), 119-144.

Albert, E., & Xu, B. (2016). *China's Environmental Crisis*. Council in Foreign Relationships. Retrieved May 6, 2017, from http://www.cfr.org/china/chinas-environmental-crisis/p12608

Alliance of CEO Climate Leaders. (2015, 23 November). These 79 CEOs believe in global climate action. Retrieved May 16, 2016, from https://www.weforum.org/agenda/2015/11/open-letter-from-ceos-to-world-leaders-urging-climate-action/

Ambec, S., & Lanoie, P. (2008). Does it pay to be green? A systematic overview. *The Academy of Management Perspectives*, 45-62.

Andersen, M. S. (1994). *Governance by green taxes: Making pollution prevention pay*. Manchester University Press.

Andersen, M. S. (1999). Governance by green taxes: implementing clean water policies in Europe 1970–1990. *Environmental Economics and Policy Studies*, *2*(1), 39-63.

Andersen, M. S. (2002). Ecological modernization or subversion? The effect of Europeanization on Eastern Europe. *American Behavioral Scientist*, *45*(9), 1394-1416.

Anderson, D. A. (2010). *Environmental Economics and Natural Resource Management*. Routledge.

Andrew. (2013). *Wind Energy Surpasses Nuclear As China's 3rd Largest Source Of Electrical Power*. Cleantechnica.com. Retrieved April 29, 2013, from https://cleantechnica.com/2013/01/29/wind-enegy-surpasses-nuclear-as-chinas-3rd-largest-source-of-electrical-power/

Andrews, S. Q. (2011). *Beijing's hazardous blue sky*. China Dialogue. Retrieved January 28, 2012, from https://chinadialogue.net/en/pollution/4661-beijing-s-hazardous-blue-sky/

Andrews-Speed, P. (2012). *The Governance of Energy in China: Transition to a Low-Carbon Economy*. Palgrave Macmillan UK.

Arimura, T., Hibiki, A., & Johnstone, N. (2007). An empirical study of environmental R&D: what encourages facilities to be environmentally innovative. *Environmental policy and corporate behaviour*, 142-173.

Archibugi, F., & Nijkamp, P. (1989). *Economy and ecology: Towards sustainable development*. Springer.

Ashford, N. A. (1993). Understanding technological responses of industrial firms to environmental problems: Implications for government policy. In K. Fischer and J. Schot (Ed.), *Environmental Strategies for Industry: International Perspectives on Research Needs and Policy Implications*, Washington D.C.: Island Press.

Ashford, N. A., Ayers, C., & Stone, R. F. (1985). Using regulation to change the market for innovation. *Harvard Environmental Law Review*, *9*, 419.

Ashford, N. A., & Hall, R. P. (2011). *Technology, Globalization, and Sustainable Development: Transforming the Industrial State*. Yale University Press.

Ashton, W. (2008). Understanding the organization of industrial ecosystems: A social network approach. *Journal of Industrial Ecology*, *12*(1), 34-51.

Azzone, G., & Manzini, R. (1994). Measuring strategic environmental performance. *Business Strategy and the Environment*, *3*(1), 1-14.

Bailey, I., Gouldson, A., & Newell, P. (2011). Ecological modernisation and the governance of carbon: a critical analysis. *Antipode*, *43*(3), 682-703.

Ballard. (2016). First Ballard-Powered Buses Hitting the Road in China's Largest Fuel Cell Bus Deployment. Retrieved October 13, 2016, from http://ballard.com/about-ballard/newsroom/news-releases/2016/09/29/first-ballard-powered-buses-hitting-the-road-in-china-s-largest-fuel-cell-bus-deployment

Banerjee, S. B. (2001). Corporate environmental strategies and actions. *Management Decision*, 39 (1), 36-44.

Bansal, P., & Bogner, W. C. (2002). Deciding on ISO 14001: economics, institutions, and context. *Long Range Planning*, *35*(3), 269-290.

Bansal, P., & Hoffman, A. J. (2012). *The Oxford Handbook of Business and the Natural Environment*. Oxford university press.

Bansal, P., & Hunter, T. (2003). Strategic explanations for the early adoption of ISO 14001. *Journal of business ethics*, *46*(3), 289-299.

Bansal, P., & Roth, K. (2000). Why companies go green: A model of ecological responsiveness. *Academy of management journal*, *43*(4), 717-736.

Bao, L., Zhao, J., & Zhu, N. (2012). Analysis and proposal of implementation effects of heat metering and energy efficiency retrofit of existing residential buildings in northern heating areas of China in "the 11th Five-Year Plan" period. *Energy policy*, *45*, 521-528.

Batenburg, R. (2006). The Mutual Relationship between the Environmental Context and Management in the Netherlands. In S. Schaltegger & M. Wagner (Ed.), *Managing the*

Business Case for Sustainability: The Integration of Social, Environmental and Economic Performance, 312-327.

Bauer, R., & Derwall, J. (2012). Values-Driven and Profit-Seeking Dimensions of Environmentally Responsible Investing. In P. Bansal & A. J. Hoffman (Ed.), *The Oxford Handbook of Business and the Natural Environment*.

BCSDH. (2015, March 26). Economic growth and environment protection hand in hand – this is the sole road to sustainability. Retrieved May 26, 2016, from https://bcsdh.hu/economic-growth-and-environment-protection-hand-in-hand-this-is-the-sole-road-to-sustainability/

Beach, M. (2001). Local environment management in China. *China Environment Series*, *4*, 21-31.

Beeson, M. (2010). The coming of environmental authoritarianism. *Environmental politics*, *19*(2), 276-294.

Bello, W., & Rosenfeld, S. (1990). Dragons in distress: the crisis of the NICs. *World Policy Journal*, *7*(3), 431-468.

Bennett, M. T. (2009). *Markets for ecosystem services in China: an exploration of China's "Eco-Compensation" and other market-based environmental policies*. Forest Trends.

Berger, G., Flynn, A., Hines, F., & Johns, R. (2001). Ecological modernization as a basis for environmental policy: Current environmental discourse and policy and the implications on environmental supply chain management. *Innovation: The European Journal of Social Science Research*, *14*(1), 55-72.

Biagioli, M. (1999). *The Science Studies Reader*. Routledge.

Blackman, A., & Kildegaard, A. (2003). Clean technology changes in developing country industrial clusters: Mexican leather tanning. *Resources for the Future*.

Blind, K. (2012). The influence of regulations on innovation: A quantitative assessment for OECD countries. *Research Policy*, *41*(2), 391-400.

Bloomberg. (2015, January 9). Clean Energy Investment Jumps 16% on China's Support for Solar. *Bloomberg*. Retrieved March 6, 2016, from https://www.bloomberg.com/news/articles/2015-01-09/clean-energy-investment-jumps-16-on-china-s-support-for-solar

Blowers, A. (1997). Environmental policy: ecological modernisation or the risk society? *Urban studies*, *34*(5-6), 845-871.

Blühdorn, I. (2000). Ecological modernisation and post-ecologist politics. In G. Spaargaren, A. P. J. Mol, & F. H. Buttel (Ed.), *Environment and global modernity*, 209-228.

Blühdorn, I., & Welsh, I. (2008). Eco-politics beyond the paradigm of sustainability: a conceptual framework and research agenda. In I. Blühdorn, & I. Welsh, (Ed.), *The Politics of Unsustainability: Eco Politics in the Post-Ecologist Era*, 1-21.

Blühdorn, I., & Welsh, I. (2008). *The Politics of Unsustainability: Eco-Politics in the Post-Ecologist Era*. Taylor & Francis.

Boix Mansilla, V. B., & Duraising, E. D. (2007). Targeted assessment of students' interdisciplinary work: An empirically grounded framework proposed. *The Journal of Higher Education*, *78*(2), 215-237.

Bookchin, M. (1980). *Toward an ecological society*. Black Rose Books Montreal.

Boyd, O. (2013). The Birth of Chinese Environmentalism: Key Campaigns. In S. Geall (Ed.), *China and the Environment: The Green Revolution*.

Bradsher, K. (2010, January 30). China Leading Global Race to Make Clean Energy. *New York Times*.

Bradsher, K. (2011, June 15). China Takes a New Interest in Energy Efficiency. *New York Times*.

Brannen, J. (2017). *Mixing methods: Qualitative and quantitative research*. Taylor & Francis.

Brettell, A. (2001). Environmental Disputes and Public Service Law: Past and Present. *China Environment Series*, *4*, 66-68.

Brettell, A. (2013). A survey of environmental deterrence in China's evolving regulatory framework. In B. Ren & H. Shou (Ed.), *Chinese Environmental Governance Dynamics, Challenges, and Prospects in a Changing Society*, 21-81.

Brunnermeier, S. B., & Cohen, M. A. (2003). Determinants of environmental innovation in US manufacturing industries. *Journal of environmental economics and management*, *45*(2), 278-293.

Bryman, A. (2017). Quantitative and qualitative research: further reflections on their integration. In J. Brannen (Ed.), *Mixing methods: Qualitative and quantitative research*, 57-78.

Buckley, C. (2015, March 1). Documentary on Air Pollution Grips China. *New York Times*.

Buckley, T., & Nicholas, S. (2017). *China's Global Renewable Energy Expansion*. Institute for Energy, Economics and Financial Analysis.

Buttel, F. H. (2000a). Classical Theory and Contemporary Environmental Sociology: some reflections on the antecedents and prospects for reflexive modernization theories in the study of environment and society. In G. Spaargaren, A. P. J. Mol, & F. H. Buttel (Ed.), *Environment and Global Modernity*.

Buttel, F. H. (2000b). Ecological modernization as social theory. *Geoforum*, *31*(1), 57-65.

Buttel, F. H. (2000c). World society, the nation-state, and environmental protection: Comment on Frank, Hironaka, and Schofer. *American Sociological Review*, *65*(1), 117-121.

Buttel, F. H. (2002). Environmental sociology and the sociology of natural resources: Institutional histories and intellectual legacies. *Society & Natural Resources*, *15*(3), 205-211.

Buttel, F. H. (2003). Environmental sociology and the explanation of environmental reform. *Organization & Environment*, *16*(3), 306-344.

Buttel, F. H. (2010). Social institutions and environmental change. In M. Redclift, & G. Woodgate(Ed.), *The International Handbook of Environmental Sociology*, 33-47.

Cai, Y., Pan, C. H., & Statman, M. (2016). Why do countries matter so much in corporate social performance? *Journal of Corporate Finance*, 41, 591-609.

Cai, D., & Wang, C. (2010). *China's Journey toward the Rule of Law: Legal Reform, 1978-2008*. Brill.

Cai, W., & Zhou, X. (2014). On the drivers of eco-innovation: empirical evidence from China. *Journal of Cleaner Production*, *79*, 239-248.

Callon, M. (1999). Some elements of a sociology of translation: Domestication of the scallops and the fishermen of Saint Brieuc Bay. In M. Biagioli (Ed.), *The Science Studies Reader*, 67-83.

Cann, C. W., Cann, M. C., & Gao, S. (2005). China's Road to Sustainable Development: An Overview. In K. Day (Ed.), *China's Environment and the Challenge of Sustainable Development*.

Carolan, M. S. (2004). Ecological modernization theory: what about consumption? *Society and Natural Resources*, *17*(3), 247-260.

Carolan, M. S. (2008). The multidimensionality of environmental problems: The GMO controversy and the limits of scientific materialism. *Environmental Values*, *17*(1), 67-82.

Carter, N., & Mol, A. P. J. (2007). *Environmental Governance in China*. Routledge.

Carter, N., & Mol, A. P. J. (2007). China and the Environment: domestic and Transnational Dynamics of a Future Hegemon. In Carter, N., & Mol, A. P. J. (Ed.), *Environmental governance in China*, 182-196.

Casey, J., & Koleski, K. (2011). *Backgrounder: China's 12th Five-Year Plan*.

Castka, P., & Prajogo, D. (2013). The effect of pressure from secondary stakeholders on the internalization of ISO 14001. *Journal of Cleaner Production*, *47*, 245-252.

Catton Jr, W. R., & Dunlap, R. E. (1978). Environmental sociology: A new paradigm. *The American Sociologist*, 41-49.

CDB. (2010, 2013-2015). *Green Loans in CSR*. China Development Bank.

CEC. (2018). *Brief Introduction of CEC Climate Change Business*. The Commission for Environmental Cooperation.

Center for International Earth Science Network. (2012). *Low Elevation Coastal Zone Urban-Rural Estimates, Global Rural-Urban Mapping Project.*

CGCC Vision 商薈. (2010). The Chinese General Chamber of Commerce 香港中华总商会

Chai, J. C. (2002). Trade and environment: evidence from China's manufacturing sector. *Sustainable Development*, *10*(1), 25-35.

Chan, H. K., Yee, R. W., Dai, J., & Lim, M. K. (2016). The moderating effect of environmental dynamism on green product innovation and performance. *International Journal of Production Economics*, *181*, 384-391.

Chan, J. M. (2000). When Capitalist and Socialist Television Clash: The Impact of Hong Kong TV on Guangzhou Residents. In C. Lee, T. V. Lee, & J. Li (Ed.), *Money, Power and Media: Communication Patterns and Bureaucratic Control in Cultural China*, 245-270.

Chang, F. K. (2014). China's Economic Reforms and the Communist Party's New Left. Retrieved March 13, 2015, from https://www.fpri.org/article/2014/03/chinas-economic-reforms-and-the-communist-partys-new-left/

Chang, Y., Du, X., & Zeng, Q. (2021). Does environmental information disclosure mitigate corporate risk? Evidence from China. *Journal of Contemporary Accounting & Economics*, *17*(1), 100239.

Che, X., & Meng, Y. (2017). 珠三角由“轻”变“重”：先进装备制造业加速跑. Retrieved February 2, 2017, from http://www.gov.cn/xinwen/2017-01/25/content_5163294.htm#allContent

Chen, G. (2009). *Politics of China's Environmental Protection: Problems and Progress*. World Scientific Publishing Company Pte. Limited.

Chen, G. (2010). A Long Way to Go Green: Rethinking China’s Environmental Policy, Laws, and Governance. In L. Zhao & T. S. Lim (Ed.), *China's New Social Policy: Initiatives For A Harmonious Society*.

Chen, G. (2012). *China's Climate Policy*. Taylor & Francis.

Chen, H. (2015, February 5). 广东省禅城一工厂偷排超标废水. *中国环境报 China Environment News*.

Chen, J. (2010). Transnational environmental movement: Impacts on the green civil society in China. *Journal of Contemporary China*, *19*(65), 503-523.

Chen, S., & Uitto, J. I. (2003). Governing marine and coastal environment in China: building local government capacity through international cooperation. *China environment series*, *6*, 67-80.

Chen, W., & Gong, Y. (2009). China launches vast water clean-up. Retrieved February 12, 2014, from https://www.scidev.net/global/news/china-launches-vast-water-clean-up/

Cheng, Z., Wang, M., & Chen, J. (2014). *Urban China in the New Era: Market Reforms, Current State, and the Road Forward*. Springer Berlin Heidelberg.

Chien, M., & Shih, L. H. (2007). An empirical study of the implementation of green supply chain management practices in the electrical and electronic industry and their relation to organizational performances. *International Journal of Environmental Science and Technology (IJEST)*, Volume 4, 3(15) 383-394.

China Centre for Modernization Research. (2007). *China Modernization Report 2007: Study on Ecological Modernization.* Peking University Press.

China Daily. (2018, February 5). Two more cities join China's trillion yuan GDP club in 2017. *China Daily*.

Chinanews.com. (2015). 环保部通报: 多家企业环境监测数据造假. Retrieved July 26, 2018, from http://www.chinanews.com/m/ny/2015/06-12/7340796.shtml

Chiu, C., Zhang, J., Li, M., Wei, S., Xu, S., & Chai, X. (2020). A study of environmental disclosures practices in Chinese energy industry. *Asian Journal of Sustainability and Social Responsibility*, *5*(1), 1-21.

Christmann, P., & Taylor, G. (2001). Globalization and the environment: Determinants of firm self-regulation in China. *Journal of international business studies*, *32*(3), 439-458.

Christoff, P. (1996). Ecological modernisation, ecological modernities. *Environmental politics*, *5*(3), 476-500.

City of Foshan . (2007). 佛山创模简报.

City of Shenzhen. (2011). 广东省深圳市鼓励政策 关于印发宝安区推进低碳经济发展工作方案的通知 龙岗区贸工局开展自愿性清洁生产审核工作方案, 龙岗区经济发展资金(节能减排、循环经济类)管理办法实施细则贸工局贸工局.

Clarke, R. A., Stavins, R., Ladd Greeno, J., Bavaria, J., Cairncross, D., Etsy, D., Gray, R. (1994). The challenge of going green. *Reader in Business and the Environment*, *45*.

Clegg, S. R., Hardy, C., Lawrence, T. & Nord, W. R. (2006). *The SAGE Handbook of Organization Studies*. Sage Publications.

Clemente , J. (2015, March 18). China's Car, Gasoline, and Oil Markets to 2020. *Forbes*.

Clifford, M. L. (2015). *The Greening of Asia: The Business Case for Solving Asia's Environmental Emergency*. Columbia University Press.

Climate group, & Nanfang media. (2011). 中国城市低碳行 China redesign. The Climate group and Nanfang media.

Cohen, M. J. (1997). Risk society and ecological modernisation alternative visions for post-industrial nations. *Futures*, *29*(2), 105-119.

Corne, P., & Browaeys, J. (2017). China cleans up its act on environmental enforcement. Retrieved March 2, 2018, from https://chinadialogue.net/en/pollution/10272-china-cleans-up-its-act-on-environmental-enforcement/

Coulon, A. (2020). *L'École de Chicago*. Presses Universitaires de France - PUF.

Cramer, J., Schot, J., Van den Akker, F., & Geesteranus, G. M. (1990). Stimulating Cleaner Technologies through Economic Instruments; Possibilities and Constraints. *UNEP Industry and Environment Review*, *13*(2), 46-53.

CREJ. (2018). 我国上市企业环境信息披露总体水平偏低. Retrieved June 28, 2018, from http://www.cfej.net/bwzl/jxdt/201804/t20180412_573580.shtml

Creswell, J. W., & Clark, V. L. P. (2011). *Designing and Conducting Mixed Methods Research*. Sage Publications.

Crippa, M., Solazzo, E., Huang, G., Guizzardi, D., Koffi, E., Muntean, M., Janssens-Maenhout, G. (2020). High resolution temporal profiles in the Emissions Database for Global Atmospheric Research. *Scientific data*, *7*(1), 1-17.

Cushing, K. K., McGray, H., & Lu, H. (2005). Understanding ISO 14001 adoption and implementation in China. *International journal of environment and sustainable development*, *4*(3), 246-268.

Cushing, K. K., McGray, H., & Lu, H. (2008). Environmental Leapfrogging through Voluntary Measures ? ISO 14001 in China. In P. Ho (Ed.), *Leapfrogging Development in Emerging Asia*, 39-61.

Cushing, K. K., Wise, P. L., & Hawes-Davis, J. (1999). Evaluating the implementation of cleaner production audit demonstration projects. *Environmental Impact Assessment Review*, *19*(5-6), 569-586.

Darnall, N., & Edwards Jr, D. (2006). Predicting the cost of environmental management system adoption: the role of capabilities, resources and ownership structure. *Strategic management journal*, *27*(4), 301-320.

Darnall, N., Henriques, I., & Sadorsky, P. (2008). Do environmental management systems improve business performance in an international setting? *Journal of International Management*, *14*(4), 364-376.

Dasgupta, S., Hettige, H., & Wheeler, D. (2000). What improves environmental compliance? Evidence from Mexican industry. *Journal of Environmental Economics and Management*, *39*(1), 39-66.

Dasgupta, S., & Wheeler, D. (1996). *Citizen Complaints as Environmental Indicators Evidence from China*. The World Bank.

Day, K. (2005). *China's Environment and the Challenge of Sustainable Development*. M.E. Sharpe.

Dayoo. (2010a). 解密创尔特获得厨卫业首张低碳产品证书. Retrieved March 29, 2010, from http://www.dayoo.com/roll/201003/26/10000307_101426167.htm

Dayoo. (2010b). 低碳家装悄然兴起 神洲化工力拔头筹. Retrieved May 2, 2010, from http://www.dayoo.com/roll/201004/30/10000307_101874412.htm

Dayoo. (2010c). 广东 25 家企业在环保信用等级评价中被亮红牌. Retrieved May 30, 2010, from http://www.dayoo.com/roll/201005/28/10000307_102171797.htm

Dayoo.com. (2010a). 广东公布重点污染源环境保护信用管理评价结果. Retrieved May 12, 2013, from http://www.dayoo.com/

Dayoo.com. (2010b). 重金属污染引环保组织"通牒" 知名 IT 企业表现漠然. Retrieved May 12, 2013, from http://www.dayoo.com/

De Barros, R., de Fatima, F., de Paiva, M., & Sisinno, C. (2003). Cleaner production challenges in Brazilian SMEs. *Industry and environment*, *26*(4), 26-28.

De Burgh, H., & Rong, Z. (2011). *China's Environment and China's Environment Journalists: A Study*. Intellect.

Delang, C. O. (2016). *China's Air Pollution Problems*. Taylor & Francis.

Delang, C. O. (2017). *China's Soil Pollution and Degradation Problems*. Taylor & Francis.

Delmas, M., & Montiel, I. (2009). Greening the supply chain: when is customer pressure effective? *Journal of Economics & Management Strategy*, *18*(1), 171-201.

Delmas, M. A. (2002). The diffusion of environmental management standards in Europe and in the United States: An institutional perspective. *Policy sciences*, *35*(1), 91-119.

Der Spiegel. (2005, March 7). *The Chinese Miracle Will End Soon* [Interview]. Retrieved June 1, 2012, from https://www.spiegel.de/international/spiegel/spiegel-interview-with-china-s-deputy-minister-of-the-environment-the-chinese-miracle-will-end-soon-a-345694.html

Desrochers, P. (2004). Industrial symbiosis: the case for market coordination. *Journal of Cleaner Production*, *12*(8-10), 1099-1110.

Dhaliwal, D. S., Li, O. Z., Tsang, A., & Yang, Y. G. (2011). Voluntary nonfinancial disclosure and the cost of equity capital: The initiation of corporate social responsibility reporting. *The accounting review*, *86*(1), 59-100.

Ding, X., & Gao, J. (2017, August 2). 简化审批加强监管释放活力—国务院法制办、环保部负责人就《国务院关于修改〈建设项目环境保护管理条例〉的决定》答记者问

Dixon-Fowler, H. R., Slater, D. J., Johnson, J. L., Ellstrand, A. E., & Romi, A. M. (2013). Beyond "does it pay to be green?" A meta-analysis of moderators of the CEP–CFP relationship. *Journal of business ethics*, *112*(2), 353-366.

Dong, L. (2015, July 20). 367 shades of grey: why China needs a coal cap. Retrieved March 12, 2016, from http://www.greenpeace.org/eastasia/news/blog/367-shades-of-grey-why-china-needs-a-coal-cap/blog/54429/

Dong, L., Kriesi, H., & Kübler, D. (2016). *Urban Mobilizations and New Media in Contemporary China*. Ashgate.

DRC & OECD. (2017). *Industrial upgrading for green growth in China: Thematic focus on environment*. Development Research Centre of the State Council of China and OECD.

Dryzek, J. S. (1995). Review: Toward an ecological modernity. *Policy Interpretation*, *28*(2), 231-242.

Dryzek, J. S. (2021). *The politics of the earth*. Oxford university press.

Dryzek, J., & Schlosberg, D. (1998). *Debating the Earth: The Environmental Politics Reader.* Oxford University Press.

Dunlap, R. E., Bechtel, R., & Churchman, A. (2002). Environmental sociology. *Handbook of environmental psychology*, *2*, 160-171.

Dunlap, R. E., & Catton Jr, W. R. (1979). Environmental sociology. *Annual review of sociology*, *5*(1), 243-273.

Dunlap, R. E., & Catton, W. R. (1994). Struggling with human exemptionalism: The rise, decline and revitalization of environmental sociology. *The American Sociologist*, *25*(1), 5-30.

Dunlap, R. E., & Rosa, E. A. (2000). Environmental Sociology. In E. F. Borgotta, & J. V. Montgomery (Ed.), *Encyclopedia of Sociology*. New York.

Díaz-García, C., González-Moreno, Á., & Sáez-Martínez, F. J. (2015). Eco-innovation: insights from a literature review. *Innovation*, *17*(1), 6-23.

Eckersley, R. (1996). *Markets, the state and the environment: towards integration*. Macmillan International Higher Education.

Economy, E. (2004). *The River Runs Black: The Environmental Challenge to China's Future*. Cornell University Press.

Economy, E. (2007). The Great Leap Backward-The Costs of China's Environmental Crisis. *Foreign Affairs*, *86*, 38.

Economy, E., & Levi, M. (2014). *By All Means Necessary: How China's Resource Quest is Changing the World*. Oxford University Press.

Economy, E., & Lieberthal, K. (2007). Scorched earth: Will environmental risks in China overwhelm its opportunities? *Harvard Business Review*, *85*(6), 88.

Eder, N. R. (1996). *Poisoned Prosperity: Development, Modernization, and the Environment in South Korea*. M.E. Sharpe.

Edmonds, R. L. (2011). The evolution of environmental policy in the People's Republic of China. *Journal of Current Chinese Affairs*, *40*(3), 13-35.

EIA. (2015). *China, International energy data and analysis*. Energy Information Administration.

Elkington, J. (1994). Towards the sustainable corporation: Win-win-win business strategies for sustainable development. *California management review*, *36*(2), 90-100.

Edmonds, R. L. (2000). *Managing the Chinese environment*. Oxford University Press.

Enright, M. J., Scott, E., & Chang, K. (2005). *Regional Powerhouse: The Greater Pearl River Delta and the Rise of China*. Wiley.

Eriksson, C. (2004). Can green consumerism replace environmental regulation?—a differentiated-products example. *Resource and energy economics*, *26*(3), 281-293.

Esty, D. C., & Porter, M. E. (1998). Industrial ecology and competitiveness: Strategic implications for the firm. *Journal of Industrial Ecology*, *2*(1), 35-43.

Esty, D. C., & Winston, A. S. (2006). *Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage*. Yale University Press.

Evans, P. B. *Livable Cities?: Urban Struggles for Livelihood and Sustainability*. University of California Press.

Guangdong Treasury and ETC. (2013). 广东省电机能效提升（*2013-2015* 年）及注塑机节能改造工作实施方案.

Etzioni, A. (1991). Socio-Economics Revisited. *Sociological Inquiry*, *61*(1), 68-73.

Evans, P. (1997). Government action, social capital, and development: Reviewing the evidence of synergy. *Research series-Institute of international studies University of California Berkeley,* 178-209.

Evans, P. B. (2012). *Embedded autonomy*. Princeton University Press.

Factsanddetails.com. (2011). Chinese Television and Radio: Stations, Channels, Cable and Satellite TV. Retrieved December 10, 2021, from https://factsanddetails.com/china/cat7/sub43/item236.html

Fan, C. C. (2006). China's eleventh five-year plan (2006-2010): from" getting rich first" to" common prosperity". *Eurasian geography and economics*, *47*(6), 708-723.

Faules, D. (1982). The use of multi-methods in the organizational setting. *Western Journal of Communication (includes Communication Reports)*, *46*(2), 150-161.

Feng, J. (2012, April 19). 能源消费总量指标, 推不动？中央地方暗战升级. *Nan Fang Weekend*.

Ferris Jr, R. J., & Zhang, H. (2005). Environmental Law in the People Republic of China. In K. Day (Ed.), *China's Environment and the Challenge of sustainable Development*, 66-101.

Ferron Vilchez, V., & Darnall, N. (2016). Two are better than one: The link between management systems and business performance. *Business Strategy and the Environment*, *25*(4), 221-240.

FGE. (2014, June 17). China's Power Sector Developments: An Update. *FGE China Oil & Gas Monthly*.

FGE. (2015, March). Renewable Energy Policy Network for the 21st Century, Renewables 2014: Global Status Report. *China Oil & Gas Monthly*.

Fisher, D. R., & Freudenburg, W. R. (2001). Ecological modernization and its critics: Assessing the past and looking toward the future. *Society & natural resources*, *14*(8), 701-709.

Florida, R. (1996). Lean and green: the move to environmentally conscious manufacturing. *California management review*, *39*(1), 80-105.

Florida, R., & Davison, D. (2001). Gaining from green management: environmental management systems inside and outside the factory. *California management review*, *43*(3), 64-84.

Florig, K., & Spofford, W. (1994). *Economic incentives in China's environmental policy*. The World Bank.

Forbes, L. C., & Jermier, J. M. (2012). The new corporate environmentalism and the symbolic management of organizational culture. In P. Bansal & A. J. Hoffman (Ed.), *The Oxford handbook of business and the natural environment*, 556-571.

Ford, P. (2012, April 16). Ma Jun helps Chinese find out who's polluting and shame corporations into cleaning up. *The Christian Science Monitor*.

Fridley, D., Zheng, N., Zhou, N., Aden, N., Lin, J., Cheng, J., & Sakamoto, T. (2008). *China Refrigerator Information Label: Specification Development and Potential Impact*.

Friends of Nature, IPE, & Green Beagle. (2010). *Study of Heavy Metal Pollution by IT Brand Supply China*. Institute of Public and Environmental Affairs.

Friends of Nature, IPE, & Green Beagle. (2011). *The Other Side of Apple*. Institute of Public and Environmental Affairs.

Frijins, J., Kirai, P., Malombe, J., & van Vliet, B. (1997). *Pollution Control of Small-scale Metal Industries in Nairobi*. Wageningen University.

Frijns, J., Phuong, P. T., & Mol, A. P. J. (2000). Developing countries: Ecological modernisation theory and industrialising economies: The case of Viet Nam. *Environmental politics*, *9*(1), 257-292.

Frondel, M., Horbach, J., & Rennings, K. (2008). What triggers environmental management and innovation? Empirical evidence for Germany. *Ecological Economics*, *66*(1), 153-160.

Fryxell, G. E., Chung, S. S., & Lo, C. W. (2004). Does the selection of ISO 14001 registrars matter? Registrar reputation and environmental policy statements in China. *Journal of environmental management*, *71*(1), 45-57.

Fu, B. (2008). Blue skies for China. *Science*, *321*(5889), 611.

Fu, T. (2007). Development of Environmental NGOs in China. In C. Liang & D. Yang (Ed.), *The China Environment Yearbook, Volume 1 (2005): Crisis and Breakthrough of China's Environment*, 291-310.

Fugui, L., Bing, X., & Bing, X. (2008). Improving public access to environmental information in China. *Journal of Environmental Management*, *88*(4), 1649-1656.

Fussler, C., & James, P. (1996). *Driving Eco-innovation: A Breakthrough Discipline for Innovation and Sustainability*. Pitman Publishing.

Gan, N., & Griffiths, J. (2021, April 23). The latest area of competition between the US and China: Saving the world. *CNN*. Retrieved May 26, 2021, from https://www.cnn.com/2021/04/23/china/china-us-climate-mic-intl-hnk/index.html

Gao, G. (2011, February 21). 广州亚运: 蓝天碧水带给亚洲惊喜. *Nanfang Daily*.

Gao, Y. (2012). *China as the Workshop of the World: An Analysis at the National and Industry Level of China in the International Division of Labor*. Routledge.

Gardner, D. (2014, September 14). China's Environmental Awakening. *New York Times*.

Gardner, H. (2008). *Five Minds for the Future*. Harvard Business School Press.

Gaudu, A. (1998). Environment in China: From Fast Development to Sustainable Development. *China News Analysis,* (1618), 1–10.

GBD Risk Factors Collaborators. (2016). Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet*, *388*(10053), 1659.

GDCP. (2010). 广东省清洁生产工作资料汇编. 广东省清洁生产.

GDDJ.Chinanews. (2014). 东莞 4 企业涉嫌环境违法 2 五金厂被责令停产. Retrieved August 12, 2014, from http://guangzhou.baogaosu.com/xinwen/2%25E4%25BA%2594%25E9%2587%2591%25E5%258E%2582%25E8%25A2%25AB%25E8%25B4%25A3%25E4%25BB%25A4%25E5%2581%259C%25E4%25BA%25A7%25E4%25BA%2594%25E9%2587%2591/21372059/

GDEIC 广东省经济和信息化委员会.（2011）广东省“十二五”清洁生产规划（2011-2015）.

GDPTO. (2012). 印发广东省“十二五”节能减排综合性工作方案的通知. (006939748/2012-00198). 广东省人民政府办公厅.

Gdzxb.gov.cn. (2005). Provincial government-commissioned research. 广东政协网.

Geall, S. (2013). China's environmental journalists: a rainbow confusion. In S. Geall (Ed.), *China and the Environment: The Green Revolution*.

Geall, S. (2013). *China and the Environment: The Green Revolution*. Zed Books.

Geng, Y., Wang, X., Zhu, Q., & Zhao, H. (2010). Regional initiatives on promoting cleaner production in China: a case of Liaoning. *Journal of Cleaner Production*, *18*(15), 1502-1508.

Ghisetti, C., & Pontoni, F. (2015). Investigating policy and R&D effects on environmental innovation: A meta-analysis. *Ecological Economics*, *118*, 57-66.

Gibbs, D. (2006). Prospects for an environmental economic geography: linking ecological modernization and regulationist approaches. *Economic Geography*, *82*(2), 193-215.

Gibson, R. B. (1999). *Voluntary Initiatives and the New Politics of Corporate Greening*. Broadview Press.

Gille, Z. (2000). Transitional economies: Legacy of waste or wasted legacy? The end of industrial ecology in post-socialist Hungary. *Environmental politics*, *9*(1), 203-231.

Gille, Z. (2004). Europeanising Hungarian waste policies: progress or regression? *Environmental Politics*, *13*(1), 114-134.

Gille, Z. (2007). *From the cult of waste to the trash heap of history: the politics of waste in socialist and postsocialist Hungary*. Indiana University Press.

Gittsham, M. (2015, February 4). More big businesses push for stricter environmental regulations. *The Guardian*.

Goldblatt, D. (2013). *Social theory and the environment*. John Wiley & Sons.

Golding, C. (2009). Integrating the disciplines: Successful interdisciplinary. Centre for the Study of Higher Education. The University of Melbourne.

González-Benito, J., & González-Benito, Ó. (2006). A review of determinant factors of environmental proactivity. *Business Strategy and the environment*, *15*(2), 87-102.

Gouldson, A., Hills, P., & Welford, R. (2008). Ecological modernisation and policy learning in Hong Kong. *Geoforum*, *39*(1), 319-330.

Gouldson, A., & Murphy, J. (1997). Ecological modernisation: restructuring industrial economies. *Political Quarterly*, *68*(B), 74-86.

Gouldson, A., & Murphy, J. (2013). *Regulatory realities: The implementation and impact of industrial environmental regulation*. Routledge.

Gov.cn. (2010). 国务院关于进一步加强淘汰落后产能工作的通知. Retrieved July 12, 2012, from http://www.gov.cn/zwgk/2010-04/06/content_1573880.htm

Gov.cn. (2011). 《关于逐步禁止进口和销售普通照明白炽灯的公告》. Retrieved May 1, 2013, from http://www.gov.cn/zwgk/2011-11/14/content_1992476.htm

Gov.cn. (2019). 国家发展改革委产业发展司负责人就《产业结构调整指导目录（*2019*年）》答记者问. Retrieved January 24, 2020, from http://www.gov.cn/zhengce/2019-11/06/content_5449198.htm

Government of the Hong Kong SAR. (2017). Guangdong-Hong Kong-Macao Pearl River Delta Regional Air Quality Monitoring Network results for 2016. Government of the Hong Kong SAR.

Government of the PRC. (1994). *China's Agenda 21: White Paper on China's Population, Environment and Development in the 21st Century*. China Environmental Press.

Gray, P. S., Williamson, J. B., Karp, D. A., & Dalphin, J. R. (2007). *The Research Imagination: An Introduction to Qualitative and Quantitative Methods*. Cambridge University Press.

Gregg, A., & Anderson, D. (2017). It’s complicated: Canadian opinion and the fuels sector. Retrieved June 19, 2018, from https://www.canadianfuels.ca/perspectives-2018/its-complicated-canadian-opinion-and-the-fuels-sector/

Grossman, G. M., & Krueger, A. B. (1995). Economic growth and the environment. *The quarterly journal of economics*, *110*(2), 353-377.

Grunow, D. (2011). Structures and logic of EP implementation and administration in China. *Journal of Current Chinese Affairs*, *40*(3), 37-75.

Guangdong Treasury, & ETC. (2013). 广东省电机能效提升（2013-2015 年）及注塑机节能改造工作实施方案. Guangdong Treasury and ETC.

Guangzhou Metro. (2018). 公司简介. Retrieved November 4, 2018, from http://www.gzmtr.com/ygwm/gsgk/gsjs/

Guay, L. (2020). *Les enjeux sociaux de l'environnement: des problèmes aux actions*. Presses de l'Université Laval.

Guay, L., & Hamel, P. (2018). *Les aléas du débat public*. Presse de l'Université Laval.

Guay, L., & Hamel, P. (2018). Conflits et controverses sous l'angle du débat public. In L. Guay & P. Hamel (Ed.), *Les aléas du débat public*, 1-24.

Gunningham, N., Kagan, R. A., & Thornton, D. (2003). *Shades of green: business, regulation, and environment*. Stanford University Press.

Gunther, M. (2015, February 9). Under pressure: campaigns that persuaded companies to change the world. *The Guardian*.

Guo, C., & Saxton, G. D. (2014). Tweeting social change: How social media are changing nonprofit advocacy. *Nonprofit and voluntary sector quarterly*, *43*(1), 57-79.

Guo, P. (2005). Corporate Environmental Reporting and Disclosure in China, CSR Asia Corporate environmental reporting and disclosure in China. In R. Welford (Ed.), *CSR Asia*. Tsinghua University.

Guo, W., & Zhang, C. (2016, June 20). 迈向“质量时代”打造“质量东莞”. *Nanfang Daily*.

Guo, X. (2010). 广东家电二次创业大幕拉起. Retrieved April 23, 2010, from http://www.dayoo.com/roll/201004/21/10000307_101751017.htm

Gurría, A. (2012, March 18). *Promoting Technological Innovation for New Sources of Growth*. OECD.

GZCPC. (2013). 全面推行清洁生产行动. 广州市清洁生产中心.

GZETC. (2010). 千家企业清洁生产绿色行动. 广州市经济贸易委员会.

Haas, B. (2016, December 12). China riot police seal off city centre after smog protesters put masks on statues. *The Guardian*.

Haas, B. (2017, January 9). Beijing creates anti-smog police to tackle air polluters. *The Guardian*.

Hajer, M. A. (1995). *The politics of environmental discourse: Ecological modernization and the policy process*. Clarendon Press.

Hajer, M. A. (1996). Ecological modernization in cultural politics. In S. Lash, B. Szerszynski, & B. Wynne (Ed.), *Risk, Environment and Modernity: Towards a New Ecology*, 246-268.

Hamschmidt, J., & Dyllick, T. (2006). Profitable? Yes! But is it eco-effective? In S. Schaltegger, & M. Wagner (Ed.), *Managing the business case for sustainability: the integration of social, environmental and economic performance*, 554-568.

Hannigan, J. (2014). *Environmental Sociology*. Routledge.

Hannigan, J. (1995). *Environmental Sociology: A Social Constructionist Perspective*. Routledge.

Hanson, S., Nicholls, R., Ranger, N., Hallegatte, S., Corfee-Morlot, J., Herweijer, C., & Chateau, J. (2011). A global ranking of port cities with high exposure to climate extremes. *Climatic change*, *104*(1), 89-111.

Harney, A. (2016). How old-school factories stay alive in China's south. Retrieved July 16, 2017, from https://www.reuters.com/article/us-china-labour-idUKKCN0YD00L

He, G. (2014, June 30). The human cost of China's untold soil pollution problem. *The Guardian*.

He, G., Lu, Y., Mol, A.P.J., & Beckers, T. (2012). Changes and challenges: China's environmental management in transition. *Environmental Development*, *3*, 25-38.

He, G., Lü, Y., Zhang, L., Mol, A. P. J., & Feng, Y. (2011). Evaluation of environmental information disclosure by environmental agencies in China. *Huan jing ke xue*, *32*(11), 3137-3144.

He, G., Zhang, L., Lu, Y., & Mol, A. P. J. (2011). Managing major chemical accidents in China: Towards effective risk information. *Journal of hazardous materials*, *187*(1-3), 171-181.

Heeres, R., Vermeulen, W. J., & De Walle, F. (2004). Eco-industrial park initiatives in the USA and the Netherlands: first lessons. *Journal of cleaner production*, *12*(8-10), 985-995.

Heggelund, G. (2007). China's climate change policy: Domestic and international developments. *Asian perspective*, 155-191.

Heggelund, G., Andresen, S., & Fritzen Buan, I. (2010). Chinese Climate Policy, Domestic Priorities, Foreign Policy and Emerging Implementation. In K. Harrison & L. McIntosh (Ed.), *Global Commons, Domestic Decisions: The Comparative Politics of Climate Change*.

Hemmelskamp, J., & Physica-Verlag, H. D. (2000). *Innovation-oriented environmental regulation*. Springer.

Henriques, I., & Sadorsky, P. (2004). *Environmental policy tools and firm level management practices in Canada*. OECD.

Henry, R. S. (1992, September/October). Saving Hong Kong's Environment. *China Business Review*, 39-43.

Heras-Saizarbitoria, I., Boiral, O., & Arana, G. (2016). Renewing environmental certification in times of crisis. *Journal of Cleaner Production*, *115*, 214-223.

Hicks, C., & Dietmar, R. (2007). Improving cleaner production through the application of environmental management tools in China. *Journal of Cleaner Production*, *15*(5), 395-408.

Hilderbrandt, T., & Turner, J. L. (2002). Environmental Journalism in China: Event Summary. China Environment Forum Woodrow Wilson International Centre for Scholars.

Hilaire, E., & Mead, N. V. (2016, May 10). The great leap upward, China's Pearl River Delta, then and now. *The Guardian*.

Hill, S. (2013). *Reforms for a cleaner, healthier environment in China*. OECD.

HKTDC. (2016). PRD economic profile. HKTDC.

HKTDC. (2017). Overall economic competitiveness ranked by 2*016 Report on China's Urban Competitiveness* published by the C*hinese Academy of Social Sciences*. HKTDC.

HKTDC. (2018). Foshan (Guangdong) City Information profile. HKTDC.

Ho, P. (2001). Greening without conflict? Environmentalism, NGOs and civil society in China. *Development and Change*, *32*(5), 893-921.

Ho, P. (2008). *Leapfrogging Development in Emerging Asia: Caught Between Greening and Pollution*. Nova Science Publishers.

Ho, P., & Edmonds, R. L. (2008). *China's Embedded Activism: Opportunities and Constraints of a Social Movement*. Routledge.

Hoffman, A. J. (1999). Institutional evolution and change: Environmentalism and the US chemical industry. *Academy of management journal*, *42*(4), 351-371.

Hoffman, A. J., & Georg, S. (2012). *Business and the Natural Environment*. Routledge.

Hoffman, A. J., & Woody, J. G. (2008). *Climate change: what's your business strategy?* Harvard Business Press.

Hoffman, S., & S., J. (2015, June 22). Environmental Protests Expose Weakness In China's Leadership. *Forbes*.

Holdaway, J., & Husain, L. (2014). Food Safety in China: a Mapping of Problems. *Governance and Research*, *27*.

Hong, J., & Li, X. (2013). Speeding up cleaner production in China through the improvement of cleaner production audit. *Journal of cleaner production*, *40*, 129-135.

Hong, P., Kwon, H., & Roh, J. J. (2009). Implementation of strategic green orientation in supply chain: an empirical study of manufacturing firms. *European Journal of Innovation Management*.

Hoque, A., Mohiuddin, M., & Su, Z. (2018). Effects of industrial operations on socio-environmental and public health degradation: evidence from a least developing country (LDC). *Sustainability*, *10*(11), 3948.

Horbach, J. (2008). Determinants of environmental innovation—New evidence from German panel data sources. *Research policy*, *37*(1), 163-173.

Horbach, J., Rammer, C., & Rennings, K. (2012). Determinants of eco-innovations by type of environmental impact—The role of regulatory push/pull, technology push and market pull. *Ecological economics*, *78*, 112-122.

Howard-Grenville, J. A. (2006). Inside the “black box” how organizational culture and subcultures inform interpretations and actions on environmental issues. *Organization & Environment*, *19*(1), 46-73.

Hsiao, H. M., & Liu, H. J. (2002). Collective Action toward a Sustainable City: Citizens’ Movements and Environmental Politics in Taipei. In P. B. Evans (Ed.), *Livable Cities?: Urban Struggles for Livelihood and Sustainability*, 67-94.

Hsu, S. (2016, December 28). China's Urbanization Plans Need To Move Faster. *Forbes*.

Hu, A. (2011, March 28). Green light for hard targets. *China Daily*.

Huang, S. (2016, June 20). 撬动社会力量参与产业创新. *Nanfang Daily*.

Hart, S. L., & Ahuja, G. (1996). Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance. *Business strategy and the Environment*, *5*(1), 30-37.

Huang, X. (2014, June 5). 广州公布首批环境违法“黑名单” 19 家企业上榜. *Yangcheng Evening News-Xin Kuai Bao 羊城晚报-新快报*.

Huber, G. P. (1991). Organizational learning: The contributing processes and the literatures. *Organization science*, *2*(1), 88-115.

Huber, J. (2000). Towards industrial ecology: sustainable development as a concept of ecological modernization. *Journal of environmental policy and planning*, *2*(4), 269-285.

Huber, J. (2004). *New technologies and environmental innovation*. Edward Elgar Publishing.

Huber, J. (2008a). Pioneer countries and the global diffusion of environmental innovations: Theses from the viewpoint of ecological modernisation theory. *Global Environmental Change*, *18*(3), 360-367.

Huber, J. (2008b). Technological environmental innovations (TEIs) in a chain-analytical and life-cycle-analytical perspective. *Journal of Cleaner Production*, *16*(18), 1980-1986.

Huber, J. (2009). Ecological modernization: beyond scarcity and bureaucracy. In A. P. J. Mol, D. A. Sonnenfeld, & G. Spaargaren (Ed.), *The Ecological Modernisation Reader: Environmental Reform in Theory and Practice*.

Huisingh, D. (1993). *Cleaner production: theories, concepts and practice*. Erasmus Universiteit.

IEA. (2016). *Energy, Climate Change & Environment: 2016 insights*. International Energy Agency.

IEA. (2021). 中国能源体系碳中和路线图. International Energy Agency.

IHS Energy. (2013). Coal Rush: The Future of China's Coal Market.

IISD. (2010). Business for the Environment (B4E) Summit. International Institute for Sustainable Development.

IISD. (2015). Business and Climate Summit. International Institute for Sustainable Development.

Institute for Energy Economics and Financial Analysis. (2015). *Briefing Note: Global Energy Markets in Transition*. Institute for Energy Economics and Financial Analysis.

Iresearchnet. (n. d.). Sociology, Urban Sociology, Chicago School of Sociology. Retrieved March 12, 2012, from http://sociology.iresearchnet.com/urban-sociology/chicago-school-of-sociology/

ISDP. (2018). *Made in China 2025*. Institute for Security & Development Policy.

ISO. (2004). *The ISO survey of ISO 9001: 2000 and ISO 14001 certificates, 2003*. ISO Publishing.

ISO. (2012). *Template 11 From CP to EMS; Template for an environmental management system manual according to ISO 14001: 2004*. ISO Publishing.

Jacobs, A. (2012, November 6). As China Awaits New Leadership, Liberals Look to a Provincial Party Chief. *New York Times*.

Jaffe, A. B., & Palmer, K. (1997). Environmental regulation and innovation: a panel data study. *Review of economics and statistics*, *79*(4), 610-619.

Jaffe, A. B., Peterson, S. R., Portney, P. R., & Stavins, R. N. (1995). Environmental regulation and the competitiveness of US manufacturing: what does the evidence tell us? *Journal of Economic literature*, *33*(1), 132-163.

Jahiel, A. (2007). China the WTO and Implications for the Environment. In N. Carter & A. P. J. Mol (Ed.), *Environmental governance in China*, 162-181.

Jahiel, A. R. (1997). The contradictory impact of reform on environmental protection in China. *The China Quarterly*, *149*, 81-103.

Jahiel, A. R. (2000). The Organization of Environmental Protection in China. In R. L. Edmonds (Ed.), *Managing the Chinese Environment* , 33-63.

Jepson, W. (2006). Producing a modern agricultural frontier: firms and cooperatives in Eastern Mato Grosso, Brazil. *Economic Geography*, *82*(3), 289-316.

Jermier, J. M., Forbes, L. C., Benn, S., & Orsato, R. J. (2006). The New Corporate Environmentalism and Green Politics. In S. R. Clegg, C. Hardy, T. Lawrence, & W. R. Nord (Ed.), *The SAGE Handbook of Organization Studies*, 618-650.

Jiang, Q. (2015). 上半年群众举报环境违法 大气污染问题仍占首位. Retrieved October 15, 2015, from http://sd.ifeng.com/weifang/xinwenzaobanche/detail_2015_10/14/4442948_0.shtml

Jiang, R. J., & Bansal, P. (2003). Seeing the need for ISO 14001. *Journal of Management Studies*, *40*(4), 1047-1067.

Jiang, X., Hong, C., Zheng, Y., Zheng, B., Guan, D., Gouldson, A., He, K. (2015). To what extent can China's near-term air pollution control policy protect air quality and human health? A case study of the Pearl River Delta region. *Environmental Research Letters*, *10*(10), 104006.

Jiao M., Song, L., Jiang T., Zhang D., & J., Z. (2015). China's Implementation of Impact and Risk-based Early Warning. *Bulletin*, *64 (2)*. Retrieved January 12, 2016, from https://public.wmo.int/en/resources/bulletin/chinas-implementation-of-impact-and-risk-based-early-warning

Jiao, Y., Su, M., Ji, C., Yang, S., Zhang, P., Li, C., & Liu, L. (2019). Cleaner production instruments assisting sustainable transition at urban scale: A case study of Dongguan, a typical manufacturing city in China. *Journal of cleaner production*, *210*, 1449-1461.

Jing, J. (2010). Environmental Protests in rural China. In E. J. Perry & M. Selden (Ed.), *Chinese Society: Change, Conflict and Resistance*, 197-214.

Johnson, I. (2011, June 3). China Faces 'Very Grave' Environmental Situation, Officials Say. *New York Times*.

Johnson, I. (2013, June 15). China's Great Uprooting: Moving 250 Million Into Cities. *New York Times*.

Johnson, I. (2014, March 17). China Releases Plan to Incorporate Farmers Into Cities. *New York Times*.

Johnstone, N., Haščič, I., & Popp, D. (2010). Renewable energy policies and technological innovation: evidence based on patent counts. *Environmental and resource economics*, *45*(1), 133-155.

Jorgensen, D. L., & Bickman, L., (1989). *Participant Observation: A Methodology for Human Studies*. Sage Publications.

Juhre, C. (2012). The Side Effects of Unregulated Growth: Can Delta Reverse Thirty Years of Environmental Degradation? In S. Ai (Ed.), *Factory Towns of South China: An Illustrated Guidebook*,13-24.

Jänicke, M. (1997). The political system's capacity for environmental policy. In M. Jänicke, H. Jörgens, & H. Weidner. (1997). *National environmental policies*, *National Environmental Policies: A Comparative Study of Capacity-Building*, 1-24.

Jänicke, M. (2008). Ecological modernisation: new perspectives. *Journal of cleaner production*, *16*(5), 557-565.

Jänicke, M., & Jacob, K. (2004). Lead markets for environmental innovations: a new role for the nation state. *Global environmental politics*, *4*(1), 29-46.

Jänicke, M., Jörgens, H., & Weidner, H. (1997). *National Environmental Policies: A Comparative Study of Capacity-Building*. Springer Berlin Heidelberg.

Jänicke, M., & Lindemann, S. (2010). Governing environmental innovations. *Environmental Politics*, *19*(1), 127-141.

Jänicke, M., Mönch, H., & Binder, M. (1993). Ecological aspects of structural change. *Intereconomics*, *28*(4), 159-169.

Jänicke, M., Mönch, H., Ranneberg, T., & Simonis, U. E. (1989). Economic structure and environmental impacts: East-West comparisons. *Environmentalist*, *9*(3), 171-183.

Jänicke, M., & Weidner, H. (1995). *Successful environmental policy: a critical evaluation of 24 cases*. Edition Sigma Berlin.

Kagan, R. A., Gunningham, N., & Thornton, D. (2003). Explaining corporate environmental performance: how does regulation matter? *Law & Society Review*, *37*(1), 51-90.

Kahn, J., & Yardley, J. (2007, August 26). As China roars, pollution reaches deadly extremes. *New York Times*.

Kallio, T. J., & Nordberg, P. (2006). The evolution of organizations and natural environment discourse: Some critical remarks. *Organization & Environment*, *19*(4), 439-457.

Kammerer, D. (2009). The effects of customer benefit and regulation on environmental product innovation.: Empirical evidence from appliance manufacturers in Germany. *Ecological Economics*, *68*(8-9), 2285-2295.

Kan, H. (2011). Climate change and human health in China. National Institute of Environmental Health Sciences.

Kemp, R., & Pearson, P. (2007). Final report MEI project about measuring eco-innovation. *UM Merit, Maastricht*, *10*(2).

Kemp, R., Rip, A., & Schot, J. (2001). Constructing transition paths through the management of Niches. Path Dependence and Creation. Lawrence Erlbaum Associates, Inc.

Kemp, R., Smith, K., & Becher, G. (2000). How should we study the relationship between environmental regulation and innovation? In J. Hemmelskamp & H. D. Physica-Verlag (Ed.), *Innovation-oriented environmental regulation*, 43-66.

Khanna, M., & Anton, W. R. Q. (2002). Corporate environmental management: regulatory and market-based incentives. *Land economics*, *78*(4), 539-558.

Kimmelman, M. (2017, April 7). Rising Waters Threaten China's Rising Cities. *New York Times*.

King, A., & Lenox, M. (2002). Exploring the locus of profitable pollution reduction. *Management Science*, *48*(2), 289-299.

King, A. A., Lenox, M. J., & Terlaak, A. (2005). The strategic use of decentralized institutions: Exploring certification with the ISO 14001 management standard. *Academy of management journal*, *48*(6), 1091-1106.

King, E. (2013, April 17). Desertification crisis affecting 168 countries worldwide, study shows. *The Guardian*.

Kitagawa, H. (2017). *Environmental Policy and Governance in China*. Springer Japan.

Koskinen, K. (1998). Unity in environmental discourse? The role of decision makers, experts and citizens in developing Finnish environmental policy. *Policy & Politics*, *26*(1), 55-70.

Kostka, G. (2014). *Barriers to the Implementation of Environmental Policies at the Local Level in China*. The World Bank.

Koty, A. C. (2017). *Investing in China's Green Industries*. China Briefing. Retrieved June 17, 2017, from https://www.china-briefing.com/news/investing-china-clean-energy-industry/

KPMG. (2011). *China's 12th Five-Year Plan: Overview*. KPMG.

Lacey, S. (2012). Leading Global Investors Call the False Dichotomy Between Economy and Environment "Nonsense". Retrieved February 8, 2014, from https://archive.thinkprogress.org/leading-global-investors-call-the-false-dichotomy-between-economy-and-environment-nonsense-43c03cbddd03/

Lam, M. L. L. (2011). Challenges of sustainable environmental programs of foreign multinational enterprises in China. *Management Research Review*.

Lang, G. (2002). Deforestation, floods and state reactions in China and Thailand. In A. P. J. Mol, F. H. Buttel, & W. R. Freudenburg (Ed.), *The Environmental State Under Pressure*, 195-220.

Lang, J. C. (2008). Zero Landfill, Zero Waste: the Greening of Industry in Singapore. In P. Ho (Ed.), *Leapfrogging Development in Emerging Asia*, 151-172.

Lanoie, P., Ambec, S., & Scott, I. (2007). *When and why Does it Pay to be Green?* CIRANO.

Lanzi, E. (2016). *The Economic Consequences of Outdoor Air Pollution*. OECD.

Larmer, B. (2008). Bitter Waters: Can China save the Yellow—its Mother River? *National Geographic*.

Latour, B. (1987). *Science in Action: How to Follow Scientists and Engineers Through Society*. Harvard University Press.

Lee, C. C., Lee, T. V., Li, J., & Li, C. (2000). *Power, Money, and Media: Communication Patterns and Bureaucratic Control in Cultural China*. Northwestern University Press.

Lee, A., & So, L. (1999). Introduction. In A. Lee & L. So (Ed.), *Asia's Environmental Movements: Comparative Perspectives*.

Lee, Y. F., & So, A. Y. (1999). *Asia's Environmental Movements: Comparative Perspectives*. M.E. Sharpe.

Lehr, D. (2015, August 14). How Cleaning China's Environment Can Also Be Good Its Economy. Retrieved September 2, 2015, from http://www.scmp.com/comment/insight-opinion/article/1849565/how-cleaning-chinas-environment-can-also-be-good-its-economy

Lehr, D. (2016, July 30). China's Environmental Crisis : A Billion Dollar Opportunity. Retrieved July 22, 2016, from http://www.huffingtonpost.com/deborah-lehr/chinas-environmental-cris_b_7905508.html

Lei, P., Long, B., & Pamlin, C. (2005). Chinese companies in the 21st century helping or destroying the planet? April*, World Wildlife Fund survey*.

Leibo, S. A., & Li, Y. (2013). Forward. In Y. Qi (Ed.), *Chinese Research Perspectives on the Environment, Special Volume Annual Review of Low-Carbon Development in China (2011-12)*, ix-xvi.

Leibold, J. (2011). Blogging alone: China, the internet, and the democratic illusion? *The Journal of Asian Studies*, *70*(4), 1023-1041.

Lema, R., & Lema, A. (2012). Technology transfer? The rise of China and India in green technology sectors. *Innovation and Development*, *2*(1), 23-44.

Le Monde. (2013, March 21). La superficie des eaux côtières "gravement polluées" augmente en Chine. *Le Monde*.

Lenox, M., & York, J. (2012). Environmental Entrepreneurship. In P. Bansal & A. J. Hoffman (Ed.), *The Oxford Handbook of Business and the Natural Environment*, 71-82.

Leroy, P., & Van Tatenhove, J. (2000). Political Modernization Theory and Environmental Politics. In G. Spaargaren, A. P. J. Mol, & F. H. Buttel (Ed.), *Environment and Global Modernity*, 187-208.

Leroy, P., & van Tatenhove, J. (2009). Participation in a context of political modernisation. In A. P. J. Mol, D. A. Sonnenfeld, & G. Spaargaren (Ed,), *The Ecological Modernisation Reader: Environmental Reform in Theory and Practice*, 190-206.

Li, F., Zhang, B., & Wu, J. (2017, January 18). 三角镇与 103 家企业签环保目标责任书. *Nanfang Daily*.

Li, H. (2013, July 25). 偷排漏排已成习惯 约 80%企业未严格执行达标排放. *科技日报*.

Li, J. (2016, March 11). China's environment chief touts 'clean' coal tech but admits people need to clean up their act too. *South China Morning Post*.

Li, J. (2019). The last word: Xie Zhenhua: China's top climate negotiator steps down. China Dialogue. Retrieved September 22, 2020, from https://chinadialogue.net/en/climate/11717-xie-zhenhua-china-s-top-climate-negotiator-steps-down-2/

Li, K. (2014). 李克强：以产业转移促进中国经济提质升级. Retrieved July 28, 2014, from http://politics.people.com.cn/n/2014/0626/c1024-25205971.html

Li, K. (2017). 李克强说，加大生态环境保护治理力度. Retrieved June 8, 2018, from http://www.gov.cn/guowuyuan/2017-03/05/content_5173486.htm

Li, W. (2017, August 4). 3.4 万亿元！粤珠三角 9 市 GDP 总量占全省八成多. *Southern Metropolis Daily*.

Li, X. (2012). Environmental Management, Financing, and Performance in Chinese Firms: Evidence from a Nationwide Survey. In B. Ren & H. Shou (Ed.), *Chinese Environmental Governance Dynamics, Challenges, and Prospects in a Changing Society*, 125-139.

Liang, C., & Yang, D. (2007). *The China Environment Yearbook, Volume 1 (2005): Crisis and Breakthrough of China's Environment*. Brill.

Liang, Q. (2008, December 18). Changing times in Pearl River Delta region. *China Daily*.

Lieberthal, K. (1997). China’s governing system and its impact on environmental policy implementation. *China environment series*, *1*(1997), 3-8.

Lieberthal, K., & Lampton, D. M. (1992). *Bureaucracy, Politics, and Decision Making in Post-Mao China*. University of California Press.

Lieberthal, K. G. (1992). The 'Fragmented Authoritarianism' Model and Its Limitations. In K. G. Lieberthal & D. M. Lampton (Ed.), *Bureaucracy, Politics, and Decision Making in Post-Mao China*.

Lin, G. (2010). 林耿民专栏——混合动力？不仅是策略 更是一种责任. Retrieved April 16, 2010, from http://www.dayoo.com/roll/201004/14/10000307_101655792.htm

Lin, J. (2013). China’s international trade and air pollution in the United States. The National Academy of Sciences of the United States of America

Lin, L. (2013). Male fertility decline in China linked to air pollution. China Dialogue. Retrieved December 21, 2015, from https://chinadialogue.net/en/pollution/6523-male-fertility-decline-in-china-linked-to-air-pollution/

Lin, W. (2017, July 24). Cracks in the firewall: China’s VPN game of cat-and-mouse. *Asia Times*.

Lin, Z., & Guan, Y. (2013). Environmental NGOs and Participative Governance : The Case of the PM2.5 Incident. In B. Ren & H. Shou (Ed.), *Chinese Environmental Governance: Dynamics, Challenges, and Prospects in a Changing Society*.

Linster, M., & Yang, C. (2018). *China's progress towards green growth: An international perspective*. OECD.

List, P. C. (1993). *Radical Environmentalism: Philosophy and Tactics*. Wadsworth Publishing Company.

Liu, B., & Link, E. P. (2006). *Two Kinds of Truth*. Indiana University Press.

Liu, H. (2018). 208 家未完成"水十条"要求 工业园区环境管理如何破局. *Nan Fang Weekend*.

Liu, J. (2011). Picturing a green virtual public space for social change: A study of Internet activism and Web-based environmental collective actions in China. *Chinese Journal of Communication*, *4*(02), 137-166.

Liu, J. (2013a). China's MEP an "utter disappointment". *China Dialogue*, *34*.

Liu, J. (2013b). Defending Tiger Leaping Gorge. In S. Geall (Ed.), *China and the environment: the green revolution*, 202-235.

Liu, J., & Diamond, J. (2008). Revolutionizing China's environmental protection. *Science*, *319*(5859), 37.

Liu, J., Yuan, J., & Luo, Y. (2018, February 1). 大限已过, 成绩堪忧 黑臭水体治理: 是太难, 还是太快？. *Nanfang Weekend*.

Liu, W., Huang, H., & Deng, H. (2010, April 24). 63 家企业领红黄牌. *Yangcheng Evening News*.

Liu, X. (2013, February 5). 工业应对气候变化 努力形成低碳排放新体系. *中国环境报*.

Liu, X., & Anbumozhi, V. (2009). Determinant factors of corporate environmental information disclosure: an empirical study of Chinese listed companies. *Journal of cleaner production*, *17*(6), 593-600.

Liu, Y. (2003, August 20). 广东肇庆一企业偷排污水被查处. *People's Daily*.

Lo, C., & Tang, S. (2007). Institutional Reform, Economic Changes, and Local Environmental Management in China: the case of Guangdong Province. In N. Carter & A. P. J. Mol (Ed.), *Environmental governance in China*, 42-62.

Lo, C. W., & Tang, S. (2006). Institutional reform, economic changes, and local environmental management in China: the case of Guangdong province. *Environmental Politics*, *15*(02), 190-210.

Lo, C. W., & Tang, S. (2013). Institutional reform, economic changes, and local environmental management. In C. W. Lo & S. (Ed.), Tang, *Institutions, Regulatory Styles, Society and Environmental Governance in China*, 33-50.

Lo, C. W., & Tang, S. (2013). *Institutions, Regulatory Styles, Society and Environmental Governance in China.* Routledge.

Lo, C. W., & Fryxell, G. E. (2005). Governmental and societal support for environmental enforcement in China: an empirical study in Guangzhou. *Journal of Development Studies*, *41*(4), 558-588.

Lo, C. W., & Leung, S. W. (2000). Environmental agency and public opinion in Guangzhou: the limits of a popular approach to environmental governance. *The China Quarterly*, *163*, 677-704.

Lockie, S., Sonnenfeld, D. A., & Fisher, D. R. (2013). *Routledge International Handbook of Social and Environmental Change*. Taylor & Francis.

Lu, Q., Wu, Q., Zhou, Y., & Zhou, H. (2013). Analysis on the assessment of greenery transformation-upgrading of industry in Guangdong. *China Population, Resources and Environment*, *23*(07), 34-41.

Lu, Y. (1997). The Role of Nuclear Energy in the CO_2 Mitigation Strategy of the People's Republic of China. *China Environment Series*, *1*, 20-26.

Lu, Y., & Abeysekera, I. (2014a). *Social and Environmental Disclosure by Chinese Firms*. Taylor & Francis.

Lu, Y., & Abeysekera, I. (2014b). Stakeholders' power, corporate characteristics, and social and environmental disclosure: evidence from China. *Journal of cleaner production*, *64*, 426-436.

Lu, Y. L., & He, G. Z. (2009). *Contemporary Environmental Management*. China Renmin University Press.

Lu, Z., & Feng, S. S. (2017, February 22). 节水型社会建设"十三五"规划印发："十三五"全国用水总量不超 6700 亿立方米. *Nanfang Daily*.

Luken, R. A., & Van Rompaey, F. (2007). *Environment and Industry in Developing Countries: Assessing the Adoption of Environmentally Sound Technology*. Edward Elgar Publishing.

Lynas, M. (2009, December 22). How do I know China wrecked the Copenhagen deal? I was in the room. *The Guardian*.

Lü, Y. L., Geng, J., & He, G. Z. (2015). Industrial transformation and green production to reduce environmental emissions: Taking cement industry as a case. *Advances in climate change research*, *6*(3-4), 202-209.

Ma, C., & Xu, N. (2006, October 26). 跨国公司在华污染调查. *Nanfang Weekend*.

Ma, J., J., W., Collins, M., Wu, M., Orlins, S., & Li, J. (2012). *Sustainable Apparel's Critical Blind Spot*. IPE.

Ma, J. (2004). *China's Water Crisis*. Eastbridge Books.

Ma, T. (2015, January 19). Put China's tough new law to protect the environment to the test. *South China Morning Post.*

Ma, X., & Ortolano, L. (2000). *Environmental Regulation in China: Institutions, Enforcement, and Compliance*. Rowman & Littlefield Publishers.

Mackay, G. (2016, December 23). *China's name and shame pollution tactics can't clear the air*, Reuters. Retrieved November 14, 2017, from https://www.reuters.com/video/watch/chinas-name-and-shame-pollution-tactics-id125048775

Majumdar, S. K., & Marcus, A. A. (2001). Rules versus discretion: The productivity consequences of flexible regulation. *Academy of Management Journal*, *44*(1), 170-179.

Marquis, C., Zhang, J., & Zhou, Y. (2011). Regulatory uncertainty and corporate responses to environmental protection in China. *California Management Review*, *54*(1), 39-63.

Martina, M., & Niu, S. (2015, April 14). Hundreds protest against pollution from south China coal plant. *Reuters*.

Mathiesen, K. (2015, 28 April). Air pollution causes low birth weight, Beijing study shows. *The Guardian*.

Matus, K., Nam, K., Selin, N. E., Lamsal, L. N., Reilly, J. M., & Paltsev, S. (2012). Health damages from air pollution in China. *Global environmental change*, *22*(1), 55-66.

Maxwell, J. W. (1996). What to do when win-win won't work: Environmental strategies for costly regulation. *Business Horizons*, *39*(5), 60-64.

McConville, M. (2010, April 1). Guangzhou's BRT: Revolutionizing Perceptions of Bus Travel in China. Retrieved November 24, 2013, from http://thecityfix.com/blog/guangzhous-brt-revolutionizing-perceptions-of-bus-travel-in-china/

McElwee, C. (2010). *Environmental law in China: mitigating risk and ensuring compliance*. Oxford University Press.

McGuire, W. (2012). *Essays on voluntary standards in international trade*. The Ohio State University.

McGuire, W., & Sheldon, I. (2012). *Voluntary Standards and International Trade: A Heterogeneous Firms Approach*.

Medland, D. (2014, September 23). Green And Growth Can Go Hand In Hand Together. *Forbes*.

MEE. (n.d.). 应对气候变化司: 机构职责. Retrieved November 29, 2021, from https://www.mee.gov.cn/zjhb/bjg/qhs/

MEE. (2019). 广东打赢蓝天保卫战 珠三角打造大气污染防治样板. Retrieved November 2, 2020, from ttps://www.mee.gov.cn/ywgz/xcjy/shxc/201909/t20190909_733028.shtml

Melnyk, S. A., Sroufe, R. P., & Calantone, R. (2003). Assessing the impact of environmental management systems on corporate and environmental performance. *Journal of operations management*, *21*(3), 329-351.

MEP. (2007). 《环境信息公开办法(试行)》. MEP.

MEP. (2008a). 国家环保"十一五"规划. MEP.

MEP. (2008b). *全国城市环境管理与综合整治年度报告（2008 年度）*. MEP.

MEP. (2010). Guidelines of Environmental Information Disclosure of Listed Companies (Draft). MEP.

MEP. (2012). *State of the Environment (2011)*. MEP.

Milanez, B., & Bührs, T. (2008). Ecological modernisation beyond Western Europe: the case of Brazil. *Environmental Politics*, *17*(5), 784-803.

Miller, G., Burke, J., McComas, C., & Dick, K. (2008). Advancing pollution prevention and cleaner production–USA's contribution. *Journal of Cleaner Production*, *16*(6), 665-672.

Miller, M., & Boix Mansilla, V. (2004). Thinking Across Perspectives and Disciplines, Interdisciplinary Studies Project. Project Zero, Harvard Graduate School of Education.

Ministry of Commerce. (2015). *Technical Guide of Export*. Retrieved November 4, 2015, from http://english.mofcom.gov.cn/

Mol, A. P. J. (1995). *The Refinement of Production Modernization Theory and the Chemical Industry*. Utrecht: Jan van Arkel/International Books.

Mol, A. P. J. (1996). Ecological modernisation and institutional reflexivity: environmental reform in the late modern age. *Environmental politics*, *5*(2), 302-323.

Mol, A. P. J. (1997). Ecological modernization: industrial transformations and environmental reform. In M. R Redclift & G. Woodgate (Ed.), *The International Handbook of Environmental Sociology*.

Mol, A. P. J. (2000). The environmental movement in an era of ecological modernisation. *Geoforum*, *31*(1), 45-56.

Mol, A. P. J. (2003). *Globalization and Environmental Reform: The Ecological Modernization of the Global Economy*. MIT Press.

Mol, A. P. J. (2006). Environment and modernity in transitional China: frontiers of ecological modernization. *Development and Change*, *37*(1), 29-56.

Mol, A. P. J. (2009). Urban environmental governance innovations in China. *Current Opinion in Environmental Sustainability*, *1*(1), 96-100.

Mol, A. P. J. (2010). Environmental Reform in Modernizing China. In M. R. Redclift & G. Woodgate (Ed.), *The International Handbook of Environmental Sociology*.

Mol, A. P. J. (2011). China's ascent and Africa's environment. *Global Environmental Change*, *21*(3), 785-794.

Mol, A. P. J., & Carter, N. T. (2006). China's environmental governance in transition. *Environmental politics*, *15*(02), 149-170.

Mol, A. P. J., He, G., & Zhang, L. (2011). Information disclosure in environmental risk management: Developments in China. *Journal of Current Chinese Affairs*, *40*(3), 163-192.

Mol, A. P. J., & Jänicke, M. (2009). The origins and theoretical foundations of ecological modernisation theory. In A. P. J. Mol, D. A. Sonnenfeld, & G. Spaargaren (Ed.), *The ecological modernisation reader*, 17-27.

Mol, A. P. J., & Sonnenfeld, D. A. (2000). Ecological modernisation around the world: an introduction. In A. P. J. Mol & D. A. Sonnenfeld, (Ed.). *Ecological Modernisation Around the World: Perspectives and Critical Debates*.

Mol, A. P. J., & Sonnenfeld, D. A. (2000). *Ecological Modernisation Around the World: Perspectives and Critical Debates*. Frank Cass.

Mol, A. P. J., Sonnenfeld, D. A., & Spaargaren, G. (2009). *The Ecological Modernisation Reader*. Routledge.

Mol, A. P. J., & Spaargaren, G. (2000). Ecological modernisation theory in debate: A review. *Environmental politics*, *9*(1), 17-49.

Mol, A. P. J., & Spaargaren, G. (2002). Ecological modernization and the environmental state. In A. P. J. Mol & F. H. Buttel (Ed.), *The Environmental State Under Pressure*, 33-52.

Mol, A. P. J., Spaargaren, G., & Sonnenfeld, D. (2013). Ecological Modernization Theory: Taking Stock, Moving forward. In S. Lockie, D. Sonnenfeld, & D. R. Fisher (Ed.), *The Routledge International Handbook of Social and Environmental Change*, 15-30.

Mol, A. P. J., & van Buuren, J. C. L. (2003). Introduction: Transitional Economics and the Greeting of Industrialization Paths. In A. P. J. Mol & J. C. L. van Buuren (Ed.), *Greening Industrialization in Asian Transitional Economies: China and Vietnam,* 1-19.

Moser, A. (2013). The Yangzonghai Case: struggling for environmental justice. In S. Geall (Ed.), *China and the Environment: The Green Revolution*.

Mou, X. (2010, April 27). 303 家"退二进三"污染企业六年内分批迁出市区 10 家化学品企业亚运期间停产. *Xin Kuai Bao 新快报*.

Murphy, J. (2000). Ecological Modernisation: a Special Issue of Geoforum. *Geoforum*, 31(3), 1-66.

Murphy, J., & Gouldson, A. (2000). Environmental policy and industrial innovation: integrating environment and economy through ecological modernisation. *Geoforum*, *31*(1), 33-44.

Murray, A., & Meyer, D. (2020, August 10). The Fortune Global 500 is now more Chinese than American. *Fortune*.

Nakamura, M., Takahashi, T., & Vertinsky, I. (2001). Why Japanese firms choose to certify: a study of managerial responses to environmental issues. *Journal of Environmental Economics and Management*, *42*(1), 23-52.

Nanfang Daily. (2016, December 22). 环保部: 近 1/5 国土被灰霾覆盖, 最严重时 108 城重污染. *Nanfang Daily*.

Nanfang Daily. (2017a, August 3). 2017 年广东企业 500 强发布：广东大企业转型升级持续发展. *Nanfang Daily*.

Nanfang Daily. (2017b, September 27). 中国光伏新增装机量领跑全球. *Nanfang Daily*.

Nanfang Daily. (2017c, October 12). 中国创新成全球 进步的新动力源. *Nanfang Daily*.

National Geographic. (2011, January 24). Guangzhou, China, Wins Sustainable Transport Prize. *National Geographic*.

NBS. (2011). Communiqué of the National Bureau of Statistics of People's Republic of China on Major Figures of the 2010 Population Census. NBS.

NDRC. (2006). 千家企业节能行动方案. NDRC.

NDRC. (2010). 国家发展改革委关于开展低碳省区和低碳城市试点工作的通知. NDRC.

NDRC. (2011). *Report on the Implementation of the 2010 Plan for National Economic and Social Development and on the 2011 Draft Plan for National Economic and Social Development*. NDRC.

NDRC. (2015). *Enhanced actions on climate change*. NDRC.

NDRC. (2019). 发展改革委修订发布《产业结构调整指导目录（*2019* 年）》. NDRC.

NDRC & SEPA. (2004). 《清洁生产审核暂行办法》2004, 第 16 号令. NDRC and SEPA.

Neumayer, E., & Perkins, R. (2004). What explains the uneven take-up of ISO 14001 at the global level? A panel-data analysis. *Environment and planning A*, *36*(5), 823-839.

Newell, P. (2001). Managing multinationals: the governance of investment for the environment. *Journal of International Development*, *13*(7), 907-919.

Nicholls, R. J., Hanson, S., Herweijer, C., Patmore, N., Hallegatte, S., Corfee-Morlot, J., Muir-Wood, R. (2008). *Ranking port cities with high exposure and vulnerability to climate extremes: exposure estimates*. OECD.

Nickum, J. E. (2000). Is China Living on the Water Margin? In R. L. Edmonds (Ed.), *Managing the Chinese Environment*,156-174.

Nikitina, S. (2002). *Three Strategies for Interdisciplinary Teaching: Contextualising, Conceptualising, and Problem-Solving.* The University of Melbourne.

Nishitani, K. (2009). An empirical study of the initial adoption of ISO 14001 in Japanese manufacturing firms. *Ecological Economics*, *68*(3), 669-679.

Nishitani, K. (2010). Demand for ISO 14001 adoption in the global supply chain: An empirical analysis focusing on environmentally conscious markets. *Resource and Energy Economics*, *32*(3), 395-407.

Norgate, T. E., Jahanshahi, S., & Rankin, W. J. (2007). Assessing the environmental impact of metal production processes. *Journal of Cleaner Production*, *15*(8-9), 838-848.

Noronha, C., Tou, S., Cynthia, M. I., & Guan, J. J. (2013). Corporate social responsibility reporting in China: An overview and comparison with major trends. *Corporate Social Responsibility and Environmental Management*, *20*(1), 29-42.

NPC. (1989). EPL 中华人民共和国环境保护法. NPC.

OECD. (1995a). *Planning for Sustainable Development*. OECD.

OECD. (1995b). *Policies to promote technologies for cleaner production and products: guide for government self-assessment.* OECD.

OECD. (1996). *Environmental Performance in OECD Countries*. OECD.

OECD. (2007). *Environmental Performance Review*. OECD.

OECD. (2010). *OECD Territorial Reviews: Guangdong, China*. OECD.

OECD. (2016a). *G20 Innovation Report*. OECD.

OECD. (2016b). *OECD Yearbook*. OECD.

OECD. (2017a). *Economic Survey of China*. OECD.

OECD. (2017b). *The Next Production Revolution: Implications for Governments and Business*. OECD.

OECD TiVA data. (2017). *The OECD Environmental Policy Stringency Index (EPS)*. OECD.

Oelofse, C., Scott, D., Oelofse, G., & Houghton, J. (2006). Shifts within ecological modernization in South Africa: Deliberation, innovation and institutional opportunities. *Local Environment*, *11*(1), 61-78.

Ohshita, S. B., & Ortolano, L. (2006). Effects of economic and environmental reform on the diffusion of cleaner coal technology in China. *Development and Change*, *37*(1), 75-98.

Oosterveer, P. (2007). *Global governance of food production and consumption: issues and challenges*. Edward Elgar Publishing.

Ou, Y. (2010). 省重点污染源环境保护信用管理评价结果公示 东莞受检污水处理厂过半不环保. *Nanfang Daily*.

Outchiri, B. N., & He, J. (2020). Technical gap, trade partners and product mix evolution: how trading with China affects global CO_2 emissions. Working Paper. *Cahier de recherche*.

Pagell, M., Wu, Z., & Murthy, N. N. (2007). The supply chain implications of recycling. *Business Horizons*, *50*(2), 133-143.

Palmer, K., Oates, W. E., & Portney, P. R. (1995). Tightening environmental standards: the benefit-cost or the no-cost paradigm? *Journal of economic perspectives*, *9*(4), 119-132.

Parto, S. (1999). Aiming Low. In R. B. Gibson (Ed.), *Voluntary Initiatives and the New Politics of Corporate Greening*, 182-198.

Parto, S. (2007). Introduction. In S. Parto & B. Herbert-Copley (Ed.), *Industrial Innovation and Environmental Regulation: Developing Workable Solutions,* 1-22.

Parto, S., & Herbert-Copley, B. (2007). *Industrial Innovation and Environmental Regulation: Developing Workable Solutions*. IDRC & UNU-MERIT.

People's Daily. (2017, June 6). 2016 中国环境公报：254 个城市环境空气质量超标.

Perry, E. J., & Selden, M. (2010). *Chinese Society: Change, Conflict and Resistance*. Routledge.

Petricic, S. (2016). Massive layoffs coming as China confronts its overbuilt 'zombie economy'. Retrieved May 26, 2016, from https://www.cbc.ca/news/world/china-zombie-economy-layoffs-petricic-1.3473002

Pew Research Center. (2015). *Pew Research Global Attitudes Project: Environmental Concerns on the Rise in China*. Retrieved May 16, 2017, http://www.pewglobal.org/category/publications/survey-reports/

Platts. (2015). China fast tracks nationwide rollout of Phase 5 motor gasoil, gasoline to 2017. Retrieved December 16, 2016, from https://www.spglobal.com/platts/en/market-insights/latest-news/oil/042915-china-fast-tracks-nationwide-rollout-of-phase-5-motor-gasoil-gasoline-to-2017

Polimeni, J. M., Mayumi, K., Alcott, B., & Giampietro, M. (2008). *The Jevons Paradox and the Myth of Resource Efficiency Improvements*. Earthscan.

Popp, D. (2006). International innovation and diffusion of air pollution control technologies: the effects of NOX and SO2 regulation in the US, Japan, and Germany. *Journal of Environmental Economics and Management*, *51*(1), 46-71.

Porter, M. E. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance*. Free Press.

Porter, M. E. (1990). New global strategies for competitive advantage. *Planning Review*, *18* (3), 4-14.

Porter, M. E. (1996). Competitive advantage, agglomeration economies, and regional policy. *International regional science review*, *19*(1-2), 85-90.

Porter, M. E., & Van der Linde, C. (1995a). Green and competitive: ending the stalemate. *Harvard Business Review*, September-October.

Porter, M. E., & Van der Linde, C. (1995b). Toward a new conception of the environment-competitiveness relationship. *Journal of economic perspectives*, *9*(4), 97-118.

Potoski, M., & Prakash, A. (2005a). Covenants with weak swords: ISO 14001 and facilities' environmental performance. *Journal of Policy Analysis and Management: The Journal of the Association for Public Policy Analysis and Management*, *24*(4), 745-769.

Potoski, M., & Prakash, A. (2005b). Green clubs and voluntary governance: ISO 14001 and firms' regulatory compliance. *American journal of political science*, *49*(2), 235-248.

Prakash, A., & Potoski, M. (2007). Investing up: FDI and the cross-country diffusion of ISO 14001 management systems. *International Studies Quarterly*, *51*(3), 723-744.

Prakash, A., & Prakash, P. A. (2000). *Greening the Firm: The Politics of Corporate Environmentalism*. Cambridge University Press.

PRI & UNEP. (2011). *Case Study: China connects pollution costs to companies and investors*. PRI and UNEP.

Province of Guangdong. (2014). 2014 年度广东省协同创新与平台环境建设 专项资金*(*第二批*)*分配方案公示表. Province of Guangdong.

Qi, Y. (2013). *Chinese Research Perspectives on the Environment, Special Volume: Annual Review of Low-Carbon Development in China (2011-12)*. Brill.

Qian, Y., & Aruhan. (2015). 可口可乐被曝在华伪造环保数据 相关主管遭刑拘. Retrieved November 12, 2015, from http://env.people.com.cn/n/2015/1022/c1010-27727118.html

Qian, Z. M., & Liu, X. C. (2013). Regional differences in China's green economic efficiency and their determinants. *China Population, resources and environment*, *23*(7), 104-109.

Qie, J. (2016, May 21). 环保组织就常州毒地起诉三家化工企业获受理. *法制日报*.

Qie, J. (2017, May 8). 环保部：对土壤污染过度恐慌. *法制日报*.

Qiu, X., & Li, H. (2009). China's environmental super ministry reform: background, challenges, and the future. *Environmental Law Reporter News & Analysis*, *39*, 10152.

Ran, R. (2013). Perverse incentive structure and policy implementation gap in China's local environmental politics. *Journal of Environmental Policy & Planning*, *15*(1), 17-39.

Rapp, V. T., Schwägerl, C., & Traufetter, G. (2010). How China and India Sabotaged the UN Climate Summit. *Spiegel*.

Raufer, R., & Wang, S. (2003). Navigating the Policy Path for Support of Wind Power in China. *China Environment Series*, *6*, 37-54.

RE100. (2015). China's Fast Track to a Renewable Future. RE100 China Analysis.

Redclift, M. R. (2000). Environmental social theory for a globalizing world economy. In G. Spaargaren, A. P. J. Mol, & F. H. Buttel (Ed.), *Environment and global modernity*, 151-162.

Redclift, M. R., & Benton, T. (1994). *Social theory and the global environment*. Routledge.

Redclift, M. R., & Woodgate, G. (1997). *The International Handbook of Environmental Sociology*. Edward Elgar Publishing.

Redclift, M. R., & Woodgate, G. (2010). *The International Handbook of Environmental Sociology*. Edward Elgar Publishing.

Reinhardt, F. L. (1998). Environmental product differentiation: Implications for corporate strategy. *California management review*, *40*(4), 43-73.

Reinhardt, F. L. (2000). *Down to earth: Applying business principles to environmental management*. Harvard Business Press.

Ren, B., & Shou, H. (2013). *Chinese Environmental Governance: Dynamics, Challenges, and Prospects in a Changing Society*. Palgrave Macmillan US.

Ren, B., Shou, H., & Dong, L. (2016). Internet and Mobilization in China's Urban Environmental Protest. In L. Dong, H. Kriesi & D. Kübler (Ed.), *Urban Mobilizations and New Media in Contemporary China*, 51-66.

Ren, S., Yuan, B., Ma, X., & Chen, X. (2014). International trade, FDI (foreign direct investment) and embodied CO_2 emissions: A case study of Chinas industrial sectors. *China Economic Review*, *28*, 123-134.

Ren, X., (2014, July 27). 行贿环保部门的"黑色账本." *Southern Metropolis Daily*.

Rennings, K. (2000). Redefining innovation—eco-innovation research and the contribution from ecological economics. *Ecological economics*, *32*(2), 319-332.

Rennings, K., Ziegler, A., Ankele, K., & Hoffmann, E. (2006). The influence of different characteristics of the EU environmental management and auditing scheme on technical environmental innovations and economic performance. *Ecological Economics*, *57*(1), 45-59.

Repko, A., Navakas, F., & Fiscella, J. (2007). Integrating interdisciplinarity: How the theories of common ground and cognitive interdisciplinarity are informing the debate on interdisciplinary integration. *Issues in Interdisciplinary Studies*, *25*, 1-31.

Rettino-Parazelli, K. (2016, December 16). L'utilisation des technologies vertes est infime au Canada. *Le Devoir*.

Reuters. (2014). China to 'declare war' on pollution, premier says. Retrieved April 12, 2014, from https://www.reuters.com/article/us-china-parliament-pollution-idUSBREA2405W20140305

Reuters. (2020). China's new green development fund raises $12 billion in phase 1. Retrieved July 30, 2020, from https://www.reuters.com/article/us-china-environment-idUSKCN24T0E0

Ringer, F. K. (1997). *Max Weber's Methodology: The Unification of the Cultural and Social Sciences*. Harvard University Press.

Rinkevicius, L. (2000). The ideology of ecological modernization in 'double-risk' societies: a case study of Lithuanian environmental policy. In G. Spaargaren, A. P. J. Mol, & F. H. Buttel (Ed.), *Environment and global modernity,* 163-186.

Rock, M. (2010). *Pollution control in East Asia: Lessons from newly industrializing economies*. Routledge.

Rock, M. T. (2002a). Integrating environmental and economic policy making in China and Taiwan. *American Behavioral Scientist*, *45*(9), 1435-1455.

Rock, M. T. (2002b). Pathways to industrial environmental improvement in the East Asian newly industrializing economies. *Business Strategy and the Environment*, *11*(2), 90-102.

Rock, M. T. (2009). Integrating Environmental and Economic Policy Making in China and Taiwan. In A. P. J. Mol, D. A. Sonnenfeld, & G. Spaargaren (Ed.), *The Ecological Modernisation Reader: Environmental Reform in Theory and Practice*.

Rock, M. T., & Aden, J. (1999). Initiating environmental behavior in manufacturing plants in Indonesia. *The Journal of Environment & Development*, *8*(4), 357-375.

Rock, M. T., & Toman, M. (2015). *China's technological catch-up strategy: industrial development, energy efficiency, and CO_2 emissions*. Oxford University Press.

Rock, M. T., Yu, F., & Zhang, C. (1999). *The impact of China's urban environment examination system on urban environmental management and ambient environmental quality*. Winrock International.

Rohde, R., & Muller, R. (2015). Air Pollution in China: Mapping of Concentrations and Sources. Retrieved May 5, 2016, from http://berkeleyearth.org/wp-content/uploads/2015/08/China-Air-Quality-Paper-July-2015.pdf

Rondinelli, D., & Vastag, G. (2000). Panacea, common sense, or just a label? : The value of ISO 14001 environmental management systems. *European Management Journal*, *18*(5), 499-510.

Roome, N. (1998). *Sustainability Strategies for Industry: The Future Of Corporate Practice*. Island Press.

Rosenthal, E. (2000, May 16). Pollution Victims Start to Fight Back in China. *New York Times*.

Ross, L. (2000). China: Environmental Protection, Domestic Policy Trends, Patterns of Participation in Regimes and Compliance with International Norms. In R. L. Edmonds (Ed.), *Managing the Chinese Environment*, 85-111.

Rugman, A. M., & Verbeke, A. (1998). Corporate strategies and environmental regulations: An organizing framework. *Strategic management journal*, *19*(4), 363-375.

Russell, C. (2016). 中国取消钢铁出口补贴 实际影响有限但象征意义重大. Retrieved May 15, 2018, from https://www.reuters.com/article/column-russell-china-steel-idCNKCS0XC0U7

Russo, M. V. (2009). Explaining the impact of ISO 14001 on emission performance: a dynamic capabilities perspective on process and learning. *Business Strategy and the Environment*, *18*(5), 307-319.

Ruwitch, J. (2015, June 27). Thousands protest in Shanghai suburb over chemical plant fears. *Reuters*.

Sachs, W. (1993). *Global Ecology: A New Arena of Political Conflict*. Bloomsbury Academic.

Scanu, E. (2015). L'action publique urbaine et les enjeux des changements climatiques: l'exemple de Québec et Gênes. [Doctoral dissertation, Université Laval]. Corpus.ulaval.ca

Schaltegger, S., & Synnestvedt, T. (2002). The link between 'green' and economic success: environmental management as the crucial trigger between environmental and economic performance. *Journal of environmental management*, 65(4), 339-346.

Schaltegger, S., & Wagner, M. (2006). *Managing the Business Case for Sustainability: The Integration of Social, Environmental and Economic Performance*. Greenleaf.

Schiederig, T., Tietze, F., & Herstatt, C. (2012). Green innovation in technology and innovation management–an exploratory literature review. *R&d Management*, *42*(2), 180-192.

Schot, J., & Geels, F. W. (2007). Niches in evolutionary theories of technical change. *Journal of Evolutionary Economics*, *17*(5), 605-622.

Schot, J. (1992). Constructive technology assessment and technology dynamics: the case of clean technologies. *Science, Technology, & Human Values*, *17*(1), 36-56.

Schroeck, N. J. (2016). A Changing Environment in China: The Ripe Opportunity for Environmental Law Clinics to Increase Public Participation and to Shape Law and Policy. *Vermont Journal of Environmental Law*, *18*, 1.

SCMP. (2015, April 7). One dead and 50 arrested after pollution protest in China's Inner Mongolia. *South China Morning Post*.

Seippel, Ø. (2000). Ecological modernization as a theoretical device: strengths and weaknesses. *Journal of Environmental Policy and Planning*, *2*(4), 287-302.

Seuring, S. (2004). Integrated chain management and supply chain management comparative analysis and illustrative cases. *Journal of Cleaner Production*, *12*(8-10), 1059-1071.

Seymour, J. (2005). China's Environment: A Bibliographic Essay. In K. Day (Ed.), *China's Environment and the Challenge of sustainable development*. M.E. Sharpe.

Shaffer, L. (2014). *Urbanization key to China rebalancing*. The World Bank.

Shapiro, J. (2012). *China's Environmental Challenges*. Wiley.

Shenzhen Metro. (n.d.). 集团概况. Retrieved October 10, 2018, from http://www.szmc.net/page/mob/aboutus.html

Shepard, W. (2016, March 14). The Impact Of China's New Urbanization Plan Could Be Huge. *Forbes*.

Shi, H. (2003). Cleaner Production in China. In A. P. J. Mol & J. van Buuren (Ed.), *Greening Industrialization in Transitional Asian Countries: China and Vietnam*, 63-82.

Shi, H., Peng, S., Liu, Y., & Zhong, P. (2008). Barriers to the implementation of cleaner production in Chinese SMEs: government, industry and expert stakeholders' perspectives. *Journal of cleaner production*, *16*(7), 842-852.

Shi, H., & Zhang, L. (2006). China's environmental governance of rapid industrialisation. *Environmental politics*, *15*(02), 271-292.

Shi, H., & Zhang, L. (2007). China’s Environmental Governance of Rapid Industrialisation. In N. Carter & A. Mol (Ed.), *Environmental governance in China*, 123-144.

Sima, Y. (2011). Grassroots environmental activism and the Internet: Constructing a green public sphere in China. *Asian Studies Review*, *35*(4), 477-497.

Simonis, U. E. (1989a). Ecological modernization of industrial society—Three strategic elements. In F. Archibugi, & P. Nijkamp (Ed.), *Economy and ecology: Towards sustainable development*, 119-137.

Simonis, U. E. (1989b). Industrial restructuring for sustainable development: three points of departure (No. FS II 89-401). WZB Discussion Paper.

Skjærseth, J. B., & Eikeland, P. O. (2013). *Corporate Responses to EU Emissions Trading: Resistance, Innovation Or Responsibility?* Ashgate.

Smil, P. G. V., & Smil, V. (1993). *China's Environmental Crisis: An Inquiry Into the Limits of National Development*. M.E. Sharpe.

Smil, V. (2000). China's Energy and Resource Uses: Continuity and Change. In R. L. Edmonds (Ed.), *Managing the Chinese Environment*, 211-227.

Smil, V. (2004). Improving efficiency and reducing waste in our food system. *Environmental sciences*, *1*(1), 17-26.

Song, R., Yang, S., Fang, W., Tian, Z., Zhang, Z. & Tan, F. (2012).建立企业能源与温室气体统计和管理体系—广东省策略研究 *Building Energy and GHG Reporting Scheme for Enterprises: a Guangdong Strategy Study*. Retrieved November 2, 2018, from http://pdf.wri.org/building_energy_and_ghg_reporting_scheme_guangdong_study.pdf

Sonnenfeld, D. A. (1996). *Greening the tiger: Social movements' influence on adoption of environmental technologies in the pulp and paper industries of Australia, Indonesia, and Thailand*. University of California.

Sonnenfeld, D. A. (2000). Contradictions of Ecological Modernisation: Pulp and Paper Manufacturing in South-east Asia. In A. P. J. Mol & D. A. Sonnenfeld (Ed.), *Ecological Modernisation around the World: perspectives &critical debates*, 235-292.

Sonnenfeld, D. A. (2002). Social movements and ecological modernization: The transformation of pulp and paper manufacturing. *Development and Change*, *33*(1), 1-27.

Sonnenfeld, D. A., & Rock, M. T. (2009). Ecological modernization in Asian and other emerging economies. In A. P. J. Mol, D. A. Sonnenfeld, & G. Spaargaren (Ed.), *The Ecological Modernisation Reader*.

Spaargaren, G. (1997). The Ecological Modernization of Production and Consumption Essays in Environmental Sociology. Wageningen University and Research.

Spaargaren, G. (2000). Ecological modernization theory and the changing discourse on environment and modernity. In G. Spaargaren, A. P. J. Mol, & F. H. Buttel (Ed.), *Environment and global modernity*, 41-71.

Spaargaren, G., & Cohen, M. J. (2009). Greening Lifecycles and Lifecycles : Sociotechnical Innovations in Consumption and Production as Core Concerns of Ecological Modernisation Theory. In A. P. J. Mol, D. A. Sonnenfeld, & G. Spaargaren (Ed.), *The Ecological Modernisation Reader*.

Spaargaren, G., & Mol, A. P. J. (1992). Sociology, environment, and modernity: Ecological modernization as a theory of social change. *Society & natural resources*, *5*(4), 323-344.

Spaargaren, G., Mol, A. P. J., & Buttel, F. H. (2000). *Environment and global modernity*. Sage Publications.

Spaargaren, G., & Van Vliet, B. (2000). Lifestyles, consumption and the environment: The ecological modernization of domestic consumption. *Environmental politics*, *9*(1), 50-76.

Stalley, P. (2010). *Foreign Firms, Investment, and Environmental Regulation in the People's Republic of China*. Stanford University Press.

Starik, M., & Marcus, A. A. (2000). Introduction to the special research forum on the management of organizations in the natural environment: A field emerging from multiple paths, with many challenges ahead. *Academy of Management Journal*, *43*(4), 539-547.

State Council. (2010). Acceleration of Strategic Emerging Industries' Development 国务院关于加快培育和发展战略性新兴产业的决定. State Council.

State Council. (2011a). Guidelines to the State-owned Enterprises Directly under the Central Government. State Council.

State Council. (2011b). 国务院关于印发工业转型升级规划(2011—2015 年)的通知. State Council.

State Council. (2016). 关于构建绿色金融体系的指导意见 Guiding Opinions on Establishing the Green Financial System. State Council.

State Council. (2020). 高新技术企业认定事项说明. State Council.

Stern, N., & Calderon, F. (2014). Better growth, better climate: The new climate economy report. *The Synthesis Report*. The Global Commission on the Economy and Climate.

Stern, R. (2014). The political logic of China's new environmental courts. *The China Journal*, *72*, 53-74.

Strasser, K. A. (2011). *Myths and Realities of Business Environmentalism: Good Works, Good Business Or Greenwash?* Edward Elgar Publishing Limited.

Studer, S., Welford, R., & Hills, P. (2006). Engaging Hong Kong businesses in environmental change: drivers and barriers. *Business Strategy and the Environment*, *15*(6), 416-431.

Su, L. Y., Zheng, H. X., & Wang, Y. (2013). Evaluation on green development of China's provincial industry. *China Population, Resource and Environ*ment, *23*, 116-122.

Sun, J. (2018, May 16). 大涌试水家具喷漆"共性工厂" 以集约化手段解决中小型家具企业喷漆尾气、废水处理问题. *Nanfang Daily*.

Sun, X. (2015, June 15). 环保部通报:多家企业环境监测数据造假. *People's Daily*.

Sun, X., & Kou, J. (2017, August 2). 第三批中央环保督察反馈结束七省市存在多个共性问题. *People's Daily*.

Søndergård, B., Hansen, O. E., & Holm, J. (2004). Ecological modernisation and institutional transformations in the Danish textile industry. *Journal of Cleaner Production*, *12*(4), 337-352.

Tang, H. (2012). Shifang: a crisis of local rule. Retrieved February 2, 2014, from https://chinadialogue.net/en/pollution/5049-shifang-a-crisis-of-local-rule/

Tang, J., & Li, P. (2013). Corporate Social Responsibility and Firms Environmental Performance of Chinese Listed Companies. *International Journal of Computer Science*, *1*(10).

Tang, S., & Lo, C. W. (2009). The political economy of service organization reform in China: An institutional choice analysis. *Journal of Public Administration Research and Theory*, *19*(4), 731-767.

Tang, S.., Tang, C., & Lo, C. W. (2005). Public participation and environmental impact assessment in mainland China and Taiwan: Political foundations of environmental management. *The Journal of Development Studies*, *41*(1), 1-32.

Tao, J., & Mah, D. (2009). Between market and state: dilemmas of environmental governance in China's sulphur dioxide emission trading system. *Environment and Planning C: Government and Policy*, *27*(1), 175-188.

Technology Daily. (2019, July 9). 常穿牛仔裤，但你知道什么样的不能买吗. *Technology Daily 科技日报*.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic management journal*, *18*(7), 509-533.

The Economist. (2011, November 26). The Guangdong model: One Chinese province adopts a beguilingly open approach—up to a point. *The Economist*.

The Economist. (2013, Aug 10). The East is grey. *The Economist*.

The Economist. (2016, December 10). China has gained hugely from globalization So why are its workers unhappy? *The Economist*.

The Economist. (2017, April 8). Jewel in the crown What China can learn from the Pearl river delta. *The Economist*.

Theys, J. (2003). La Gouvernance, entre innovation et impuissance. Le cas de l'environnement. *Développement durable et territoires. Économie, géographie, politique, droit, sociologie* (Dossier 2).

Thinkers50.com. (2018). *Thinkers50 Hall of fame: Michael Porter*. Retrieved February 12, 2019, from https://thinkers50.com/biographies/michael-porter/

Thompson, T. (2013, April 8). Choking on China: The Superpower That is Poisoning the World. *Foreign Affairs*.

Toke, D., & Strachan, P. A. (2006). Ecological modernization and wind power in the UK. *European Environment*, *16*(3), 155-166.

Tong, J. (2015). Chinese journalists' views of user-generated content producers and journalism: a case study of the boundary work of journalism. *Asian Journal of Communication*, *25*(6), 600-616.

Topal, C., & Chung, Y. (2014). China's Off-the-Chart Air Pollution: Why It Matters (and Not Only to the Chinese): An Interview with Daniel K. Gardner. National Bureau of Asian Research.

Tran, M. (2015, March 2). Phenomenal success for new film that criticizes China's environmental policy. *The Guardian*.

Triguero, A., Moreno-Mondéjar, L., & Davia, M. A. (2013). Drivers of different types of eco-innovation in European SMEs. *Ecological economics*, *92*, 25-33.

Tsui, K., & Wang, Y. (2004). Between separate stoves and a single menu: fiscal decentralization in China. *The China Quarterly*, *177*, 71-90.

Tukker, A., Emmert, S., Charter, M., Vezzoli, C., Sto, E., Andersen, M. M., Lahlou, S. (2008). Fostering change to sustainable consumption and production: an evidence-based view. *Journal of cleaner production*, *16*(11), 1218-1225.

Turiel, J., Ding, I., & Liu, J. C. E. (2017). *Environmental Governance in China: State, Society, and Market*. Brill.

UNDP. (2002). *China Human Development Report 2002*. UNDP.

UNEP. (1994). *Cleaner Production Worldwide*. UNEP.

UNIDO. (2008). *Industrial statistics databases*. UNIDO.

UNIDO. (2015). *Demonstration Sub-Project for Conversion From HCFC-22 to Propane at Midea Room Air-Conditioner Manufacturing Company and Demonstration Sub-Project for Conversion Of Room Air-Conditioner Compressor Manufacturing From HCFC-22 to Propane at Guangdong Meizhi Company*. UNIDO.

Urban, F., Nordensvärd, J., & Zhou, Y. (2012). Key actors and their motives for wind energy innovation in China. *Innovation and Development*, *2*(1), 111-130.

Van Berkel, R. (2007). Cleaner production and eco-efficiency initiatives in Western Australia 1996–2004. *Journal of Cleaner Production*, *15*(8-9), 741-755.

Van De Poel, I. (2000). On the role of outsiders in technical development. *Technology Analysis & Strategic Management*, *12*(3), 383-397.

Van Koppen, C. S. A., & Mol, A. P. J. (2009). Ecological Modernization of Industrial Systems. In A. P. J. Mol, D. A. Sonnenfeld, & G. Spaargaren (Ed.), *The Ecological Modernisation Reader,* 295-317.

Van Rooij, B. (2006). Implementation of Chinese environmental law: regular enforcement and political campaigns. *Development and Change*, *37*(1), 57-74.

Van Rooij, B., & Lo, C. W. (2010). Fragile convergence: Understanding variation in the enforcement of China's industrial pollution law. *Law & Policy*, *32*(1), 14-37.

Van Rooij, B., Stern, R. E., & Fürst, K. (2016). The authoritarian logic of regulatory pluralism: Understanding China's new environmental actors. *Regulation & Governance*, *10*(1), 3-13.

Van Rooij, B., Zhu, Q., Li, N., Wang, Q., & Zhang, X. (2017). Pollution enforcement in China : understanding national and regional variation. In E. Sternfeld (Ed.), *Routledge Handbook of Environmental Policy in China*, 193-207.

Vermeer, E. B. (1998). Industrial pollution in China and remedial policies. *The China Quarterly*, *156*, 952-985.

Vermeer, E. B. (2000). Industrial Pollution in China and Remedial Policies. In R. L. Edmonds (Ed.), *Managing the Chinese Environment*, 228-261.

Vietnamnet. (2019). Cleaner production helps reduce production costs: experts. Retrieved July 20, 2019, from https://vietnamnet.vn/en/sci-tech-environment/cleaner-production-helps-reduce-production-costs-experts-541685.html

Vines, S. (2014). How will China deal with growing anger over pollution? Retrieved November 21, 2014, from https://www.aljazeera.com/opinions/2014/8/1/how-will-china-deal-with-growing-anger-over-pollution

Wagner, M. (2008). Empirical influence of environmental management on innovation: Evidence from Europe. *Ecological Economics*, *66*(2-3), 392-402.

Walley, N., & Whitehead, B. (1994). It's not easy being green. *Reader in Business and the Environment*, *36*(81), 4.

Wan, Y. (2017). 环保部：机动车污染已成为中国空气污染的重要来源. Retrieved June 23, 2017, from http://www.chinanews.com/gn/2017/06-03/8241034.shtml

Wang, A., Liao, W., & Hein, A. P. (2012). Bigger, better, broader: A perspective on Chinas auto market in 2020. *Automotive & Assembly Practice.* Retrieved December 2, 2014, from http://c si. mckinsey. com/knowledge_by_regi on/asia/china/chinas_a uto_market_in_2020

Wang, B., & Zhou, Q. (2020). Climate change in the Chinese mind: An overview of public perceptions at macro and micro levels. *Wiley Interdisciplinary Reviews: Climate Change*, *11*(3), 639.

Wang, C. (2010). The Rapid Development of Environmental Protection Law. In D. Cai & C. Wang (Ed.), *China's Journey toward the Rule of Law: Legal Reform, 1978-2008*.

Wang, F. (2016). 深圳一年新增中小企业 37.3 万家 同比增长 33.1%. Retrieved December 11, 2017, from http://www.gov.cn/shuju/2017-06/29/content_5206763.htm

Wang, F., Yang, S., Reisner, A., & Liu, N. (2019). Does green credit policy work in China? The correlation between green credit and corporate environmental information disclosure quality. *Sustainability*, *11*(3), 733.

Wang, H. (2016). 全国 30 个海绵城市试点 19 城出现内涝 试点失败了？. *《中国经济周刊》, 35*.

Wang, H., & Wheeler, D. (2000). *Endogenous enforcement and effectiveness of China's pollution levy system*. Policy Research Working Paper. The World Bank.

Wang, J. (1999). China's national cleaner production strategy. *Environmental Impact Assessment Review*, *19*(5-6), 437-456.

Wang, J., & Ge, C. (2006). *Environmental Tax Policy and its Implementation Strategies*. China Environmental Science Press, Beijing.

Wang, J., & Yan, H. (2011, June 20-24). *Barriers and Solutions to Better Environmental Enforcement in China*. Ninth International Conference on Environmental Compliance and Enforcement.

Wang, Y. (2017). 19th National Congress Reaffirms China's Commitment to Climate Action, Sustainable Development. Retrieved December 2, 2017, from http://sdg.iisd.org/news/19th-national-congress-reaffirms-chinas-commitment-to-climate-action-sustainable-development/

Wang, Z. (2021, September 12). 环保税法实施三年多来中国企业绿色发展路渐宽. *经济参考报*.

Warwick, M., & Ortolano, L. (2007). Benefits and costs of Shanghai's environmental citizen complaints system. *China Information*, *21*(2), 237-268.

Weale, A. (1992). *The new politics of pollution*. Manchester University Press.

Weale, A. (1998). The Politics of Ecological Modernization. In J. Dryzek & D. Schlosberg (Ed.), *Debating the Earth: The Environmental Politics Reader*, 301-318.

Weber, M. (1948). *From Max Weber: Essays in Sociology*. Routledge & Kegan Paul.

Weber, O. (2014). Environmental, social and governance reporting in China. *Business Strategy and the Environment*, *23*(5), 303-317.

Welch, E. W., Mori, Y., & Aoyagi-Usui, M. (2002). Voluntary adoption of ISO 14001 in Japan: mechanisms, stages and effects. *Business Strategy and the environment*, *11*(1), 43-62.

Welford, R., & Hills, P. (2003). Ecological modernisation, environmental policy and innovation: priorities for the Asia-Pacific region. *International Journal of Environment and Sustainable Development*, *2*(3), 324-340.

WHO. (2016). *WHO global urban ambient air pollution database (update 2016)*. WHO.

Willman, J. (2008, February 19). Top executives slow to adopt climate change strategy. *Financial Times*.

Windatt, E. (1999). Reluctant followers: Small companies pose special challenges for promoters of voluntary initiatives. In R. B. Gibson (Ed.), *Voluntary Initiatives and the New Politics of Corporate Greening*, 149-158.

WIPO. (2016). Switzerland, Sweden, UK, US, Finland, Singapore Lead; China Joins Top 25. *The World Intellectual Property Organization.—PR/2016*, *793*. WIPO.

Wong, E. (2013, March 3). Spill in China Underlines Environmental Concerns. *New York Times*.

Wong, E. (2016, November 18). Trump Has Called Climate Change a Chinese Hoax. Beijing Says It Is Anything But. *The New York Times*.

Wong, F. (2013). China's Smog Threatens Health of Global Coal Projects. Retrieved December 2, 2013, from https://www.reuters.com/article/us-china-coal-idUSBRE9AD19L20131114

World Bank. (1985). *China: The Energy Sector*. The World Bank.

World Bank. (2001). *China-Air, Land and Water: Environmental Priorities for New Millenium*. The World Bank.

World Bank. (2013). *Which Coastal Cities Are at Highest Risk of Damaging Floods? New Study Crunches the Numbers*. The World Bank.

World Bank. (2015). *Poverty and Equity Indicators*. The World Bank.

World Bank. (2016). *Cleaning Up China's Polluted Pearl River*. The World Bank.

World Bank & DRC. (2012). *China 2030: Building a Modern, Harmonious, and Creative Society*. The World Bank.

Wrenn, J. M. (2019). Why blue jeans are going green. Retrieved August 12, 2019, from https://www.bbc.com/news/business-48851820

Wright, C., & Nyberg, D. (2012). Working with passion: Emotionology, corporate environmentalism and climate change. *Human Relations*, *65*(12), 1561-1587.

Wu, G., & Pan, Y. (2002, August 15). 绿色产品满天飞，认证机构遍地是. *中国建设报*.

Wu, Q. (2018, January 13). 环保税已实施，记者调查税改给企业带来何影响. *People's Daily*.

Wu, X., & Zhao, Y. (2017, October 11). 佛山：制造业大市的生态文明之路. *Nanfang Daily*.

Wu, Z. (2010). 广东要创造低碳制造业神话. *Nanfang Daily*.

WWF. (2010). China ecological footprint report 2010: Biocapacity cities and development. WWF China.

Xi, X., & Xu, Q. (1998). 中国公众环境意识调查 *A Survey on Environmental Awareness of Chinese Citizens*. 中国环境科学出版社 China Environmental Science Press.

Xie, Q. (2016, December 21). 粤 24 家陶企获国家首批三星级绿色建材标识. *Nanfang Daily*.

Xie, Q. (2017, August 23). 21 地市 PM2.5 均达标. *Nanfang Daily.*

Xie, Q. (2018a, February 2). 去年粤主要污染物 减排超额完成任务. *Nanfang Daily*.

Xie, Q. (2018b, June 4). 广东启动"绿色企业"创建试点将从电子、化工、建材、家具、造纸等行业开展试点创建工作. *Nanfang Daily*.

Xie, Q., Chen, H., & Zhong, Q. (2017). 广东连续两年空气质量全面达标，2016 年 PM2.5 年均浓度进一步下降. *Nanfang Daily*.

Xie, S. (2011, February 21). 经济大省当上"节能先进". *Nanfang Daily*.

Xinjing Journal. (2017, July 31). 有多少地方在"假装治污". *Xinjing Journal*.

Xin, Z. (2018, January 30). Quality to go hand in hand with growth. *China Daily*.

Xing, X. (2010). 广东工业统计年鉴. 广东工业统计年鉴编辑委员会.

Xinhua. (2013). Social Security Top Concern Ahead of Two Sessions. Retrieved July 23, 2013, from http://en.people.cn/90882/8137040.html

Xinhua. (2014). China unveils energy strategy, targets for 2020. Retrieved November 24, 2014, from http://en.people.cn/n/2014/1119/c90785-8811388.html

Xinhuanet. (2020). National green development fund company established in Shanghai. Retrieved August 20, 2020, from http://www.xinhuanet.com/english/2020-07/16/c_139215364.htm

Xinhua News Agency. (2011). 《中国应对气候变化的政策与行动 (2011)》白皮书.

Xinhua News Agency. (2013). China resorts to judicial protection in green push. Retrieved August 24, 2014, from https://www.chinadaily.com.cn/bizchina/greenchina/2013-07/22/content_16811458.htm

Xinhua News Agency. (2014). EPL 中华人民共和国环境保护法(2014), Retrieved August 2, 2015, from http://www.gov.cn/zhengce/2014-04/25/content_2666434.htm

Yang, H. (2016). 我国地方政府环境治理的政策工具研究. 上海社会科学院出版社.

Yuan, D., & Feng, J. (2011). "十二五"节能减排目标是如何决策的？. *Nanfang Weekend*.

Yan, A. (2016, December 22). Smog linked to third of deaths in China, study finds. *South China Morning Post*.

Yang, C. (2013). Wind power now No.3 energy resource. Retrieved February 17, 2013, from http://en.people.cn/90778/8109836.html

Yang, G. (2005). Environmental NGOs and institutional dynamics in China. *The China Quarterly*, *181*, 46-66.

Yang, G. (2007). How do Chinese civic associations respond to the internet? Findings from a survey. *The China Quarterly*, *189*, 122-143.

Yang, G. (2009). *The Power of the Internet in China: Citizen Activism Online*. Columbia University Press.

Yang, G., & Calhoun, C. (2007). Media, civil society, and the rise of a green public sphere in China. *China Information*, *21*(2), 211-236.

Yang, H., (2014, June 11). 石化企业再上环境污染黑名单. *Yangcheng Evening News*.

Yang, L. F. (2005). Embedded autonomy and ecological modernisation in Taiwan. *International journal of environment and sustainable development*, *4*(3), 310-330.

Yang, L. F. (2008). Environmentalism in Taiwan, a Case of Embedded Autonomy and Greening. In P. Ho (Ed.), *Leapfrogging Development in Emerging Asia*, 129-149.

Yang, P. (2007). Alxa See Association: A New Initiative by Entrepreneurs. In C. Liang & D. Yang (Ed.), *The China Environment Yearbook, Volume 1 (2005): Crisis and Breakthrough of China's Environment*, 407-416.

Yang, T., & Zhang, X. (2011). Public Participation in Environmental Enforcement with Chinese Characteristics: A Comparative Assessment of China's Environmental Complaint Mechanism. *Georgetown International Environmental Law Review*, *24*, 325.

Yearley, S. (1994). Social movements and environmental change. In M. Redclift & T. Benton (Ed.), *Social theory and the global environment*, 150-168.

Yearley, S. (2014). *The green case : a sociology of environmental issues, arguments and politics*. Routledge.

Yee, W. H. (2012). *China's environmental reform: Ecological modernization, regulatory compliance, and institutional change*. University of Southern California.

Yin, H., & Schmeidler, P. J. (2009). Why do standardized ISO 14001 environmental management systems lead to heterogeneous environmental outcomes? *Business Strategy and the Environment*, *18*(7), 469-486.

York, R., & Rosa, E. A. (2003). Key challenges to ecological modernization theory: Institutional efficacy, case study evidence, units of analysis, and the pace of eco-efficiency. *Organization & Environment*, *16*(3), 273-288.

York, R., Rosa, E. A., & Dietz, T. (2010). Ecological modernization theory: theoretical and empirical challenges. *The international handbook of environmental sociology*, 77-90.

Young, S. C. (2000). *The Emergence of Ecological Modernisation: Integrating the Environment and the Economy?* Routledge.

Ytterhus, B. (2006). The Norwegian Environmental Business Barometer. In S. Schaltegger & M. Wagner (Ed.), *Managing the Business Case for Sustainability: The Integration of Social, Environmental and Economic Performance*, 328-344.

Yu, Q. (2018). 环保税来了，究竟影响几何？——权威部门详解我国首个绿色税种征管新规. Retrieved January 20, 2018, from http://www.xinhuanet.com/fortune/2018-01/11/c_1122244753.htm

Yu, W., & Ramanathan, R. (2015). An empirical examination of stakeholder pressures, green operations practices and environmental performance. *International Journal of Production Research*, *53*(21), 6390-6407.

Yu, Z., Jian, J., & He, P. (2011). The study on the correlation between environmental information disclosure and economic performance-with empirical data from the manufacturing industries at Shanghai Stock Exchange in China. *Energy Procedia*, *5*, 1218-1224.

Yue. (2020, September 9). 2019 年省企业环境信用评价结果公示. *Zhu Jiang Huan Jing Bao 珠江环境报*.

Yusoff, H., Mohamad, S. S., & Darus, F. (2013). The influence of CSR disclosure structure on corporate financial performance: Evidence from stakeholders' perspectives. *Procedia Economics and Finance*, *7*, 213-220.

Zeng, K., & Eastin, J. (2011). *Greening China: The Benefits of Trade and Foreign Direct Investment*. University of Michigan Press.

Zeng, S., Xu, X., Dong, Z., & Tam, V. W. (2010). Towards corporate environmental information disclosure: an empirical study in China. *Journal of Cleaner Production*, *18*(12), 1142-1148.

Zeng, X. D. (2011). *The Perspective and Vitality of NGO*. Environmental Science Press.

Zhan, X., Lo, C. W.-H., & Tang, S.-Y. (2014). Contextual changes and environmental policy implementation: a longitudinal study of street-level bureaucrats in Guangzhou, China. *Journal of Public Administration Research and Theory*, *24*(4), 1005-1035.

Zhan, X., & Tang, S. Y. (2013). Political opportunities, resource constraints and policy advocacy of environmental NGOs in China. *Public Administration*, *91*(2), 381-399.

Zhang, B., Cao, C., Gu, J., & Liu, T. (2016). A new environmental protection law, many old problems? Challenges to environmental governance in China. *Journal of Environmental Law*, *28*(2), 325-335.

Zhang, K., & Wen, Z. (2008). Review and challenges of policies of environmental protection and sustainable development in China. *Journal of environmental management*, *88*(4), 1249-1261.

Zhang, L., Mol, A. P., He, G., & Lu, Y. (2010). An implementation assessment of China's environmental information disclosure decree. *Journal of Environmental Sciences*, *22*(10), 1649-1656.

Zhang, L., Mol, A. P., & Sonnenfeld, D. A. (2007). The interpretation of ecological modernisation in China. *Environmental politics*, *16*(4), 659-668.

Zhang, Q., Crooks, R., & Jiang, Y. (2011). *Environmentally Sustainable Development in the People's Republic of China: Visions for the Future and the Role of the Asian Development Bank*. Asian Development Bank.

Zhang, T., & Chen, J. (2003). Industrial environmental management in China. In A. P. J. Mol & J. C. L. van Buuren (Ed.), *Greening Industrialisation in Asian Transitional Economies: China and Vietnam*, 23-38.

Zhang, X. (2021). Conflicts and order: controversies over municipal solid waste incineration in China. [Doctoral dissertation, Université de Montréal]. Papyrus.bib.umontreal.ca.

Zhang, Y. (2014, December 24). Govt plans more closures of coal mines through 2016. *China Daily*.

Zhang, C. & Lin, L. (2014). Flawed planning process partly to blame for mass protests, admits MEP official. Retrieved June 21, 2014, from https://chinadialogue.net/en/pollution/7038-flawed-planning-process-partly-to-blame-for-mass-protests-admits-mep-official/

Zhao, Q. (2014, March 24). 在线监测数据失真污染"真相"哪去了？ *Guangzhou Daily*.

Zhao, W., & Li, F. (2016, December 21). 三角镇党委书记黄泽科：以"三个创新"推动"三个三角"建设. *Nanfang Daily*.

Zheng, D., & Shi, M. (2017). Multiple environmental policies and pollution haven hypothesis: evidence from China's polluting industries. *Journal of Cleaner Production*, *141*, 295-304.

Zheng, J. (2016, February 22). China looks to regulate city growth. *China Daily*.

Zhong, L., & Mol, A. P. J. (2008). Participatory environmental governance in China: Public hearings on urban water tariff setting. *Journal of environmental management*, *88*(4), 899-913.

Zhong, Q. Z., & Huang, H. C. (2016, November 21). 同心共绘"广东蓝" 广东提前两年实现国家空气质量考核目标. *Nanfang Daily*.

Zhou, F. (2010a). 重提紫金矿业污染门：制度缺失纵容了污染. Retrieved August 23, 2014, from https://www.china5e.com/news/news-141836-1.html

Zhou, N. (2010b). Status of China's energy efficiency standards and labels for appliances and international collaboration. (No. LBNL-251E). Lawrence Berkeley National Lab.(LBNL), Berkeley, CA (United States).

Zhou, S. (2011, November 17). 积极探索环境保护新道路推动经济发展方式绿色转型—在中国环境与发展国际合作委员会 2011 年年会上的讲话 Annual meeting of China Council for International Cooperation on Environment and Development. *中国环境报*.

Zhou, Y., & Rao, W. (2018). 中国省级卫视总排行 TOP37 出炉！一线卫视"春秋五霸"抢夺收视！. Retrieved January 19, 2018, from https://www.sohu.com/a/215577931_450343

Zhou, Y., & Tian, P. (2017, May 8). 环保督察催生首批整改方案. *People's Daily*.

Zhou, Z., & He, Z. (2010, June 23). 志高世博园低碳 年均减 3.5 吨碳排放. Retrieved June 26, 2010, from http://news.dayoo.com/foshan/201006/23/67348_102532533.htm

Zhu, Q., & Sarkis, J. (2006). An inter-sectoral comparison of green supply chain management in China: drivers and practices. *Journal of cleaner production*, *14*(5), 472-486.

Zhu, Q., Sarkis, J., & Lai, K. (2012). Green supply chain management innovation diffusion and its relationship to organizational improvement: An ecological modernization perspective. *Journal of Engineering and Technology Management*, *29*(1), 168-185.

Zhu, Y., & Berry, C. (2009). *TV China*. Indiana University Press.

Zhu, Z., L., T., Jiang, S., Zheng, J., & Huang, Y. (2017, May 8). 珠三角去年日均诞生 22 家高新企业. *Nanfang Daily*.

ZSEPB. (2014). 关于公布中山市第三批应依法实施清洁生产审核的重点企业名单的通知. Zhongshan EPB.

Zusman, E. (2001). Seeking Contradictions in the Field: Environmental Economics, Public Disclosure and Cautious Optimism about China's Environmental Future. *China Environment Series*, *4*, 63-65.

Appendices

Appendix A : Multiple-choice questionnaires (Chinese and French versions)

On the cover page of the questionnaire, a brief statement identifies the sponsoring organization, explains the purpose of the survey, and assures the information would be held in strict confidence. The questionnaire is introduced by an instruction “check/click the appropriate category, multiple options can be selected”. Respondents could select the options by checking code number boxes or provide their own response by filling out “other”.

调查问卷

珠三角企业面对“绿”化的市场环境

采访者声明

本采访收集的资料仅供学术研究参考。为保证资料绝对保密，调查采用匿名方式。我们承诺不对外界披露关于贵公司的信息。

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谢谢！

拉瓦尔大学和中山大学

年　月　日

第一部分 背景信息

请选择您的答案（**纸板**-**打钩**选择；**电子版**-**点击方形图标**，**点击**默认值的**选中**项），**可多选**。

企业名称:______________________________

成立日期:______年　　　　增建或扩建年份: ______年

所属行业:______________　　　　高新企业: ☐是 ☐否

城市:__________

所在地

☐工业园区 ☐城市工业集聚区 ☐老城区 ☐高新技术开发区 ☐其它:____

经济所有体

☐国有企业　☐私有企业　☐上市企业

☐港资　☐台资　☐中资　☐中外合资

年收入

☐300 万以下　☐300-2000 万　☐2000-4000 万　☐4000 万以上

员工数目

☐20 人以下　☐20-299 人　☐300-999 人　☐1000 人以上

供应市场

☐内销　☐出口

出口地区　☐美国、加拿大　☐拉丁美洲　☐欧洲　☐日本

☐澳洲、新西兰　☐亚洲其它国家　☐非洲

出口占收入比例

☐不适用　☐1-25%　☐26%-50%　☐51-75%　☐75%以上　☐100%

贵司是☐跨国公司供应商　☐贴牌生产或原始设备制造商

第二部分 企业环境政策影响因素

1. 哪些因素影响贵企业建立环境决策和采取具体措施?

☐不适用☐国家政策法规☐地方管理法规☐当地政府目标☐政府推动

☐企业负责人决定☐企业策略☐承担社会责任　☐避免风险☐节省成本☐企业形象和名声☐提高效率☐客户要求☐群众舆论　☐媒体压力

☐投资效益　☐实施费用☐人力资源　☐技术支持　☐其它:

a. 实施环境政策（如节能降耗，减污等）是否影响经济收入?

☐不适用☐增加费用☐增加收入☐减少费用☐减少收入☐不确定

b. 环保举措会让贵企业在**国内**或**国际**市场更具竞争力吗?

☐不适用　☐不确定

国内市场☐**增强**竞争力☐**不影响**竞争力☐**削弱**竞争力

国际市场☐**增强**竞争力☐**不影响**竞争力☐**削弱**竞争力

c. 外国客户比国内客户更关注环保问题吗?

☐ 不适用　☐ 客户都<u>**不**</u>注重

☐ 外国客户比国内客户<u>**更**</u>注重　☐ 外国客户和国内客户<u>**同样**</u>注重

d. 在推行环保行动过程中，有没有碰到困难?

☐ 不适用　☐ 有困难

如果有，请指出

☐ 缺乏资金　☐ 观念障碍　☐ 技术问题

☐ 管理因素　☐ 环境标准要求过严　☐ 其它:______

2. 国家或地方政府目前执行的环保政策对贵企业绩效有什么影响?

☐ 正面效应　☐ 负面效应　☐ 没有影响　☐ 不确定

a. 如果政府实施更严格的环保政策将会对企业产生影响吗?

☐ 会　☐ 不会　☐ 不确定

如果会，请指出

☐ 增加成本　☐ 降低竞争力　☐ 提高竞争力

☐ 增加研发　☐ 促进建立或改善环境管理制度　☐ 其它:____

3. 在环保方面，贵企业和政府部门之间存在哪些关系?

a. 企业和哪些部门有联系?

☐ 不适用 ☐ 环保局 ☐ 经贸委 ☐ 科信局 ☐ 发改委 ☐ 其它:____

b. 企业和政府部门有没有联系?

☐ 没联系　☐ 很少联系　☐ 经常联系

☐ 合作　☐ 其它:____

c. 企业是否获得政府政策或手段支持实施环保举措?

☐ 有　☐ 没有　☐ 不适用

如果有，请指出

☐财政补贴 ☐贷款优惠 ☐减免税收 ☐奖励政策

☐提供咨询 ☐培训 ☐其它：

如果没有，请指出原因

☐无相关政策 ☐不了解信息 ☐申请手续繁琐 ☐不合条件 ☐其它：

d. 您如何评价政府部门实施的环保策略和行动？

☐监管 ☐指挥 ☐干预 ☐帮助 ☐推动 ☐其它：

4. 贵企业有没有在环保方面与其他机构合作？

☐不适用 ☐有合作

a. 如果有，请指出合作机构

☐研究机构 ☐大学 ☐咨询机构 ☐民间组织 ☐其它：__________

b. 如果有，请指出合作方向

☐治理污染 ☐节能减排 ☐产品研发 ☐改善生产管理

☐培训 ☐技术工艺、设施设备改造 ☐其它：

第三部分 企业与环境管理

5. 贵企业有没有 制定成文的环境管理原则或战略？

☐有成文的战略

☐有一些指导原则

☐尚无成文原则或战略

a. 如果有，这些目标是如何在战略中得以阐述？

☐遵守法规 ☐风险管理 ☐降低成本 ☐提高效率

☐差异化公司产品 ☐提升品牌形象 ☐开拓市场

☐保留市场份额 ☐提高竞争力 ☐其它：

b. 有没有提出具体目标? ☐有 ☐没有

✓ 如果有，请指出

☐节约能源资源 ☐污染物防治 ☐降低单位产值能耗

☐减少碳排放 ☐其它:

6. 贵企业有没有正式确立方案或措施达到目标?

☐有方案/措施，行动**超过**行业标准

☐有方案/措施，行动**符合**行业标准

☐有方案/措施，未转化为具体行动

☐尚无方案/措施

a. 如果有，请指出具体行动

☐降低水、电、能源消耗 ☐监管治理设备 ☐减少"三废" ☐回收废料 ☐循环用纸 ☐设备更新、改造 ☐改进工艺 ☐技术革新 ☐改善生产管理 ☐替代原辅材料 ☐产品设计升级 ☐采用清洁能源 ☐利用再生能源 ☐综合利用能源和资源 ☐参加碳交易 ☐减少、消除噪声 ☐绿化环境 ☐其它:

b. 如果尚未行动，请指明原因

☐未有法规 ☐非污染或高耗能企业 ☐成本压力 ☐缺乏人力

☐生产工艺 ☐管理问题 ☐不确定 ☐其它:

7. 贵企业目前研发投资所占比例

a. 研发投入占业务收入比例

☐不适用 ☐<1% ☐1<3% ☐3<5% ☐5-10% ☐>10% ☐不确定

b. 企业环保投入占业务收入比例

☐不适用 ☐1<3% ☐3<5% ☐5-10% ☐10<20% ☐>20% ☐不确定

c. 环保投资占企业总项目投资比例

☐不适用 ☐<5% ☐5%<10% ☐10<20% ☐20%<30% ☐>30% ☐不确定

8. 企业是否有制度化的环保工作负责人?

☐有专人负责 ☐尚无专人负责

a. 如果有，哪一层级的人员负责环保事务?

☐公司/厂级领导 ☐部门负责人 ☐基层管理人员 ☐职员

b. 如果没有，是由哪一层级的人员兼管环保事务?

☐不适用 ☐公司/厂级领导

☐部门负责人 ☐基层管理人员 ☐职员

c. 执行环保法规措施

☐不适用 ☐分级领导责任制 ☐职能部门责任制

☐环保科研规划 ☐环境资料、统计报表台帐、环保技术档案

☐环护考核 ☐环境监测 ☐宣传教育培训

☐推广技术和科研成果 ☐纠正不合法规行为

☐奖励处罚管理制度 ☐其它:

第四部分 成效与贡献

9. 贵企业的环保措施是否已见成效?

☐不适用 ☐未有成效 ☐已见成效

a. 请指出在环保方面的成果和贡献

✓ 成果

☐减少耗纸量 ☐污染物排放达标 ☐能耗、水耗达标 ☐削减原材料

☐提高能效 ☐减少“三废” ☐通过清洁生产验收

☐减少碳排放 ☐开发新产品 ☐其它:

✓ 优异表现

☐自愿参加清洁生产 ☐自愿参加碳交易 ☐开展碳盘查

☐获环境管理体系 ISO14001 认证 ☐获产品环保标签

☐建立、改善环境管理制度 ☐其它：

☐发表企业社会环境与责任/可持续发展报告

b. 与同行相比，您如何评估该成绩？

☐好于同行 ☐持平 ☐差于同行 ☐不确定

第五部分 展望未来

10. 未来五年里，贵企业的环保举措会不会发生变化？

☐会 ☐不会 ☐不确定

a. 如果有变化，请指出

☐改进生产工艺 ☐研发新产品 ☐建立环境管理机制

☐确立行动方案 ☐增加环保投入 ☐削减环保投资

☐选用高效电机 ☐实施节能改造 ☐其它：

b. 在环保方面，企业将面临哪些挑战？

☐国际市场压力 ☐国家地方政策要求 ☐成本增加

☐资源短缺 ☐不确定 ☐其它：

c. 环境问题看法

✓ 您认为目前首要的环境问题是

☐环境污染（如空气、水污染、废弃物、土壤污染） ☐不确定

☐自然环境、生物的保护 ☐减少温室气体排放 ☐其它：

✓ 政府应怎样解决环境问题？

☐利用市场机制 ☐增加扶持资金 ☐公正执法 ☐加大惩罚力度 ☐其它：

✓ 您认为贵企业应如何应对环境挑战？

☐环境问题属公共事务，企业创造财富和就业

☐企业遵守相关法规，协助政府解决环境问题
☐企业制定环境策略，在市场竞争中取得先机
☐企业主动承担社会责任，树立良好社会和品牌形象
☐其它：____

受访者信息

1. 职位 ☐公司/工厂级领导 ☐部门负责人 ☐基层管理人员
☐职员 ☐退休人员

2. 年龄 ☐30 岁及 30 以下 ☐31-45 岁 ☐46-59 岁 ☐60 岁以上

3. 从事该行业________年， 在当前企业工作________年

L'usine du monde face à un marché plus vert

Déclaration de l'intervieweuse

Les données récoltées de l'entrevue seront utilisées uniquement à des fins de recherche. Nous prenons soin de préserver l'anonymat de chaque répondant. Nous vous promettons de ne pas divulguer les informations concernant votre entreprise.

Votre collaboration précieuse est la clé du succès du projet. Je vous remercie sincèrement de votre aide.

Veuillez nous faire parvenir votre questionnaire complété en dix jours ouvrables. Merci beaucoup pour votre collaboration!

Université Laval/Université Sun Yat-sen

Année Mois Jour

Section 1 Profil de l'entreprise

Choisissez vos réponses parmi les propositions de réponses en cliquant dans le carré qui paraît à côté de celles-ci pour sélectionner l'item. Plusieurs choix sont possibles. Utilisez les champs libres pour préciser vos réponses.

Nom de l'entreprise:

Année de création: Année de rénovation ou d'expansion:

Secteur industriel: Entreprise de «haute-technologie» : ☐Oui ☐Non

Municipalité :

Lieu de l'établissement :

☐Parc industriel ☐Quartier industrialo-urbain ☐Vieux quartier-urbain
☐Zone de haute technologie et de développement ☐Autres :

Statut de l'entreprise
☐Société publique ☐Société privée ☐ Société cotée en Bourse

Origine des capitaux
☐Chinois ☐Hongkongais ☐Taïwanais ☐Coentreprise (*joint-venture*)

Chiffre d'affaires (dix mille yuans)

☐< 300 ☐300-2000 ☐2000-4000 ☐≥4000

Effectif d'employé

☐< 20 ☐20-299 ☐300-999 ☐≥1000

Marchés desservis :

☐Marché national ☐Marchés internationaux :

☐ÉU, Canada ☐Europe ☐Japon ☐Australie, Nouvelle Zélande
☐Afrique ☐Amérique latine ☐D'autres régions asiatiques

Part des ventes à l'exportation
☐N/A ☐1-25% ☐26%-50% ☐51-75% ☐>75% ☐100%

Votre entreprise est :

☐Fournisseur pour l'entreprise multinationale ☐Fabricant d'équipement d'origine *(OEM)* ☐Marque de fabricant

Section 2 Facteurs qui influencent des décisions environnementales

1. Quels sont les <u>facteurs</u> qui influencent votre entreprise dans la prise de décisions et la mise en place des mesures environnementales?

☐N/A

☐Lois/réglementations nationales ☐Réglementations locales

☐Objectifs du gouvernement local ☐Promotion gouvernementale

☐Éviter de risques ☐Décisions des dirigeants de l'entreprise

☐Stratégie de l'entreprise ☐Image et réputation de l'entreprise

☐Rentabilité de l'investissement ☐Coût de l'opération ☐Réduction de coût

☐Augmentation d'efficacité ☐Soutien technologique ☐Ressources humaines

☐Responsabilité sociale ☐Opinion publique ☐Pressions des média

☐Exigence de consommateurs ☐Autres :

a. Est-ce que la mise en place des politiques environnementales affecte votre revenu?

☐N/A

☐Augmentation de coût ☐Diminution de revenu

☐Augmentation de revenu ☐Diminution de coût

☐Aucune influence ☐Incertain

b. Diriez-vous que les actions environnementales vous permettent d'avoir plus de l'avantage concurrentiel dans les marchés nationaux ou internationaux?

☐ N/A ☐Incertain

Marchés **nationaux** ☐<u>Amélioration</u> de compétitivité ☐<u>Aucune</u> influence

☐<u>Affaiblissement</u> de la compétitivité

Marchés **internationaux**

☐<u>Amélioration</u> de compétitivité ☐<u>Aucune</u> influence

☐<u>Affaiblissement</u> de la compétitivité

c. Est-ce que les acheteurs étrangers se préoccupent davantage de la performance environnementale de l'entreprise?

☐N/A

☐Ni l'un ni l'autre <u>ne se préoccupe</u> de la performance environnementale

☐Les étrangers se préoccupent <u>plus</u> de la performance environnementale

☐Les étrangers se préoccupent <u>autant</u> que les acheteurs domestiques

d. Est-ce que votre compagnie a rencontré de difficultés dans la mise en place des actions environnementales?

☐N/A ☐Oui

Si oui, précisez

☐Manque de fonds ☐Problème d'attitude

☐Domaine technologique ☐Éléments de gestion

☐Normes environnementales trop élevées ☐Autres :

2. Les lois et les réglementations environnementales actuelles ont-elles de répercussions sur la performance économique de votre entreprise?

☐Effet positif ☐Aucun ☐Effet négatif ☐Incertain

Est-ce que votre entreprise serait affectée par la mise en œuvre des politiques environnementales plus sévères?

☐Oui ☐Non ☐Incertain

Si oui, précisez :

☐Augmenter le coût ☐Affaiblir la compétitivité

☐Augmenter la compétitivité ☐Augmenter la R&D

☐Établir/améliorer le système de management environnemental

☐Autres :

3. Votre entreprise a-t-elle des liens avec des gouvernements en matière de la protection de l'environnement ?

a. Si oui, avec quelles autorités?

☐N/A

☐Bureau de la protection de l'environnement ☐Comité d'économie et du commerce ☐Bureau d'information technologique

☐Comité de développement et de réforme ☐Autres :

b. Y-a-t-il des liens entre votre entreprise et les gouvernements ?

☐Aucun ☐Peu de contacts ☐Collaboration

☐Contacts fréquents ☐Autres :

c. Est-ce que votre entreprise a obtenu du soutien gouvernemental pour la mise en place des mesures environnementales?

☐Oui ☐Non ☐N/A

Si oui, précisez

☐Aide financière ☐Prêts à un taux avantageux ☐Réduction d'impôt

☐Récompenses ☐Assistance-conseils ☐Formation

☐Autres :

Si non, précisez

☐Absence de politique ☐Manque de renseignements

☐Complexité de procédure d'application ☐Inadmissibilité

☐Autres :

d. Comment qualifieriez-vous la stratégie et l'action des autorités à l'égard de la protection de l'environnement?

☐Supervision ☐Commandement

☐Intervention ☐Soutien ☐Autres :

4. Est-ce que votre entreprise travaille en collaboration avec d'autres organismes en matière d'environnement ?

☐N/A ☐Oui

Si oui, précisez le type de l'organisation

☐Institut de recherche ☐Université ☐Génie conseils ☐ONG ☐Autres :

Si oui, précisez le domaine de votre collaboration

☐Prévention et réduction de pollution ☐Conserver l'énergie et réduire l'émission ☐R&D ☐Améliorer la gestion ☐Formation du personnel

☐Amélioration technologique ou rénovation des équipements de procédés

☐Autres :

Section 3 Entreprise et gestion de l'environnement

5. Est-ce que votre entreprise dispose d'une stratégie ou de directives en gestion environnementale?

☐Stratégie officielle énoncée

☐Quelques directives

☐Aucune stratégie directive élaborée

a. Si oui, quels sont les objectifs?

☐Se conformer à la loi ☐Gérer des risques

☐Réduire les coûts ☐Augmenter l'efficacité

☐Améliorer l'image de marque ☐Différencier l'offre produits
☐Accéder au nouveau marché ☐Garder la part de marché
☐Autres :

b. Y-a-t-il les cibles concrètes?
☐Oui ☐Non
Si oui, précisez :
☐Conservation des ressources
☐Réduction de consommation d'énergie par unité de PIB
☐Prévention ou lutte à la pollution
☐Réduction des émissions du dioxyde de carbone
☐Autres :

6. Est-ce que votre entreprise a mis en œuvre un plan ou des mesures pour l'atteinte des objectifs?
☐Mise en œuvre effectuée, action prise **dépasse** les normes exigées
☐Mise en œuvre effectuée, action prise en **conformité** avec les normes exigées
☐Plan/mesure élaborée, pas d'action
☐Aucun plan/mesure

a. Si l'action concrète prise, précisez :

☐Atténuer /faire disparaître les bruits ☐Verdissement autour et dans les environs
☐Conserver l'eau/l'électricité/l'énergie
☐Entretien régulier de l'équipement de dépollution ☐Changement ou rénovation d'équipements
☐Réduire des eaux usées/effluents gazeux/déchets solides ☐Recyclage de papier
☐Gestion de déchets
☐Amélioration de précédé ☐Innovation, rénovation technologique ☐Substitution de matières premières ☐Conception de produits
☐Amélioration de la gestion
☐Utilisation des énergies propres ☐Utiliser les énergies renouvelables
☐Utilisation combinée des ressources et des énergies
☐Participation à la bourse du carbone ☐Autres :

b. en cas d'absence d'action prise, préciser les raisons :
☐Absence de réglementations ☐Entreprise non polluante ou non énergivore
☐Coût élevé ☐Manque de personnel
☐ Question d'ordre de technologie ou de procédé
☐ Problème au niveau de gestion

☐Incertain ☐Autres :

7. Recherche et développement de l'entreprise
   a. Investissements de R&D en pourcentage du chiffre d'affaire

☐N/A ☐1<3% ☐3<5% ☐5-10% ☐>10%☐Incertain

   b. Investissements dans la protection environnementale en pourcentage du chiffre d'affaire

☐N/A ☐1<3% ☐3<5%☐5%<10% ☐10<20% ☐>20%☐Incertain

   c. Investissements dans la protection environnementale en pourcentage d'investissement total

☐N/A☐5%☐5%<10% ☐10<20%☐20<30%☐>30%☐Incertain

8. Y-a-t-il une personne désignée qui s'occupe de l'environnement dans votre entreprise?

☐Oui ☐Non

   a. Si oui, quel est son niveau hiérarchique?

☐Dirigeant ☐Chef de département☐ Cadre ☐Employé ☐Autres :

   b. Si non, qui s'implique dans les dossiers relatifs à l'environnement?

☐N/A☐Dirigeant ☐Chef de département ☐ Cadre ☐Employé

   c. Mise en œuvre des mesures environnementales

☐N/A ☐Système de responsabilité hiérarchique de gestionnaire
☐Système de responsabilité de département
☐Système de récompense et de punition ☐Audit environnemental
☐Planification de la R&D en environnement ☐Surveillance environnementale
☐Constitution de la base d'informations (statistique, inventaire, technologie)
☐Éducation et formation ☐Correction des non-conformités
☐Planification de la R&D et diffusion des technologies ☐Autres :

Section 4 Résultats et contributions

9. Quels sont les résultats de la prise d'action environnementale?

☐N/A ☐Aucun résultat concret ☐Résultats concrets acquis

   a. Précisez les résultats obtenus et les contributions
      ✓ Résultats

☐Réduction de la consommation de papier
☐Réduction de la consommation de matières premières

☐Émissions de polluants conformes aux limites
☐Réduction de la consommation de l'eau, l'électricité et l'énergie
☐Augmenter l'efficacité énergétique
☐Réduction des eaux usées, des effluents gazeux et des déchets
☐Réduction de l'émission de CO_2
☐Réalisation de l'audit de la production plus propre
☐Développement de nouveaux produits ☐Autres :

- ✓ Performance et excellence environnementale

☐Participation volontaire à la production plus propre
☐Participation volontaire au marché du carbone
☐Certification ISO14001 ☐Certification éco-étiquette
☐Adhésion ou amélioration du système de management environnemental
☐Publication du rapport annuel sur le développement durable
☐Effectuer l'inventaire de GES ☐D'autre certification

b. Comparée avec d'autres entreprises du même secteur, comment évaluez-vous votre performance environnementale?

☐Meilleure ☐Pareille ☐Inférieure ☐Incertain

Section 5 Vision de l'avenir

10. Dans les cinq ans à venir, aurait-il un changement dans votre entreprise en matière de protection environnementale?

☐Oui ☐Non ☐Incertain

a. Si oui, précisez

☐Amélioration de procédés ☐Développement de nouveaux produits
☐Élaboration du système de management environnemental
☐Mise en place d'un plan d'action
☐Accroissement de l'investissement environnemental
☐Utiliser les moteurs électriques industriels
☐Mise en œuvre de rénovations pour la conservation énergétique
☐Diminution de l'investissement environnemental ☐Autres :

b. Quels seront les défis environnementaux pour l'entreprise?

☐Pression des marchés internationaux ☐Prescriptions environnementales
☐Augmentation du coût ☐Manque de ressources
☐Incertain ☐Autres :

c. Avis sur les enjeux environnementaux

Selon vous, le problème principal environnemental est :

☐Pollution ☐Incertain

☐Protection de la biosphère et d'espèces ☐Réduction de GES ☐Autres :

D'après vous, comment le gouvernement devrait-il résoudre les problèmes d'environnement?

☐Utiliser les mécanismes du marché ☐Augmenter les fonds de soutien ☐Application juste et équitable de la loi

☐ Renforcement des mesures coercitives ☐Incertain

À votre avis, comment votre entreprise devrait-elle faire face aux défis environnementaux?

☐L'enjeu environnemental appartient aux affaires publiques, l'entreprise crée de la richesse et de l'emploi.

☐L'entreprise se conforme aux réglementations, collabore avec les autorités pour résoudre les problèmes environnementaux

☐L'entreprise met en œuvre de stratégies environnementales et acquiert un avantage concurrentiel

☐L'entreprise prend sa responsabilité sociale et maintient une bonne réputation et une bonne image de marque

Profil du répondant

Poste occupé : ☐Dirigeant ☐Chef de département ☐Cadre ☐Employé ☐Retraité

Âge : ☐30 ans et moins ☐31-45 ans ☐46-59 ans ☐60ans et plus

Vous travaillez dans ce secteur depuis ans， chez cette entreprise pendant années

Appendix B: Open-ended questions

采访提纲 Schéma d’entrevue

珠三角企业应对气候变化
L’usine du monde face à un marché plus vert

李远征 Yuan Zheng Li

在读社会学博士研究生 Doctorat en sociologie

拉瓦尔大学和中山大学 Université Laval/Université Sun Yat-sen

年　　月　　日　Année　　Mois　　Jour

受访者信息 Profil du répondant

名字 Nom : Prénom：

职位 Position： 董事长/董事/总经理 président/PDG; 副总经理/总经理助理 VP 部门总监/部门经理 chef du département; 基层管理人员 cadre; 员工 employé

年龄大致是在 Âge : 25 岁及以下/ans et moins; 26-35 岁/ans; 36-45 岁/ans; 46-55 岁/ans; 56 -65 岁/ans; 66 岁及以上/ans et plus;

从事该行业有 年 vous travaillez dans ce secteur depuis ans; 为当前企业工作了 年 chez cette entreprise années

第一部分 Section 1 公司背景信息 Profil de l’entreprise

公司名称 Nom de l’entreprise :

公司规模 Taille de l’entreprise : 大 Grande ; 中 Moyenne ; 小 Petite

员工数目 Nombre d’employés :

成立日期 Année de création :

城市 municipalité :

所在地 endroit :

生态工业园区 parc industriel écologique; 工业园区 parc industriel; 高新技术开发区 zone de haute technologie et de développement; 城市工业集聚区 quartier industrialo-urbain; 老城区 vieux quartier urbain

经济所有体 statut de l’entreprise :

国有 secteur public;

私有企业 secteur privé; 股份制 entreprise cotée;

外资企业 participation financière étrangère

所属行业 Secteur :

高科技 、 电子、信息产品制造业电子 haute-technologie, produits informatiques et matériel électronique

电信 télécommunication

加工业 industrie de transformation:能源 énergie; 供电 production d'électricité; 石油 pétrole; 天然气 gaz; 金属 métaux; 制浆造纸 papeterie

汽车制造业 automobile: 整车 fabrication des véhicules ; 汽车配件 fabrication des pièces d'automobile

其它制造业 d'autres secteurs manufacturiers;日用工业品制造业 produits de consommation; 化学工业 produits chimiques; 塑料橡胶工业 produits en caoutchouc et en plastique; 家电制造业 appareils ménagers; 机械制造业 secteur de la machinerie; 纺织品制造业 textiles et vêtements

食品加工业 secteur alimentaire

生物医药业 secteur biologique et pharmaceutique

其它行业 d'autres secteurs :

经营产品(是否环保？) Offre de produits (écologique?) :

供应市场 Marchés desservis : 内销 Chine ; 亚洲国家 d'autres pays asiatiques - ;

北美 Amérique du Nord - ; 欧洲 Europe - ; 其他地区 d'autres régions -

年收入/增长率 revenu annuel/taux de croissance :

公司相关文件 Documents fournis par l'entreprise :

第二部分 Section 2

企业与环境管理 L'entreprise et la gestion de l'environnement

Dans le cadre de ce projet, l'engagement environnemental des entreprises est mesuré en fonction de la présence des éléments principaux des systèmes de gestion de l'environnement (SGE) :

A. Information (contrôle, analyse, rapport, communication)
Statistiques, évaluation de performance, étalonnage concurrentiel (*benchmarking*); responsabilité; vérification et évaluation du risque; évaluation du cycle de vie et éco-balances; gestion des problèmes environnementaux, notification & communication (actionnaires, partie prenantes, personnel, fournisseurs, clients)

B. Organisation et développement du personnel
Personne désignée (*environmental officers*), comité, responsabilités écologiques du conseil d'administration aux ouvriers, directive ligne de commande; considérations environnementales équivalent une partie intégrante des activités quotidiennes; formation et éducation; campagne spéciale (e.g. économiser énergie); remise des prix écologiques;

C. Stratégie environnementale et gestion opérationnelle
Vision/mission de l'entreprise (identité et culture de l'entreprise); mise en œuvre le programme écologique, planifier d'action, objectifs écologiques; se conformer aux lois et réglementations juridiques (à vérifier); mise en place les meilleures technologies disponibles; processus du progrès continu, gestion par la qualité totale, ISO 14000, BS7750/EU-EMAS etc.); politique d'achats écologiques, gestion de la chaîne logistique; politique de ventes écologiques, s'approcher des consommateurs pro-environnement; production économe sur site, recyclage entre sites, projet de symbiose industrielle, procédure en boucle fermé, production design pour l'environnement : introduire les produits et les processus plus propres, substituer les matériaux écologiques pour remplacer des flux matériels et des substances toxiques

2.1 目标 Objectifs， 战略 stratégie， 业务模式 modèle d'affaire

1. 公司是否有以环境保护或减少温室气体排放的目标？公司有没有有关环保的指导原则或战略？这些目标是如何在策略中得以阐述（如差异化公司产品，管理风险，提升品牌形象和声誉，提高效率，遵守法规，降低成本，开拓市场或保留市场份额）？

Est-ce que les objectifs de votre entreprise constituent un élément portant sur la protection de l'environnement ou sur l'atténuation des émissions de gaz à effet de serre? Y-a-t-il des principes ou des stratégies sur la protection de l'environnement? Comment sont-ils présentés dans vos stratégies (e.g. différencier les produits, gérer les risques, améliorer l'image et la réputation des produits, augmenter l'efficacité, se conformer aux lois, réduire les coûts de production, entrer dans un nouveau marché, garder la part du marché existant etc.) ?

2. 有没有确立与环保相关行动方案？有没有节能和减排举措？如果有，烦描述具体的方案和措施。

Est-ce que votre entreprise a mis en place un plan d'action pour la protection de l'environnement? Avez-vous pris des mesures pour conserver l'énergie et pour réduire des émissions (e.g. rien, politique formelle, action concrète)? Si oui, veuillez expliquer les détails.

例如：核心活动[266]：生产（降低二氧化碳排放、利用可再生资源能源267或绿色能源，绿色采购份额、生产增能效、友好型原材料、减少原材料、节水、节能、降耗、减废、减污）、物流运营（使用低碳足迹运输模式，避开高峰），产品的使用期间环保性能，可回收产品份额%。
支持职能[268]方面如建筑内部节能，制定节能节水激励计划，办公室内部节水设备，公司建筑符合能效建筑标准 （<70kw/m^2/年），再生纸，商务差旅（避免密集出差、电话会议、提供公司运输）

Par exemple,
Activités principales : <u>production</u> (réduire des émissions, utiliser des énergies renouvelables/vertes, augmenter l'efficacité énergétique, utiliser des matériaux écologiques, réduire la matière première/déchet/polluant, conserver l'eau); <u>achat</u> écologique %, <u>logistique</u> (mode de transport ayant une empreinte carbone faible, éviter les heures de point), <u>produit</u> (écologique/recyclable? utilisation de matériaux recyclable %)

266 核心活动（研发、采购、生产、配送、使用和处置）

267 可再生资源能源：持续不断补充的自然过程中得到的能量来源，包括太阳、风、海洋、水电、生物量、地热资源、生物燃料等产生的电能和热能及来自可再生资源的氢, Global Reporting Initiative: Environment performance indicators

268 支持职能（包括人力资源相关活动：信息技术、财务、会计、房产和设备管理）

Activités de soutien : conservation de l'énergie dans les bâtiments, équipement de conservation d'eau dans les bureaux, les bâtiments se conforment aux normes énergétiques de construction, papier recyclé, déplacements (éviter des voyages fréquents, utiliser les visioconférences, offre de transport en commun)

2.2 研发和投资 R&D et Investissement/acquisition

3. 请问贵公司是否有关于环保研发预算（如无具体行动，有政策无行动，有政策有符合行业标准行动或超过行业标准）？公司有没有以环境保护为主的投资或并购（如回收机制、水净化系统）？

Pourriez-vous indiquer si votre entreprise fixe un budget alloué à la R&D dans l'environnement (e.g. aucune politique; avec politique sans action; dépasser les normes de l'industrie)? Avez-vous effectué des investissements/acquisitions permettant la protection de l'environnement (e.g. système de recyclage, système de traitement des eaux)?

2.3 组织 Organisation

4. 公司是否有环境保护负责人? 哪一层级的人员负责实施该策略? （如董事会、部门经理、处室负责人）请问你们如何贯彻和执行环保措施?

   Y-a-t-il quelqu'un qui s'occupe de la protection environnementale dans votre entreprise? Qui est responsable de la mise en œuvre de votre politique environnementale? Comment vous vous organisez pour la mise en place de cette politique?

第三部分 Section 3 环保决策影响因素

Facteurs qui influencent les décisions environnementales

5. 贵公司注重环保吗? 客户有没有关注企业在环境方面的表现? (如果企业外销: 请问外国客户比国内客户更关注环保问题吗?) 致力于环保会让贵司在国际或国内市场上更具竞争力吗?

   Est-ce que l'environnement constitue l'une des préoccupations de votre entreprise? Est-ce que vos clients se préoccupent de la performance environnementale de votre entreprise ? (si l'entreprise <u>exporte </u>ses produits: est-ce qu'il y a plus de préoccupation de la part des clients étrangers?) Diriez-vous que vos performances environnementales vous permettent d'avoir plus d'<u>avantage concurrentiel</u>?

6. 贵司在环保方面所做出的努力有没有影响经济收入（如果没有举措，提出假设：会不会）？ 哪些因素促使公司建立环保决策和采取措施（或：妨碍行动）？在实施环保行动过程中，有没有碰到困难？有哪些障碍?

   Est-ce que vos efforts dans la protection environnementale influencent la performance financière de votre entreprise? Quels sont vos <u>raisons</u> principales pour la prise en compte de l'environnement dans vos décisions et vos pratiques? Quels sont les <u>obstacles</u> de la mise en place des mesures environnementales?

e.g.,
Facteurs favorables:
1. raisons juridiques : loi, réglementation, objectifs définis par les autorités;
2. retombées économiques : efficacité énergétique, économie des coûts, amélioration de la productivité, stratégie de marketing et gestion des risques;
3. avantage concurrentiel et adaptation aux exigences du marché/fournisseurs/clients;
4. point de vue personnel/éthique/ responsabilité;
5. d'autres facteurs (image, pression de la part des parties prenantes, pression internationale).

Obstacles
1. manque de ressources et d'expertise dans le domaine de l'environnement;
2. coût élevé de la mise en place (à court terme?), par exemple, les améliorations difficilement justifiables financièrement, notamment les charges associées à l'achat d'équipements et aux dépenses de fonctionnement de ces derniers e.g. dépollution);
3. manque de connaissance sur les avantages.

7. 贵司有没有与政府及其他机构合作，制定和执行环保政策 (如政府三级部门，私企，研究所，大学和民间组织)? 政府是否出台了政策或手段鼓励企业实施环保举措? 如果有，请指出有哪些 (如经济手段：价格、贷款、税收，其它：培训)?

   Est-ce que vous travaillez en partenariat avec des organisations pour l'élaboration et la mise en place des politiques (e.g. gouvernements local/municipal/provincial, d'autres entreprises privées, centre de recherche/université, ONG)? Est-ce que le pouvoir public encourage la mise en place des mesures environnementales? Si oui, de quelle façon (e.g. des prêts /aides financières/mesures fiscales; formation)?

8. 贵公司在环保方面和各级政府部门之间存在哪些关系 (如遵守法律，参与制定标准，政府部门包括市政府，环保部、发改委、经信委等地方机构)? 您如何评价政府部门在企业实施环保举措方面的行动（例如：监管，指挥，帮助，干预）?

   Quelle est la nature des liens entre votre entreprise et les différents paliers de gouvernement en matière d'environnement (la nature des liens : e.g. respect des lois, élaboration des normes; gouvernement : e.g. la municipalité, le bureau local du ministère de l'environnement/du comité de développement et de réforme/du comité d'économie et d'information etc.)? Comment qualifieriez-vous l'action de ces paliers de gouvernement concernant des pratiques environnementales de votre entreprise (commandement, aide, intervention etc.)?

第四部分 Section 4 成效与贡献 Résultats et contributions

9. 贵公司的环保措施是否已见成效（例如：尚无方案和措施、有但未取得成果，已有效果）？请列举贵司在环保方面的贡献（如体现公司举措文档：报告、奖项、出版文章等）。与同行相比，您如何评估该成绩（差, 好于，持平）？

Quels sont vos résultats en matière de l'environnement (e.g. aucun politique/plan/action; avec politique/plan/action, mais sans résultat concret, résultats acquis : e.g. fait des économies, diminution des déchets, réduction de la consommation de l'eau, réduction des GES etc.)? Veuillez indiquer les contributions principales de l'entreprise dans le domaine de l'environnement (matériels qui reflètent vos actions : rapports, prix, articles publiés). Comparez avec vos concurrents, comment vous évaluez vos résultats (pire, meilleur, pareil)？

第五部分 Section 5 放眼未来 Vision de l'avenir

10. 贵公司的环保举措会不会发生变化（例如：技术方面-改进生产工艺，投产新的环保产品，管理方面-建立环境管理机制、确立行动方案，加大环保投资）？在环保方面，公司将面临哪些挑战? 是否有远景目标?

    Est-ce que votre entreprise va effectuer des changements à l'égard de l'engagement environnemental (e.g. engagement technique : amélioration des procédés, lancer nouveaux produits écologiques; engagement managérial : mettre en place le système de gestion/plan d'action, augmenter l'investissement)? Quels seront vos défis particuliers en matière de la protection de l'environnement? Quelle est la vision d'avenir pour votre entreprise dans le domaine de l'environnement?

Appendix C: Integrating qualitative and quantitative data

1) Data processing

We developed a codebook including the survey questions to translate the raw data onto computer. A data file was created manually from the raw paper-based survey data, and data was entered into a computerized spreadsheet. Microsoft Excel was used for quantitative data analysis. The code number box facilitated to transfer data to a spreadsheet. Each time the data was transferred from questionnaires to the data file, we verified item-by-item, checked for obvious inconsistencies in responses, and corrected errors.

2) Hand-coding process

Qualitative data analysis was conducted in stages. We first read material and coded relevant points around practices, strategies narratives, and discourses. The transcription and notes were divided into units (phrase, sentence, paragraph). Each unit was assigned a code label, which came from the exact words of respondents, the notions composed by us, and the concepts used in theories. These codes were grouped into theme and placed directly in one margin, and recorded theme in the other margin. We last noted relationships between environmental measures, strategies, technologies, policies, and actors. Evidence was grouped into codes that were categorized into themes that assembled into broader dimensions and perspectives.

3) Creating consolidated data

Based on the same themes covered by questionnaires and interviews, we transformed qualitative data into quantitative datasets and created new consolidated data. The steps involved are the following: creating a new document of questionnaire, transcribing identical background information about the firm from the transcription and notes, reading the notes and filling out the questionnaire section by section (factors and reasons that influence environmental policy, environmental management and environmental performance, perspectives about the environment), entering the data into the abovementioned spreadsheet.

Appendix D: Scoring templates for CPAs

The template for voluntary CPA is composed of three sections; while the obligatory one includes four sections. The first section of voluntary CPA presents general situation (30 points) containing 10 items (i.e., implementation report, project appraisal, continuous CPA). Focusing on organizational structure and increasing awareness, section one of obligatory CPA addresses organization and leadership (20 points) covering four items (e.g., established structure, plans made, and measures initiated regarding to the stipulated procedures). Section two of both assessments includes nine subsections. One (voluntary) is on resource, energy, production process, technology and implementation of integrated systems (40 points); another (mandatory) includes polluting factor analysis and proposed options (50 points). The last section of evaluation (voluntary) is related to environmental protection, environmental management and conformance levels of discharge standards (30 points). The third and last sections of assessment (mandatory) contain the results obtained with 5 items (20 points) and continuous CPA (10 points).

The highest-scored items (eight-point) of voluntary CPA evaluations include implementation report and levels of conformance to industry CP standards, followed by six-point subsections (energy consumption per unit of product and CP technology application), five-point items (environmental management systems, operation of environmental protection equipment, conformance levels of emissions, and levels of effluents, R&D investment, water consumption per unit of product and raw material (choice and utilization). Eco-labeling, organization and setting target are some of the lowest-scored items of 2-3 points.

For mandatory adopters, the proposed option (feasibility, time limit, focus) is the single most important item (10 points), followed by five-point subsections such as reutilization and recycling of water, solid waste, and heat, four-point items (training and facility appearance), and three-point subsections (implementation of no/low cost options, economic benefits, leadership, CP related documentation and records). The evaluation criteria push efforts toward organized process along with a pre-appraisal prior to auditing. The scores per item are 8, 6, 5, 4, 3, 2, respectively.

Appendix E: Fields of activities

Collaborators	Activities involved in collaboration						
	pollu. treat. & preven.	energy saving & emiss. reduct.	R&D	prod. manag.	training	tech. proced. & upgrade	others
research institute/ university	3	2	0	0	0	1	0
consulting firm	16	25	3	16	16	15	0
NGO	2	1	0	0	0	0	0
research institute/ university & consulting firm	5	10	7	6	5	6	3
research institute/ university & NGO	0	0	0	0	0	0	1
consulting firm & NGO	1	1	0	2	1	0	1
consulting firm & others	3	2	2	2	2	3	0
research institute/ university & consulting firm & others	2	2	2	2	2	2	0
Total number	**33**	**43**	**14**	**28**	**26**	**33**	**5**

Appendix F.1: Government agencies and measures

Government agencies and measures						
Measures	Agencies					
	None	ETC	Others	TCB	DRC	Multiple
Voluntary CPA	0	18	10	7	4	7
Mandatory CPA	0	1	4	1	2	1
ISO 14001	1	17	13	7	5	7
In-house EMS	1	14	8	6	3	6
Carbon trade	1	2	1	0	1	0
Carbon inventory	0	2	1	0	1	0
Eco-labelling	0	0	2	0	1	0
Public report publication	0	2	1	1	1	1
Total number	**8**	**20**	**20**	**9**	**7**	**8**

Appendix F.2: Type of relationships and measures

Type of relationships and measures			
Measures	Relationships		
	collaborative	frequent	occasional
Voluntary CPA	5	12	4
Mandatory CPA	0	0	1
ISO 14001	6	12	4
In-house EMS	5	12	3
Carbon trade	3	3	0
Carbon inventory	1	3	0
Eco-labelling	1	1	1
Public report publication	1	2	1
Total number	**6**	**16**	**10**

Appendix F.3: Perceptions of government actions and measures

Perceptions of actions and measures					
Measures	Perceptions				
	monitoring	command	intervention	assistance	promotion
Vol. CPA	23	2	3	20	13
Man. CPA	8	1	1	8	6
ISO 14001	25	2	3	23	15
In-house EMS	19	2	2	17	14
Carbon trade	3	1	0	0	1
Carbon inventory	3	0	0	0	1
Eco-labelling	4	1	1	5	2
Public report publication	3	0	0	0	1
Others	0	0	0	14	11
Total number	**56**	**6**	**4**	**36**	**21**

Appendix G.1: Drivers and implementers

Drivers (quan.)	Measures undertaken								
	CPA		EMS		carbon		eco-label	report	other
	vol.	man.	ISO	in-house	trade	inv.			
law (68)	34	14	39	32	4	4	6	4	19
decision (44)	22	10	26	21	1	2	6	1	15
customer (18)	7	2	8	4	1	1	2	1	2
strategy (52)	20	9	25	19	1	2	6	1	15
cost (57)	30	13	33	24	3	3	6	1	18
tech. sup. (9)	6	1	6	8	0	1	2	0	5
HR (3)	1	0	0	3	0	1	0	1	1
CSR (31)	18	6	20	15	4	3	5	3	7
public pressure(3)	2	1	2	2	0	0	0	1	1
Total	**37**	**16**	**43**	**34**	**4**	**4**	**7**	**4**	**20**

Appendix G.2: Perceptions of customers' attention for the environment and measures

Perceptions of attention and measures		
Measures (quantity)	Foreign vs. domestic customers (quantity)	
	more attention (33)	same attention (17)
Voluntary CPA (37)	16	6
Mandatory CPA (16)	5	4
ISO 14001 (41)	16	7
In-house EMS (40)	13	5
Carbon trade (4)	2	0
Carbon inventory (4)	3	0
Eco-labelling (7)	2	2
Public report publication (5)	2	0
Others (20)	5	3

Appendix G.3: Perceptions of customers' attention for the environment and markets

Perceptions of attention and markets		
Market/customer (quantity)	More attention (33)	Same attention (17)
Domestic only	10	4
MNC (13)	N/A	
Domestic & international	18	13
MNC (13)	2	1
Own brand (9)	4	3
OEM (12)	6	2
Export destination		
Europe (30)	11	6
Japan (16)	10	2
USA & Canada (28)	12	4
Australia & New Zealand (9)	5	2
Latin America (9)	5	2
Asia except Japan (29)	12	6
Africa(9)	5	2
International only	**5**	N/A
Europe (30)	3	
Japan (16)	1	
USA & Canada (28)	3	
Australia & New Zealand (9)	0	
Latin America (9)	2	
Asia except Japan (29)	2	
Africa (9)	0	
MNC (13)	1	
Own brand (9)	2	

Appendix H.1: Perceptions of impacts of current regulations and measures

Perceptions of current regulations and measures				
Measures (quantity)	Impacts (total number)			
	positive (41)	negative (11)	neutral (6)	uncertain (28)
Voluntary CPA (37)	23	4	4	6
Mandatory CPA (16)	8	0	2	6
ISO 14001 (41)	26	4	3	3
In-house EMS (40)	22	3	3	2
Carbon trade (4)	1	1	0	0
Carbon inventory (4)	2	2	0	0
Eco-labelling (7)	7	0	0	0
Public report publication (5)	2	0	1	1
Others (20)	17	2	1	0

Appendix H.2: Perceptions of impacts of stricter regulation and measures

Perceptions of stricter regulation and measures			
Measures (quantity)	Impacts (total number)		
	enhance competitiveness (21)	increase R&D (15)	establish/ enhance EMS (20)
Voluntary CPA (37)	15	9	11
Mandatory CPA (16)	5	1	1
ISO 14001 (41)	18	8	12
In-house EMS (40)	14	6	10
Carbon trade (4)	2	0	1
Carbon inventory (4)	1	0	1
Eco-labelling (7)	5	3	3
Public report publication (5)	2	0	2
Others (20)	10	3	7

Appendix I.1: Government agency and location

Government agency and location						
Location	None	ETC	Others	TCB	DRC	Multiple
Industrial park	2	14	8	8	3	7
Urban industrial areas	3	4	3	1	0	1
Down-town	0	1	5	0	2	0
High-tech zone	1	0	2	0	1	0
Other areas	2	1	2	0	1	0
Total number	**8**	**20**	**20**	**9**	**7**	**8**

Appendix I.2: Collaborator, headquarter and location

Collaborator, headquarter and location		
Headquarter (quantity)	Collaborator	
	presence	absence
Guangzhou (41)	37	4
Foshan (22)	0	20
Shenzhen (3)	2	1
Zhongshan (9)	9	0
Dongguan (4)	1	3
Zhaoqing (5)	4	1
Jiangmen (1)	1	0
Meizhou (1)	1	0
Location		
Industrial park (43)	34	7
Urban industrial areas (15)	6	9
Down-town (11)	3	8
High-tech zone (8)	5	3
Other areas (9)	7	2
Total number	**55**	**29**

Appendix I.3: Incentives, headquarter and location

Incentives, headquarter and location				
Headquarter	Type of incentives		Receiving	
	pecuniary	non-pecuniary	both	none
Guangzhou	28	19	15	7
Foshan	3	5	2	14
Shenzhen	2	0	0	1
Zhongshan	7	6	6	1
Dongguan	1	2	1	3
Zhaoqing	3	4	3	2
Jiangmen	0	0	0	1
Meizhou	0	0	0	1
Location				
Industrial park	26	20	16	12
Urban industrial areas	6	6	4	7
Down-town	5	4	4	6
High-tech zone	3	3	1	4
Other areas	4	3	2	1
Total number	**44**	**36**	**27**	**30**

Appendix J.1: Sectors and presence of measures

Sectors and presence of measures		
Sectors (code#)	No measure	With measures
Pollution/energy intensive sectors		
3	1	2
9	N/A	1
Subtotal	*1*	*3*
Sectors targeted by CPA		
4	N/A	2
8	2	1
12	N/A	1
Subtotal	*2*	*4*
Other sectors		
10	2	N/A
13	2	2
14	1	N/A
15	2	N/A
Subtotal	*7*	*2*
Total	**10**	**12**

Appendix J.2: Sectors and compliant measures

Sectors and compliant measures		
	Compliance	
Sectors (code#)	with/without guideline	with strategy
Pollutant /energy intensive sectors		
3	3	3
5	3	2
6	N/A	2
9	N/A	1
11	4	1
Subtotal	*10*	*9*
Sectors targeted by CPA		
2	2	N/A
4	N/A	2
8	2	3
12	1	2
Subtotal	*5*	*7*
Other sectors		
1	1	3
7	1	1
10	2	N/A
13	N/A	1
14	1	1
15	2	N/A
Subtotal	*7*	*6*
Total	**22**	**22**

Appendix K: Firm characteristics, markets, sectors and factors

Firm character. & markets & sectors	Factors									
	law	deci.	cust.	strat.	cost	tech. sup.	HR	CSR	pub. pres.	total
LE	44	28	8	24	36	8	2	24	4	**51**
ME	10	7	1	6	9	1	1	2	N/A	**11**
SE	10	6	1	4	7	N/A	N/A	2	N/A	**15**
IE	4	3	N/A	2	5	N/A	N/A	3	N/A	**9**
SOE	11	5	3	3	9	1	N/A	7	1	**12**
Private	57	39	7	33	48	8	3	24	2	**74**
Hong Kong	7	5	2	5	3	1	1	5	1	**7**
Taiwan	5	3	1	3	3	2	N/A	4	N/A	**5**
CN	47	31	6	24	43	6	2	19	2	**63**
JV	9	5	2	4	8	0	N/A	3	N/A	**11**
HNTE	17	16	6	14	18	2	N/A	9	2	**24**
non-HNTE	51	28	4	22	39	7	3	22	1	**62**
listed	11	7	3	5	8	3	1	7	1	**12**
Non-listed	52	34	6	30	46	6	2	21	2	**74**
Domes. only	29	17	3	13	22	3	2	10	1	**36**
Domes.& intern.	35	24	6	21	30	6	1	18	2	**44**
Intern. only	4	3	1	2	5	1	0	3	0	**6**
Pollutant/ energy intensive #3,5,6,9,11	9,5,2 ,1,7 (24)	4,2,1 ,0,5 (12)	1,0,0 ,0,1 (2)	4,2,1 ,0,5 (12)	5,4,1 ,1,8 (19)	1,1,0 ,0,0 (3)	0,1,0 ,0,0 (1)	3,2, 00,2 (7)	0,0,0 ,0,1 (1)	**28**
CPA target #2,4,8,12	5,3,5 ,5 (18)	4,1,6 ,1 (12)	0,1,0 ,0 (1)	4,1,3 ,1 (9)	5,3,4 4 (16)	1,0,2 ,0 (3)	0	2,2, 3,2 (9)	0,1,0 ,0 (1)	**24**
Other sectors #1,7,10,13,14,15	11,2, 2,5,4 ,2 (26)	10,1, 1,4,3 ,0 (19)	3,0,0 ,1,1, 0 (5)	10,1, 0,2,2 ,0 (15)	11,1, 2,4,3 ,1 (22)	1,0,0 ,0,1, 1 (3)	0,0,0 ,0,2, 0 (2)	8,1, 1,3, 1,1 (15)	0,0,0 ,0,1, 0	**34**
subtotal	**68**	**44**	**18**	**52**	**57**	**9**	**3**	**31**	**3**	
% / valid respon. (86)	79%	51%	21%	60%	66%	10%	3%	36%	3%	

Appendix L.1: Collaborator, size, ownership and investment

Collaborator, size, ownership and investment		
Size (total number)	Collaborator	
	presence	absence
LE(51)	41	9
ME (11)	7	4
SE (15)	7	7
IE (9)	0	8
Ownership		
Private (74)	45	27
SOE (12)	10	2
Investment		
Hong Kong (7)	5	2
Taiwan (5)	4	1
Mainland China (63)	36	25
Joint-venture (11)	10	1
Total number	**55**	**29**

Appendix L.2: Collaborator and sectors

Collaborator and sectors		
Sector by environmental impact (total number)	Collaborator	
	presence	absence
Pollutant/energy intensive #3,5,6,9,11 (28)	7,5,2,0,5 (19)	3,0,0,2,3 (8)
CPA target #2,4,8,12 (24)	5,4,4,3 (16)	0,0,5,2 (7)
Other sectors #1,7,10,13,14,15 (34)	9,2,2,2,2,2 (19)	4,0,2,2,2,2 (12)

Appendix M.1: Government incentives and measures

Incentives and measures				
Measures	Incentives		Receiving	
	pecuniary	non-pecuniary	both	none
Voluntary CPA	29	20	17	1
Mandatory CPA	10	10	8	10
ISO 14001	31	23	19	7
In-house EMS	22	20	14	7
Carbon trade	3	1	1	1
Carbon inventory	3	1	1	1
Eco-labelling	7	5	5	0
Public report publication	1	2	1	2
Others	0	15	16	0
Total number	**44**	**36**	**27**	**30**

Appendix M.2: Government incentives and sectors

Incentives and sectors				
Sectors by environmental impacts	Incentives		Receiving	
	pecuniary	non-pecuniary	both	none
Pollutant/energy intensive #3,5,6,9,11	4,2,1,1,7 (15/28)	5,2,1,1,5 (14)	3,1,1,0,4 (9)	3,1,1 (5)
CPA target #2,4,8,12	4,2,4,2 (12/24)	3,1,4,2 (10)	3,1,2,2 (8)	2,0,4,4 (10)
Other sectors #1,7,10,13,14,15	11,1,1,3,1,0 (17/34)	8,0,0,2,2,0 (12)	7,0,0,2,1 (10)	2,0,3,3,3,4 (15)
Total number	**44**	**36**	**27**	**30**

Appendix N: Type of measures and EMSs

Measures and EMSs					
Measures (type and quantity)		EMSs			
		Joint	ISO	in-house	None
Decrease noise; landscaping and grounds, natural cover trees and shrubs	40	26	2	6	6
Conserve resource/energy	60	26	5	8	21
Maintain & refurbish equipment	34	23	2	6	3
Reduce pollution; recycle paper, waste management	56	27	4	8	17
Improve process, technological change, innovation; substitute raw materials, conceive product	49	25	3	6	15
Improve production management	34	22	1	7	4
Use clean /renewable energy; energy combination systems	34	16	3	4	11

Appendix O.1: Measures and impacts on revenue and expense

<table>
<tr><th colspan="5">Measures and impacts</th></tr>
<tr><th rowspan="2">Measures
(total number)</th><th colspan="4">Impacts (total number)</th></tr>
<tr><th>+ revenue
/-expense
(30)</th><th>+ expense
/- revenue
(31)</th><th>neutral
(16)</th><th>uncertain
(6)</th></tr>
<tr><td>Voluntary CPA (37)</td><td>21</td><td>12</td><td>1</td><td>2</td></tr>
<tr><td>Mandatory CPA (16)</td><td>7</td><td>3</td><td>5</td><td>1</td></tr>
<tr><td>ISO 14001 (41)</td><td>21</td><td>13</td><td>4</td><td>4</td></tr>
<tr><td>In-house EMS (40)</td><td>18</td><td>11</td><td>2</td><td>3</td></tr>
<tr><td>Carbon trade (4)</td><td>1</td><td>3</td><td rowspan="4">0</td><td rowspan="3">0</td></tr>
<tr><td>Carbon inventory (4)</td><td>2</td><td>2</td></tr>
<tr><td>Eco-labelling (7)</td><td>6</td><td>1</td></tr>
<tr><td>Public report publication (5)</td><td>1</td><td>2</td><td>1</td></tr>
<tr><td>Others (20)</td><td>15</td><td>2</td><td>1</td><td>2</td></tr>
</table>

Appendix O.2: Measures, impacts on competitiveness and markets

<table>
<tr><th colspan="7">Measures, impact on competitiveness and markets</th></tr>
<tr><th rowspan="3">Measures
(total number)</th><th colspan="6">Competitiveness</th></tr>
<tr><th colspan="3">Domestic</th><th colspan="3">International</th></tr>
<tr><th>+(38)</th><th>-(4)</th><th>neutral(17)</th><th>+(30)</th><th>-(2)</th><th>neutral(8)</th></tr>
<tr><td>Voluntary CPA (37)</td><td>20</td><td>3</td><td>4</td><td>18</td><td>1</td><td>0</td></tr>
<tr><td>Mandatory CPA (16)</td><td>11</td><td>0</td><td>3</td><td>7</td><td>0</td><td>2</td></tr>
<tr><td>ISO 14001 (41)</td><td>24</td><td>3</td><td>3</td><td>21</td><td>1</td><td>1</td></tr>
<tr><td>In-house EMS (40)</td><td>19</td><td>2</td><td>5</td><td>16</td><td>0</td><td>2</td></tr>
<tr><td>Carbon trade (4)</td><td>2</td><td rowspan="2" colspan="2">0</td><td>1</td><td rowspan="4" colspan="2">0</td></tr>
<tr><td>Carbon inventory (4)</td><td>1</td><td>1</td></tr>
<tr><td>Eco-labelling (7)</td><td>4</td><td>1</td><td>1</td><td>6</td></tr>
<tr><td>Public report publication (5)</td><td>1</td><td rowspan="2">0</td><td>1</td><td>2</td></tr>
<tr><td>Others (20)</td><td>13</td><td>4</td><td>10</td><td>0</td><td>1</td></tr>
</table>

Appendix P: Characteristics (seller & buyer), markets, export destinations and competitiveness

<table>
<tr><th colspan="7">Characteristics, markets, export destinations and competitiveness</th></tr>
<tr><th rowspan="3">Seller & buyer & markets & export destinations (quantity)</th><th colspan="6">Competitiveness</th></tr>
<tr><th colspan="3">Domestic</th><th colspan="3">International</th></tr>
<tr><th>+ (38)</th><th>- (4)</th><th>Neutral(17)</th><th>+ (30)</th><th>-(2)</th><th>neutral(8)</th></tr>
<tr><td>Domestic only (36)</td><td>14</td><td>N/A</td><td>7</td><td>4</td><td>N/A</td><td>1</td></tr>
<tr><td>MNC (13)</td><td>2</td><td>N/A</td><td>N/A</td><td colspan="3">N/A</td></tr>
<tr><td>Both markets (44)</td><td>24</td><td>4</td><td>8</td><td>23</td><td>1</td><td>6</td></tr>
<tr><td>Buyer: MNC (13)</td><td>7</td><td>N/A</td><td>1</td><td>7</td><td rowspan="4">N/A</td><td>0</td></tr>
<tr><td>Seller</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>own brand (9)</td><td>4</td><td>2</td><td>1</td><td>5</td><td>1</td></tr>
<tr><td>OEM (12)</td><td>3</td><td>N/A</td><td>4</td><td>5</td><td>2</td></tr>
<tr><td>Export destination</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Europe (30)</td><td>18</td><td>2</td><td>3</td><td>20</td><td>1</td><td>1</td></tr>
<tr><td>Japan (16)</td><td>8</td><td>N/A</td><td>2</td><td>10</td><td colspan="2">N/A</td></tr>
<tr><td>USA & Canada (28)</td><td>14</td><td>2</td><td>5</td><td>16</td><td>1</td><td>2</td></tr>
<tr><td>Australia & New Zealand (9)</td><td>5</td><td>1</td><td>1</td><td>6</td><td>1</td><td>N/A</td></tr>
<tr><td>Latin America (9)</td><td>5</td><td>1</td><td>1</td><td>5</td><td>1</td><td>0</td></tr>
<tr><td>Asia except Japan (29)</td><td>13</td><td>2</td><td>6</td><td>15</td><td>1</td><td>3</td></tr>
<tr><td>Africa (9)</td><td>5</td><td>1</td><td>1</td><td>5</td><td>1</td><td>0</td></tr>
<tr><td>International only (6)</td><td>N/A</td><td>N/A</td><td>2</td><td>3</td><td>1</td><td>1</td></tr>
<tr><td>Europe (30)</td><td colspan="3" rowspan="5">N/A</td><td>3</td><td>1</td><td rowspan="5">N/A</td></tr>
<tr><td>Japan (16)</td><td>1</td><td>1</td></tr>
<tr><td>USA & Canada (28)</td><td>3</td><td>1</td></tr>
<tr><td>Australia & New Zealand (9)</td><td>0</td><td rowspan="2">N/A</td></tr>
<tr><td>Latin America (9)</td><td>0</td></tr>
<tr><td>Asia except Japan (29)</td><td colspan="2" rowspan="4">N/A</td><td>2</td><td>1</td><td>N/A</td><td>1</td></tr>
<tr><td>Africa (9)</td><td rowspan="3">N/A</td><td>N/A</td><td colspan="2" rowspan="2">N/A</td></tr>
<tr><td>Buyer: MNC (13)</td><td>1</td></tr>
<tr><td>Seller: Own brand (9)</td><td>2</td><td>1</td><td>N/A</td></tr>
</table>

Appendix Q: Self-report results and comparative performance

Results and comparative performance						
Results (quan.)	eco-innovator	CPA		EMS		
		vol.	man.	ISO 14001	in-house	joint
reduced resource consumption (41)	10	23	8	9	7	16
environmental compliance (51)	13	32	9	12	8	23
increased energy efficiency (37)	12	24	8	9	6	19
reduced waste, pollutants (44)	11	28	9	12	7	21
reduced carbon emissions (17)	6	11	4	3	3	8
Comparative performance	eco-innovator	vol.	man.	ISO 14001	in-house	joint
better (37)	11	20	8	3	4	19
same (30)	3	12	6	13	4	5
worst (0)	0	0	0	0	0	0
uncertain (15)	0	3	1	1	0	1
Total number	**14**	**37**	**16**	**17**	**8**	**26**

Appendix R: CPA options, investment and savings

Options, investment and savings									
Options (quan.)	Item (quan.)			Investment (¥10,000)				Total savings (¥10,000)	
	max	med	min	max	med	min	total	per annum	audit period
low-cost (789)	45	24	8	72.1	12.6	0.3	403.34	895.93	60.62
high-cost (137)	10	4	2	3334	397	13.8	13101.01	4162.23	365.24
Total **(926)**				Total			**13504.35**	**5058.16**	**425.86**