

# Environmental Regulations, Innovation and Firm Performance: A Revisit of the Porter Hypothesis

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# **Environmental Regulations, Innovation and Firm Performance: A Revisit of the Porter Hypothesis**

## **Abstract**

This paper examines the relationships between environmental regulations, firms' innovation and private sustainability benefits using nine case studies of UK and Chinese firms. It aims to unravel the mechanisms by which a firm's environmental behaviour in improving its private benefits of sustainability is influenced by its relationship with the government, which primarily enacts regulations to maximise public sustainability benefits in the interests of society as a whole. This paper takes the cue from the Porter hypothesis to make some broad preliminary assumptions to inform the research design. A conceptual framework was developed through inductive case studies using template analysis. The results show that depending on firms' resources and capabilities, firms that adopt a more dynamic mindset to respond to environmental regulations innovatively and take a proactive approach to manage their environmental performance are generally better able to reap private benefits of sustainability.

**Keywords:** Environmental regulations; Flexibility; Innovation; Public benefits of sustainability; Private benefits of sustainability; Porter hypothesis

# 1. INTRODUCTION

Among various elements of corporate sustainable development (CSD), the issue of pollution prevention/control can be viewed as one way in which the government as a stakeholder in improving public benefits of sustainability is attempting to influence behaviour of firms in maximising their own private benefits of sustainability (Porter and van der Linde, 1995b). This is done by promulgating environmental regulations. Although there is a general consensus on the requirement for governmental legislation to regulate environmental responsibilities of corporations, there is still debate on how best governments can formulate regulations and how best corporations can use the regulatory requirements to improve their own performance (Porter and van der Linde, 1995a; Majumdar and Marcus, 2001; Orlitzky *et al.*, 2003; Bi *et al.*, 2014; Ford *et al.*, 2014; Debnath, 2015; Rubashkina *et al.*, 2015; Tanaka, 2015; Zhao *et al.*, 2015).

The main aim of this paper is about how public and private benefits of sustainability are affected by two prominent actors in the sustainability debate: the government and private firms. Governments aim to improve public benefits of sustainability (for example in the form of reduced pollution) by forcing firms to adopt sustainable practices through regulations, while firms attempt to maximise private sustainability benefits (for example, in the form of reduced energy/raw material consumption) that positively impacts their financial bottom-line. Regulations are a common form of governance structure (Williamson, 1999). The impact of environmental regulations on the financial performance of firms becomes a contentious issue surrounding the relationship between policy makers and firms. While a traditional view rooted in neoclassical economics would see regulations as damaging to business, albeit socially desirable, more modern perspectives suggest that, if properly designed, regulations can in fact improve firms' business performance by inspiring and enabling innovation to occur (Porter and van der Linde, 1995b; Porter and van der Linde, 1995a; Tello and Yoon, 2008). The ability of a firm to meet regulatory requirements and at the same time improve its overall performance is sometimes called a 'win-win' scenario or the Porter hypothesis (Porter, 1991). The Porter hypothesis is a key to understanding how the actions of governments and firms could improve public and private benefits of sustainability.

Recent insights from the field of industrial ecology have suggested that the design of regulations and other environmental variables are crucial factors in determining their potential to create win-win scenarios (Costa and Ferrao, 2010; Costa *et al.*, 2010). 'Flexible regulation' (also referred to as 'innovation friendly' and 'smart' regulation) has come to be seen as a crucial driver for a positive outcome for all stakeholders from environmental regulation (Majumdar and Marcus, 2001; Partzsch, 2009). Other work suggests that factors such as managerial attitude and the capacity of a firm to innovate are also important in determining the nature of the relationship between environmental regulations and business performance (Christmann, 2000; Iraldo *et al.*, 2009; Lopez-Gamero *et al.*, 2010). While such concerns were highlighted in the early discussions in this field (Porter and van der Linde, 1995b; Porter and van der Linde, 1995a), empirical work on the matter has only recently expanded in scope to consider these and other nuances. Thus the consideration of flexibility of regulations and innovativeness of firms in the design of environmental regulations and impact on financial performance is a significant research gap, which this paper attempts to address. In this research, improvements in environmental performance and consequent positive impact on financial performance are considered as the basis for improving public and private benefits of sustainability. Improved environmental performance (for example due to

effective design of products or processes) results in reduced environmental impact. This reduces negative externalities and consequently improves public sustainability benefits to the society as a whole. This pollution reduction is often the results of reduced consumption of energy and raw materials, which in turn improves financial performance by cutting costs of energy/raw materials, thus improving private benefits of sustainability to firms.

This study extends the previous literature and provides better articulation of the practical value of the Porter hypothesis in the area of corporate responsibility. This paper develops a conceptual framework, which contributes to the literature by extending from the Porter hypothesis with more comprehensive explication of the mechanisms representing the interplay between environmental regulations, innovation and financial performance of businesses. More specifically, this paper develops a framework to evaluate the current design of environmental regulations. Moreover, inspired by the dynamic capabilities view (DCV) of the firm (Teece et al., 1997), the conceptual framework better clarifies the differences in the ability of firms to respond to regulatory pressures dynamically and to innovate to achieve positive win–win outcomes that result in improvement of both public and private sustainability benefits.

The conceptual framework is derived empirically from the case studies using an inductive logic (see also in Eisenhardt and Graebner, 2007). Some broad a priori assumptions are first developed based on Porter Hypothesis. The intention is not to test these assumptions but to use them as guidelines for the case studies and as the starting point for further expansion of the Porter Hypothesis. Nine case studies in the UK and in China are then conducted to get deeper insights beyond these assumptions to the real business context. Implications both for policy makers involved in setting out environmental regulations and for firms implementing and managing them are discussed.

## **2. THEORETICAL FOUNDATIONS**

### **2.1 Environmental regulations – the Porter hypothesis**

Generally, environmental regulations are critical in limiting the potentially harmful effects of economic activity on the natural environment. However, regulations can impose a very significant cost on businesses (Gray and Shadbegian, 2003; Filbeck and Gorman, 2004; Blackman *et al.*, 2010). The conventional wisdom exhibited throughout the 1970s and 80s was that while regulations might be desirable from a broader social perspective, the impact on business would be negative, as firms are forced to internalize environmental costs that had previously been ignored (e.g., Gollop and Roberts, 1983; Barbera and McConnell, 1990).

To rectify the seemingly paradoxical relationship between environmental regulation and firms' financial performance, a growing number of researchers have highlighted the argument of Porter (1991). Porter (1991) advocated that environmental regulations, rather than uniformly penalizing all firms, can in fact provide an opportunity for some firms to become more competitive and ultimately to improve their financial performance. He referred specifically to competitiveness in international markets and drew largely on anecdotal evidence from the experiences of three countries in particular (Japan, Germany and the United States). Porter developed his ideas further, with more focus on the individual business

level, in two subsequent papers published with Claus van der Linde (Porter and van der Linde, 1995b; Porter and van der Linde, 1995a). These papers argued that regulations, if properly designed and incorporating an appropriate level of flexibility, can help improve the performance of a firm. This is because properly designed regulations may induce cost-saving innovation that more than compensates for the cost of compliance. The idea that environmental regulations can improve a firm's environmental and financial performance via their impact on innovation has become known as the Porter hypothesis or the win-win hypothesis (Ambec and Barla, 2006).

Porter hypothesis has been tested in several studies but these tests have shown mixed results. Evidences were gained that compliance with regulations can be lowered financial returns of firms (Filbeck and Gorman, 2004), with positive impact (Zhu et al., 2007) or no clear relationship at all (Triebswetter and Hitchens, 2005). Similarly, results have been mixed when studying the impact of regulations on innovation (Jaffe and Palmer, 1997; Sanchez and McKinley, 1998). There are evidences with no clear impact on innovation (Jaffe and Palmer, 1997), with positive impact (Brunnermeier and Cohen, 2003; Horbach, 2008), or with negative impact (Walker et al., 2008).

Only a very few studies have sought to examine the relationship between these three constructs (regulations, innovation and performance) simultaneously (Montabon *et al.*, 2007; Eiadat *et al.*, 2008; Triebswetter and Wackerbauer, 2008; Lopez-Gamero *et al.*, 2010; Ramanathan *et al.*, 2010). Triebswetter and Wackerbauer (2008) found that environmental regulation did not improve performance, nor did it significantly harm it, based on a qualitative case study analysis of 14 German firms. They conclude that regulation is only one of the many drivers of innovation, and the effects of regulation-driven innovations on competitiveness are similar to those of innovations motivated by other pressures. Using data from firms in Jordan, Eiadat et al. (2008) investigated the mediating effect of environmental innovation on the relationship between regulations and economic performance. They found strong support for the Porter hypothesis. Black et al. (2010) investigated the moderating effect of innovation on the relationship between regulations and economic performance in each of these areas in the UK. They found that innovation positively moderates the relationship in the case of more flexible regulations but not in the case of less flexible regulations, implying that there is an important role played both by the design of regulations and the capability of the regulated (i.e. firms) to innovate.

A careful examination of the prior work indicates that a main contributory factor leading to the inconclusiveness of the tests undertaken to verify the Porter hypothesis is that they are not sufficiently sophisticated. The prior work has largely failed to consider in their approaches, and hence analyse, the two conditions that Porter and van der Linde explicitly identified as being necessary for the positive impact of environmental regulations on business performance. These are (1) the design of sufficiently flexible regulations, which is an issue for government; and (2) the willingness of the regulated firms to respond 'dynamically', which is an issue for firms. This paper tries to fill this gap by emphasizing these two conditions and attempt to verify the feasibility of the Porter hypothesis using empirical evidence from UK and Chinese businesses.

## **2.2 Condition 1: The design of environmental regulations**

The design of environmental regulations is of crucial importance. As Williamson (1999) has argued, regulations are a form of governance structure, usually combining elements from the extremes of market and hierarchy. The market mode is characterised by high-powered incentives with little administrative control while the hierarchy combines low-powered incentives and excessive administrative control. Regulations could be considered as a hybrid structure combining elements of market and hierarchy.

Only a handful of studies have sought to incorporate the role of design of regulations into the empirical effort (e.g., Majumdar and Marcus, 2001; Crotty and Smith, 2006; Partzsch, 2009; Costa *et al.*, 2010; Lopez-Gamero *et al.*, 2010) on Porter hypothesis. Regulations need to be ‘innovation friendly’ (i.e. with flexibility as a central tenet underpinning innovation) (Majumdar and Marcus, 2001). Following Majumdar and Marcus (2001), environmental regulations are classified into two categories: flexible and inflexible. Flexible regulations are innovation friendly in encouraging firms to develop appropriate new processes/products to meet regulatory requirements, whereas inflexible regulations prescribe specific processes/products to achieve a particular outcome. Looking at Williamson’s (1999) view above, flexible regulations have higher levels of market governance while inflexible regulations are dominated by elements of hierarchical governance.

If environmental regulations specify that any company wishing to produce a particular product or substance must use a certain technique to reduce its pollution, then the company is forced into paying for the pollution control equipment. Examples of such inflexible regulations are the air and water pollution regulations in the US prior to 1990 as demonstrated by Majumdar and Marcus (2001). Majumdar and Markus (2001) have illustrated that these regulations have forced polluters to conform to pre-specified standards or else face closure. Obviously, this kind of inflexible regulations do not encourage creativity and innovation in firms: any desire to innovate and to develop new techniques that are less harmful is nullified.

On the other hand, flexible regulations specify only the desired outcome but leave the process of achieving the outcome to individual firms so that these firms can choose the best way to achieve the outcome. Majumdar and Marcus (2001) have demonstrated that the solid waste regulations in the US are examples of flexible regulations in that these regulations have allowed certain discretion to deal with the issue of solid waste pollution subject to achieving the challenging pollution prevention goals. More recent regulations such as the the European Union-wide greenhouse gas Emissions Trading Scheme (EU-ETS) Regulations 2003/05 could also be classified as flexible because these regulations set an overall cap on the permissible levels of emissions, and then grants permits to businesses for trading (Zhang and Wei, 2010). If environmental regulations specify that emissions of a certain pollutant must not exceed a given concentration, then it is up to the firm as to how to achieve the desired level of pollutant emissions. The firm might continue with their old techniques and simply purchase additional end-of-pipe equipment in order to meet the targets. In contrast, a proactive firm might attempt to redesign the process altogether so that such end-of-pipe pollution abatement expenditure is avoided. This can also result in a source of competitive advantage for the firm, not only in terms of reducing operating costs but also in terms of green marketing leadership (Hart, 1995).

Thus environmental regulations with a high degree of flexibility afford firms a certain level of operational autonomy, helping them to decide whether they prefer to be dynamic and innovative, or to be reactionary and rely on conventional tactics (Haughton and Browett,

1995; Lopez-Gamero et al., 2010). On the other hand, if regulations are inflexible, firms' attempts to develop innovative solutions are likely to be stifled, restricting them to much less value-adding legislative requirement compliance approaches. As a consequence, they may not be able to develop market-leader capabilities in environmental practices even if they are highly motivated to do so.

## **2.3 Condition 2: Firms' capabilities and innovation**

The other major element in the Porter hypothesis is based on the behaviour of firms in terms of how they choose to respond to environmental regulations or other pressures to improve their environmental performance. If regulations are flexible enough firms can choose to adopt a dynamic approach (Wu et al., 2012), which seeks to improve their environmental performance via (1) the redesigning of polluting production processes; (2) the adoption of environmental management practices such as energy conservation and waste management; and (3) strategically positioning themselves as a leader in environmental protection. Alternatively, they might choose to carry on as before, paying increasing taxes and levies resulting from the regulations, and/or implementing costly end-of-pipe solutions.

In general, if the firm has a 'dynamic mindset' flexible regulations could provide opportunities for innovation, which in turn would improve financial performance. This paper draws on the literature on innovation strategy (Li and Atuahene-Gima, 2001; Cassiman and Veugelers, 2006) to define dynamic mindset as the firm's capabilities to reconfigure its internal and external resources and competencies to deal with changing environments (e.g., Teece et al., 1997). Here the environment changes are triggered by new or modified environmental regulations.

The dynamic approach is supported by the dynamic capabilities view (DCV) of the firm (Teece *et al.*, 1997; Eisenhardt and Martin, 2000). This theoretical paradigm suggests that 'the competitive advantage of firms is seen as resting on distinctive processes (ways of coordinating and combining), shaped by the firm's (specific) asset positions (such as the firm's portfolio of difficult-to-trade knowledge assets and complementary assets), and the evolution path(s) it has adopted or inherited' (Teece et al., 1997, p. 509). Such processes enact a firm's capabilities, which include a firm's organizational skills and ability to innovate. In this view, having the ability and willingness to develop innovative solutions, as well as the flexibility in management systems necessary to implement such solutions, can be considered as valuable capabilities. Firms with these capabilities will be able to use well designed regulations as an opportunity to deploy and reconfigure their resources to develop a competitive advantage.

Several studies, although limited in number, have investigated the strategic choices of firms to respond to environmental regulations and generally support the view that firms deploying their resources in a proactive manner will benefit more from, and be able to cope better with, the requirements of environmental regulations (Klassen and Whybark, 1999; Christmann, 2000). Such proactive environmental strategy is characterized as a dynamic capability by Aragon-Correa and Sharma (2003).

Overall, although little academic work has incorporated considerations of both the regulatory design and the capabilities to innovate (i.e. the two conditions of the Porter hypothesis) simultaneously, the available literature indicates that both of these factors are important

(Janicke, 2008; Black et al., 2010; Lopez-Gamero et al., 2010). This paper stresses the importance of the two conditions of the Porter hypothesis that underpin the relationship between environmental regulations, innovation and financial performance of firms.

### **3. BROAD A PRIORI ASSUMPTIONS**

Emphasizing the two conditions of the Porter hypothesis, this paper developed some broad a priori assumptions on the nature of the relationships between environmental regulations and other drivers of environmental innovation, environmental management practices (EMPs) and firm financial performance. In this context, several links between regulations, innovation and financial performance are evident from the literature presented in the previous section.

Specifically, (1) inflexible regulations force firms to spend money on pollution-control measures without giving them the opportunity to innovate – ultimately harming their financial performance; (2) more flexible regulations, along with other pressures that exist to improve environmental performance, provide firms with the opportunity to respond with a dynamic mindset, and help them to innovate and invest in sound EMPs, potentially improving their financial performance while simultaneously improving their environmental performance; (3) alternatively, firms can take a reactionary attitude and improve their environmental performance via costly pollution-control methods that ultimately harm their financial performance (Haughton and Browett, 1995; Klassen and Whybark, 1999; Christmann, 2000; Majumdar and Marcus, 2001; Black *et al.*, 2010; Lopez-Gamero *et al.*, 2010).

This paper now seeks to address how appropriate are these broad a priori assumptions for thinking about environmental regulations and their effects on regulated firms. The evaluation was undertaken via a qualitative case-study methodology in nine firms in the UK and China.

### **4. RESEARCH METHOD**

According to Eisenhardt (1989) building theory from case studies is especially appropriate in new topic areas. Rich information generated from case studies can usually produce testable novel theories (Eisenhardt, 1989). Given the relative complexity of the broad a priori assumptions, case studies were chosen as the appropriate methodological basis (Eisenhardt, 1989; Ketokivi and Choi, 2014). Moreover, to ensure the propositions of this paper are theoretically generalizable to a wider international context, case studies were conducted in both the UK and China, so that case companies will come from two typical countries from the Western (UK) and the Eastern (China) part of the world, and also from a developed (UK) economy and an emerging economy (China) (c.f., Zhu *et al.*, 2003; Ozsomer and Simonin, 2004).

Albeit the differences in detailed regulations, businesses in both countries are nowadays subject to increasingly significant environmental regulations. Especially for China, taking more and more responsibilities of global climate change and environment protection, its government is introducing increasingly stringent regulations.

This study followed an inductive approach. Based on the suggestions of Eisenhardt (1989) this study adopted theoretical sampling (where cases are selected for theoretical, not statistical, reasons). Thus in line with inductive logic, the choice of the case companies was

based on a thorough understanding of the nature the business and relevance of the business to the research theme to ensure the cases selected were capable of extending the emergent theory based on the Porter hypothesis.

First, a case study protocol was developed based on the broad a priori assumptions, which specifies the case company selection criteria and a set of interview questions (see Appendix A). Coarse grained selection criteria were agreed between the authors, so that 1) case firms are typical or major market players, and they should all have sustainable development on their agenda either incorporated in their corporate strategies or embedded in their production processes; 2) case firm are regulated by various environmental regulations, and the environmental regulations should have direct impact on their businesses; 3) R&D and innovation are essential for case companies' competitive advantage, with environment protection as a major key performance indicator for innovation.

Second, 170 UK companies and 100 Chinese companies were initially identified using the FAME database (UK) and Mingluji and Chinainfo databases (China) by two co-authors following the coarse grained criteria.

Third, finer grained shortlist criteria were agreed between the authors, so that 1) sustainable development strategy of case companies are explicit and is available in the public domain; 2) case companies should have explicit strategies for R&D innovation and are leading players in its own sector or region; 3) case companies should be subject to a range of environmental regulations locally or nationally. 11 UK companies and 10 Chinese companies were then shortlisted based on a second stage screening by the co-authors, so that non-comparable companies were removed from the list. Telephone or email invitations were sent via the contacts identified through the FAME database, Mingluji.com, and Chinainfo.org. Eventually, 5 UK companies and 4 Chinese companies agreed to participate in the case studies. The rest of the authors independently checked case companies' profiles to make sure they met the selection criteria. In this process, triangulation using secondary information sources, such as news reports, company websites, companies' annual reports, and government announcements, was used.

Fourth, following case-study approaches in the literature (e.g., Chen and Li-Hua, 2011), in-depth interviews with these companies were conducted between September 2009 and July 2014. Senior managers or managers involved in the sustainability agenda within their company were identified as interviewees. The interviewees had specific responsibilities related to environmental management or environmental management is embedded in their roles. At least one interview was conducted for each organization. All the respondents were managers at the strategic or senior/middle management level, with substantial management experience.

Although case study companies operate in very different sectors and in two different countries, for all of the case companies environmental regulations are becoming increasingly stringent and have the potential to impact on their business operations and competitive position. Thus the case companies have rich experience in dealing with environmental regulations or in developing innovative ideas in response. Their experiences were used as the basis in developing a conceptual framework and in drawing implications from the data for both policy makers and managers.

To be noticed, although the sample size of nine case-study companies could limit the empirical generalizability of the study, given the inductive nature of this study, the insiders' views generated from the interviews with experienced senior managers formed a good basis to inform effective policy design. Further, though many studies reported in the scientific literature generally use a larger sample size, there are also several studies that have used smaller sample sizes (Dobrov, 1978; Storper *et al.*, 1981; Angel and Rock, 2005; Chen and Li-Hua, 2011). According to Eisenhardt (1989) four to ten cases are the norm of the inductive case-study approach. Too many cases may, on the other hand, increase the difficulty for researchers in coping with the complexity and volume of data.

## 4.1 Data collection and analysis

Two versions of interview questions have been developed, in English and in Chinese, following a translation–back–translation process (Maxwell, 1996). Prior to conducting the main interviews, the questions were pilot tested with academics and a few people from the industry, and corrected some of the questions based on feedback from the pilot interviews. The main interviews were semi-structured to maximize interaction with interviewees. 14 interviews (6 from UK companies, and 8 from Chinese companies, see also in Appendix B), lasted between 45 minutes and an hour, were conducted face to face or through telephone. At the beginning of the interview, interviewees were briefed the context of the study and the definitions of flexible and inflexible environmental regulations. The interviewees were assured that their responses would be treated in an anonymous and confidential way. Each interview was recorded using a digital voice recorder and transcribed. The Chinese transcriptions were translated into English following a translation–back–translation process. Transcriptions were read and cross-checked by two of the authors, and then sent to the interviewees for validation. Necessary corrections were made according to interviewees' feedback.

Following validation, a template analysis was conducted with the interview transcripts with the assistance of NVivo 8 software (King, 2004). First, based on the broad a priori assumptions and the case-study protocol, two of the authors identified the main concepts independently to construct an initial template (see Table 1). Since the initial template was broad enough, the concepts identified by the authors were largely consistent despite the occasional issue having been extracted by one but not the other author.

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Insert Table 1 about here  
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This initial template was then used as the starting point and a guide for an in-depth analysis of the interview transcripts through the NVivo software by one of the authors. Initial codes were added to the interview transcripts based on the main concepts identified in the initial template. These codes were further refined to identify new emerging concepts for the development of the final template. This was an iterative process involved revising the initial template through adding new codes, removing existing codes and moving concepts from one coding area to another, while reviewing the detailed quotations of the interviewees. Towards the end of this process the second author was asked to evaluate the relevancy of the emerging concepts. The final template (see Table 2) was achieved when no new concepts emerged and both authors were confident that the emerging themes were exhaustive and were supported by relevant quotations.

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The authors then evaluated the final template collectively and assessed the nature of the relationships between environmental regulation, innovation and financial performance from the cases. The concepts and preliminary findings were cross-checked with secondary information from relevant documents of the case-study companies (e.g., annual reports and companies' websites corresponding to the case study period (September 2009 to July 2014)) and also using external sources such as newspaper articles, editorials, government announcements, and online reports during this period. Annual reports and third-party databases, such as the FAME database, were used to obtain financial data of case-study companies.

## **5. RESULTS**

This section discusses the findings, examines the extent to which they are commensurate with the broad a priori assumptions and identify notable variations to formulate the conceptual framework.

### **5.1 An overview of case study companies**

Qualitative research methodology requires a detailed analysis of case study companies, which forms the basis for within-case analysis (Eisenhardt, 1989). Accordingly, an overview of the nine case study companies was presented in this section. The details are also available succinctly in Appendix B.

CHEM Co. is a chemical company manufacturing construction chemicals, pest control solutions, polyurethane systems, industrial coatings, pigments and products that enhance industrial processing in various industries. The company employs nearly 2,000 people for its operations in the UK and Ireland. In 2011 the turnover of its operations in the UK and Ireland reached over £2 billion. The company has sustainability and social responsibility as an important agenda. According to the company's recent annual report, CHEM Co. combines economic success with environmental protection and social responsibility through science and innovation. The company's share has been included in the Dow Jones Sustainability World Index for more than ten years in succession. Over €1 billion have been invested in R&D each year. Although the company regards sustainability through innovation as a major driving force for business growth, another focus of the innovation is to fulfil increasingly strict regulations as indicated in its recent annual report. CHEM Co. anticipates increasing regulation risks due to the cost-intensive regulative procedures. The interviewee highlighted Control of Major Accident Hazards (COMAH) regulations, the Carbon Reduction Commitment regulations and the Waste Electrical and Electronic Equipment Recycling (WEEE) regulations, though the interviewee also mentioned that the firm was subjected to most environmental regulations.

ELEC Co. is one of the UK's largest energy suppliers of electricity and gas to residential and business customers. It is considered a manufacturing company because it produces electricity and is affected by regulations similar to those of other manufacturing companies. It is also one of the largest producers of low-carbon electricity and nuclear power in the UK. The UK operation of ELEC Co. has a turnover of over €9 billion. Part of the company's mission is to bring low-carbon energy to customers, so sustainability is a major agenda of its strategy. The company regards economic viability as important to its environmental and social viability, and has developed a systematic agenda of sustainability commitments. Such commitment is to be realized through reducing carbon emissions and improved waste management, and developing better relationships with customers, employees and local communities. Innovation is reportedly playing an important role in ELEC Co.'s sustainable development strategy. ELEC Co.'s R&D ambitions focus on consolidating and developing a carbon-free energy mix, fostering flexible and low-carbon energy demand, and providing smarter energy management systems. Because energy production and consumption are under stringent monitoring from regulators and various stakeholders, compliance to numerous regulations is essential for the operations of the company. This also makes the company very sensitive to environmental regulations and policies. During the interview, the interviewee highlighted that the firm was subjected to nearly 260 environmental regulations and specifically mentioned the following: Radioactive Substances Act 1993 governing nuclear plants, Production Prevention and Control (PPC) Regulations (Now Environmental Permitting Regulations, 2007), EU Emissions Trading Scheme, Packaging (Producer Responsibility) Regulations, and the Waste Electronic and Electrical Equipment Regulations.

RAIL Co. is a world-leading manufacturer of rail vehicles and related products, such as propulsion and controls equipment, transportation systems and rail control solutions. The company highlights the importance of corporate social responsibility and sustainable development, which is incorporated into its corporate strategy. Innovation is seen as the driving force of RAIL Co.'s business growth, while developing safe, efficient and environmentally responsible products is regarded the central target of its product innovation. RAIL Co. also highlights the importance of collaboration with its supply-chain partners and various stakeholders to develop its business responsibly. The company is aware of the increasingly stringent environmental regulatory requirements or enforcements, and may incur additional costs in order to be compliant with such requirements or enforcements. This also makes the company very careful in dealing with safety and environment related issues in its business operations. During the interview, the interviewee mentioned a long list of regulations affecting the firm, including Local Air Pollution Prevention and Control (LAPPC) regulations, the Packaging Waste Regulations 1997, hazardous waste regulations, Environmental Protection Act Section 34 – duty of care, the environmental permitting regulations, the control of pollution oil storage regulations, the Water Industries Act, and the fluorinated gases regulations.

SUPR Co., headquartered in London, is engaged in manufacturing and developing innovative and practical high-temperature superconductor (HTS) applications around the world. The company is publicly listed with a turnover of over £2 million in 2010. The company develops a number of energy applications for use in renewable energy power generation, energy distribution and large-scale energy-intensive industrial processes. Thus the company emphasizes the importance of innovation to its competitive position and invests a significant proportion of its revenues in R&D activities. A substantial amount of its R&D investment actually comes from large government grants, which are normally policy driven. For this reason, the business of SUPR Co. can be significantly affected by governmental regulations

and policies. The company relies on a sustainable production process as a key to its competitive advantage, which enabled the company to win major innovation and environmental prizes for sustainable production technology from various governmental bodies. The interviewee mentioned that the firm faced regulations similar to other comparable businesses but did not highlight any regulation in particular.

TEL Co. is a UK based subsidiary of a large Chinese private ICT company, which offers range of new generation end-to-end telecoms and IT network solutions to mobile and fixed line operators and providers of enterprise networks. It also have a product portfolio ranges from wireless products, smart phones, mobile broadband products to various data communication products. It has 15 offices across the UK and with nearly 1,000 employees for its UK operation. Being a UK based Chinese company means that the company has to meet the environmental performance standards of both European Union, and China. Despite that the company has taken a proactive approach to meeting the most stringent environmental regulations across nations to ensure company is free from future sanctions caused by rising standards. The company is keen to develop and adopt innovative ideas and also to collaboration with various stakeholders to reduce carbon emission and improve energy efficiency of its products. As indicated by the interviewee, the company is subject to most of the UK and EU environmental regulations. In addition it is also subject to Chinese regulations such as the Environmental Protection Law of China, the Cleaner Production Promotion Law (CPPL), the Energy Saving Law, as many of its products are sourced from China.

TEX Co. is one of the leading Chinese textile and garment material companies based in Zhejiang province in China. The products of TEX Co. range from textile materials, garment components, and a whole range of small consumer products and appliances, which are exported to around the world. The company has over 3,000 employees and an annual turnover of over 4 billion RMB. The company originated from a traditional labour intensive manufacturing sector. However, the company is nowadays putting more and more effort in improving sustainable performance of its operations, thanks to the increasingly stringent local regulations and also the raising environmental requirements from purchasers from around the world, especially those from North America and Europe. In recent years, the company has invested heavily in reducing environment impact of its manufacturing operations to meet various environmental requirements locally and internationally. Compare to other local companies, the company is getting more aware of the up-to-date local and international environmental requirements while dealing with local government agencies and international clients. TEX Co. is cautious about the sustainable challenges faced by the company and is taking more and more strategic considerations to improve its environmental performance to secure higher growth rate. Since the company is operating in a traditional sector, it has to comply with increasingly stringent regulations such as, the Air Pollution Prevention Law, the Water Pollution Prevention Law, the Cleaner Production Promotion Law (CPPL), which enforces more specific standards and guidance notes enacted by Chinese Ministries, such as Emission Standard for Industrial Enterprises Noise at Boundary, Cleaner Production Standard (sector specific), and the relatively newly introduced Corporate Environmental Credit Evaluation (Trial).

CHXIN Co. is a family own small and medium sized pharmaceutical company established in the early 1990s based in Henan province, China. Products of CHXIN Co. range from traditional Chinese medicine patent prescriptions to herbal medicine materials. The company not only sources its raw medicine materials nationally and from overseas suppliers (India

being the most important source), but also sources from its own herbal plantation field of about 165 acres. The production of the company is mainly regulated by the China Food and Drug Administration which enforces Good Manufacturing Practices (GMP) certification. The GMP renews every 5 years with updated standards and imposes guidelines of minimum requirements that a pharmaceutical or a food product manufacturer must meet to assure that the products are of high quality and do not pose any risk to the consumer or public. Minimizing environmental impact is also one important aspect of the GMP certification. The company is also subject to the Corporate Environmental Credit Evaluation (Trial), which is a new regulatory guideline that imposes more explicit responsibilities and penalties for incompliance of environmental regulations. In addition, since the company has experienced fast expansion since 2005 with newly established manufacturing plant, the company has to meet the requirements of the Environmental Impact Assessment (EIA), which enacts various environmental regulations, such as Emission Standard for Industrial Enterprises Noise at Boundary, Integrated Emission Standard of Air Pollutants, Cleaner Production Standard (sector specific), and Integrated Wastewater Discharge Standard, in order to commence its manufacturing during this period. Despite external requirements, the company is actively adopting closed-loop manufacturing, for example to recycle and reuse herbal residues into manufacturing process or into generating related by-products.

KLUN Co. is a large Chinese pharmaceutical PLC headquartered in Sichuan province, China. The company is listed in the Shenzhen Stock Exchange with 87 subsidiaries throughout China. KLUN Co. is specialized in manufacturing and sale of 562 different products including IV solutions, lyophilized, sterile powders for injections, small volume parenterals, etc. With its own research institute, the company has invested heavily in R&D, including developing environment friendly IV solutions. In addition to GMP certification, which is compulsory for all pharmaceutical companies, the company has acquired various other certifications, including ISO9000, ISO18000, and Environmental Management Standards ISO 14000. The company has to comply with the Air Pollution Prevention Law, the Water Pollution Prevention Law, the Cleaner Production Promotion Law (CPPL), which enforces more specific standards and guidance notes enacted by Chinese Ministries, such as Emission Standard for Industrial Enterprises Noise at Boundary, Cleaner Production Standard (sector specific), and the newly introduced Corporate Environmental Credit Evaluation (Trial) like other pharmaceutical companies in China. Due to its size and relatively sufficient funding sources, the company can afford investing in developing various environmental solutions in its products and manufacturing processes.

OIL Co. is a large edible oil company based in Henan province, China with an annual production capacity of 700,000 tons and an annual turnover of 9 billion RMB. The company source its main raw material, i.e. soybean, worldwide. Its main products include edible oil, soybean meal, and Soybean Lecithin which are sold nationwide. The production of edible oil employs hot pressed method relying on coal burning boiler, which is the main source of pollution of OIL Co.'s production. The company is subject to the Air Pollution Prevention Law, the Water Pollution Prevention Law, the Cleaner Production Promotion Law (CPPL), and those more specific standards and guidance notes, such as Emission Standard for Industrial Enterprises Noise at Boundary, Integrated Emission Standard of Air Pollutants, Cleaner Production Standard (sector specific), and Integrated Wastewater Discharge Standard. However, according to the interviewee that the company has adopted current technologies to increase production efficiency and to reduce carbon emissions, thanks to its investment into heat recycling and emission control technologies and the increasingly stringent governmental

regulations on environmental control. Due to the nature of its products, majority of its materials and residues can be recycled and reused into generating other profit making by-products. However, how to reduce environmental impact as required by tougher and tougher governmental regulations is still a challenge facing the company.

Overall, all 9 case-study companies have sustainable development on their agenda, which is either incorporated in their corporate strategies or embedded in their production processes. R&D and innovation are essential for all case companies' competitive advantage. They all invest significantly in innovation, with environment protection as a major key performance indicator for innovation. Although they operate in very different sectors, environmental regulations are becoming increasingly stringent for all of the companies and have the potential to impact on their business operations and competitive position. Moreover, the case companies all have rich experience in dealing with environmental regulations and in developing innovative ideas in response. Their experience was used as the basis in developing a conceptual framework. Implications were also drawn from the data for both policy makers and managers. The cross-case analysis, where the themes/concepts presented in Tables 1 and 2 are compared using the interview results of the case companies, is discussed in the following sections.

## **5.2 The impact of environmental regulations on innovation and the adoption of EMPs**

It was found that environmental regulations affect innovation and the adoption of EMPs through a wide variety of mechanisms in the UK and in China. The influence of regulation can be either positive or negative. For instance, environmental regulations can alter the incentives offered to companies. Increasing costs of energy or waste disposal, for example, mean that energy saving and waste-reduction measures are increasingly attractive. The interviewee from SUPR Co. discussed an instance of process redesign to reduce the production of hazardous waste, the disposal of which is closely regulated, thereby making the company financially more competitive.

*“... we had managed to eliminate one of the interim processes, and in that interim process you would produce ...hazardous materials...that's great for us because we are avoiding the need, unlike our competitors, to produce this toxic material. That's also beneficial for us because if you reduce the toxic material you don't have to pay to handle it, or pay to clean it up, or pay to exhaust it in a certain way, which we avoid. So we have cost savings in our manufacturing base.”*

On the other hand, this is also example of poor regulatory design preventing improved environmental behaviour and resulting in increased financial and administrative cost for the firm. The interviewee from RAIL Co. pointed out that with some regulations, the administrative burden of simply complying with the regulation was so high that it made improving the company's environmental performance in that area an entirely secondary activity.

*“The absolute bottom line is that we could get prosecuted if we do not pay the right amount of Packaging Recovery Notes (PRN), therefore our priority for today is to gather the right data to calculate the amount of PRN we have to buy. And unfortunately that is all I have time*

*for, the time I'm spending calculating that tax, means that I am not able to spend that time speaking to our major suppliers and try to get them to reduce our packaging.”*

The same concern was expressed by interviewee from CHXIN Co.:

*“Year on year there are new standards introduced by the China Food and Drug Administration (CFDA) or the Ministry of Environmental Protection (MEP). Normally, the new standards are higher standards for environmental protection. We will have to improve our processes and standards in response. Normally the new standards are achievable, but sometimes new testing facilities will have to be installed. The production process may not be affected much. However, the testing facilities will be affected. For pharmaceutical industry, the cost on testing is enormous, sometimes beyond your imagination. Much more training is also needed for that.”*

Given there is constant updates of regulatory standards, the company has to dedicate extra resources to cope with the inspections.

Moreover, environmental regulations can indirectly affect innovation by altering the other pressures that can lead to environmental innovation and the adoption of EMPs. For instance, regulations can encourage the adoption of EMPs by ensuring a more level playing field: by ensuring certain minimum standards it is possible for companies to engage in environmentally responsible ways of doing things without worrying about being undercut by less environmentally conscientious competitors (e.g., CHEM Co., TEL Co., KLUN Co.). Thus, even an environmentally less pro-active firm can engage in innovations in the presence of appropriate environmental regulations.

It was also found that some companies undertake innovative voluntary actions to improve their environmental performance as a pre-emptive response to the possibility of regulations being introduced in an attempt to weaken future regulations (e.g., CHEM Co., TEL Co., and KLUN Co.) or to avoid any future surprises by sudden increase of standards (e.g., TEX Co. and CHXIN Co.). Despite being wasteful on resources (in terms of taking extra actions not necessarily needed to satisfy the current regulation) in setting higher internal standards, these voluntary innovative pre-emptive responses were commonly adopted by companies. Regulations have also encouraged some firms to have formal innovative systems in place to collect and analyze environment-related data (e.g. RAIL Co. and KLUN Co.).

### **5.3 Other determinants of innovation and adoption of EMPs**

The interviewee from ELEC Co. pointed out that the firm's environmental practices were not driven by regulations but by the firm's own sustainability agenda, which formed part of the strategic repositioning of the company. Clearly regulations do not play too much of a part in such a decision. Examples can be found in CHEM Co., and TEL Co. that environmental management practices not being driven by any particular regulations, but by the fact that a myriad of regulations exist that vary across different countries and regions of the world. The interviewee from both CHEM Co. and TEL Co. suggested that as a multinational business the administrative burden of working to several different sets of environmental regulations would be so great that they thought it an easier approach to simply follow the same high environmental standards in their business anywhere in the world. As the interviewee from TEL Co. suggested,

*“legal requirement is the bottom line. But we are put higher standard than that.”*

Similarly, the interviewee from CHEM Co. said,

*“One of the practical issues we have that actually steps us away from legislation, is to try and get the finer points of the legislation complied with; it's a problem because obviously it depends on where you are, both sometimes regionally as well as nationally. Therefore we've tended to have our own quite high standards and work on the principle that we're probably a better standard than anything there is within the legislation. It's actually an easier way of dealing with things from a management perspective than it is worrying about what the legislators and local enforcers are going to ask for.”*

These examples support the use of global standards for environmental performance and agrees well with similar findings from the literature (Angel and Rock, 2005).

With the growth of environmental awareness, economic pressures have come to be a major driver of the adoption of EMPs by firms, since it is believed that such strategies reduce costs and improve competitiveness (Hart and Dowell, 2010). As discussed earlier, regulations that increase the cost of energy as well as the cost of pollution can increase the return on EMPs further (e.g., Ramanathan and Akanni, 2015).

Some case companies particularly saw their companies as wishing to position themselves strategically as environmentally friendly companies, with a view to increasing market share in the long term as the environmental consciousness of consumers grows and environmental standards are continually strengthened (e.g., CHEM Co., TEL Co., KLUN Co.). For example, KLUN Co. is proud of being the market leader in innovating and producing environmental friendly large volume injection packaging products, because it sees the huge market potential. TEL Co. highlighted that its new development in energy efficient data transmission devices are becoming unique selling points to its clients. Most case companies have suggested that customers were the driving force behind companies' moves towards greener products. To the extent that regulation affects customer demands for greener products, this suggests another way in which environmental regulations can lead to innovation, albeit indirectly.

## **5.4 The impact of firms' capabilities on their responses to regulations**

In addition to those other determinants mentioned above, the respondents highlighted that whether the firm will follow a dynamic or proactive approach of EMPs, or adopt a reactive approach to simply comply with regulations, also depended upon the firm's internal resources and capabilities. CHEM Co., for example, is able to position itself ahead of other competitors in EMPs mainly because of its capabilities to deploy and reconfigure excessive expertise and knowledge as well as financial resources. The existence of formal environment management roles in the organization also enabled the firm to adopt EMPs more proactively. The similar situation happens in KLUN Co.. As a plc, KLUN Co. can afford its own research institute which will generate or promote new state of the art technologies. On the other hand, smaller companies like CHXIN Co. is unable to adopt more advanced low-emission technologies simply because those options does not balance the book, despite being a proactive and environmental conscious firm. As the interviewee from CHXIN Co. suggested,

*“We have even considered using solar energy to replace traditional electricity. But think about the cost and the life cycle of solar panels. It is still expensive to us. We considered installing solar panels to our manufacturing plants. We can consume directly and also transmit excessive energy into the main power frame. But we know it will be a very good practice. For example, the solar panels on roof top can reduce the temperature of the plant when it is in operation; you know it is very hot especially in the summer. But the investment on solar panel is massive.”*

However, it is not just the availability of tangible resources, but whether firms are environmentally conscious, strategically ready, and is able to reconfigure their existing resources, that will also make a difference to whether firms adopt a proactive approach to EMPs. The proactive environmental strategy adopted by the firm enacts a dynamic capability response to environmental regulations (Aragon-Correa and Sharma, 2003). Actually, almost all case companies have reportedly to have voluntarily set higher environmental standards than what is required by relevant regulations to avoid possible violations. Such strategy is undoubtedly backed up by extra tangible or intangible resources and capabilities deployed by the case companies.

## **5.5 The impact of innovation and the adoption of proactive EMPs on firms’ financial performance (private benefits of sustainability)**

Clearly, some of the EMPs discussed with the interviewees have a beneficial impact on firms’ financial performance (private benefits of sustainability to firms). Increasing energy efficiency or redesigning production processes to produce less hazardous waste can produce a very tangible financial benefit. Some case companies had taken this to the extreme by using the waste products of some of their production processes as inputs to others, minimizing the amount of waste and transportation and maximizing their energy efficiency (e.g., CHEM Co., CHXIN Co., and OIL Co.). As mentioned by the interviewee from CHEM Co.,

*“I term it ‘Everything connected to everything else’. The idea being ‘no waste’ or ‘nothing lost’. And it also strategically links into the idea that you start centralising things, because it means stuff doesn't have to be transported.”*

There are also examples of selling waste products to other companies but not for environmental reasons, simply because it made financial sense to do so (e.g. RAIL Co., CHXIN Co., and OIL Co.).

Environmentally related product innovation also offered business opportunities to all of the case-study companies. As firms are getting more heavily regulated or seek to be more competitive, products or production processes with better energy efficiency become increasingly attractive. For example, TEL Co. and KLUN Co. are reportedly to have gained better market share because eco-friendly concepts are better integrated into their products. As previously noted, if regulation increases the demand of customers for improved environmental performance, companies in sustainability industries or those focused on product innovation may face increased demand for their products, and consequently enjoy better financial returns. As stressed by the interviewee from SUPR Co.:

*“If the aluminium or copper industry are included in some sort of a carbon scheme...then obviously our machine, the payback from our machine, will be far improved.”*

## **5.6 The impact of environmental regulations on firms’ private sustainability benefits – reactive practices by firms**

The case studies also reveal the impact of environmental regulation on a company’s financial performance (private sustainability benefits) that are results of reactive pollution control and other reactive EMPs, rather than by innovation or the adoption of proactive EMPs following a dynamic mindset.

Some regulations were identified as imposing significant financial and administrative costs. The interviewee from ELEC Co. said that the command-and-control nature of some regulations (specifically the Integrated Pollution Prevention and Control Regulations, which in some cases necessitate a plant to use the ‘best available technique’) can go so far as to make a plant no longer financially viable. By contrast, market-based instruments imposed a much lower cost burden on the company in complying.

The interviewees from case companies suggested that, even if regulations were relatively flexible, the timescale surrounding their implementation was crucial in determining the cost to the company (e.g., CHEM Co. and CHXIN Co.). Shorter time scales reduce level of flexibility in regulations and force even innovative firms to be reactive as they do not have enough time to innovate. In some situations, even relatively small costs can cause havoc if they have not been budgeted for. As mentioned by the interviewee from CHEM Co.,

*“...in general if we know it's (a new environmental regulation) coming we can build it into our business models...But it's when things sneak up on you. The Carbon Reduction Commitment regulations have just appeared. In the UK it's probably going to cost us, rough calculation, £20,000-25,000, which in the bigger picture is not a lot of money, but the trouble is its completely unbudgeted.”*

Sudden regulation changes can spring a surprise on companies to react to those changes administratively (e.g., RAIL Co.). The interviewee from CHEM Co. pointed out that, especially at smaller sites, environmental auditing can prove to be very administratively costly, and could potentially cause more environmental damage than it prevents.

*“...when I've got a site that has only got 4 or 5 people, when there's only a sales office with only two people permanently in it, you know, not much bigger than this room<sup>1</sup>, asking us to multi-level environmental reporting does not help either the environment or our business. It's more environmentally insecure to do the reporting than not to do the reporting.”*

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<sup>1</sup> The room in which the interview was conducted was a small seminar room with two tables and a few chairs. Its size was approximately 2m × 4m.

Obviously, in this case, the cost of environmental reporting to the company is viewed as greater than the associated environment-related benefits such reporting is expected to result in.

Overall, it was found that regulations can be inflexible not just in the sense of rigid command and control; they can also be inflexible as a result of being sudden, ambiguous and overcomplicated, and sometimes due to the sheer number that may be applied to an industry. Such inflexible regulation designs can create much administrative burden and may not necessarily enhance the environmental performance of firms.

## **6. DISCUSSION, PROPOSITIONS AND CONCEPTUAL**

### **FRAMEWORK**

This study has focused on two important conditions of Porter hypothesis (design of environmental regulations and firms' innovation capabilities). Starting with three a priori assumptions derived from the literature, an inductive case-study approach has been used to understand the mechanisms through which environmental regulations influence the environmental behaviours of firms. The qualitative study was conducted with nine firms in the UK and China.

The results have not only confirmed the validity of the three broad assumptions but have shed further insights on the influence of environmental regulations. The three assumptions appear to be valid: inflexible regulations force firms to be reactive and adversely affect financial performance, flexible regulations help innovative firms in meeting regulations as well as improving performance, firms without innovative capabilities are not able to improve financial performance even with flexible regulations. The results show that it is vital that any environmental regulations promulgated by government fosters innovation in firms by providing sufficient flexibility to firms. Some prominent additional findings beyond these a priori assumptions include (i) multi-country context to verify these assumptions, (ii) firms may find setting own high environmental standards be more useful than trying to comply with all the different levels of regulation at work in different countries or regions, (iii) any given regulation (or set of regulations) cannot be characterized in a dichotomous scale (as purely 'flexible' or 'inflexible'), and (iv) a similar sliding scale would be more appropriate to capture how firms react (proactive or reactive) to environmental regulations. These results are further discussed in the rest of this section.

### **6.1 Impact of regulatory pressures**

The case studies have demonstrated that firms can either hold a dynamic mindset to turn regulatory and other pressures into innovative actions, or a reactive attitude to simply comply with regulatory items. The choice of either approach is decided by resource capabilities, which is used to shape the first proposition.

**Proposition 1:** Depending upon firms' internal resources and capabilities, firms will approach flexible regulations with a dynamic mindset to develop innovative solutions or a reactive mindset of pollution control. The choice of the approach will not only affect the private sustainability benefits of firms but also impact public sustainability benefits.

This proposition will be further elaborated in the next few sub-sections.

## 6.2 Regulatory design and innovation

The importance of regulatory design was strongly highlighted in the case-study interviews. More market-orientated mechanisms were preferred because they allowed firms to deal with environmental pressures in their own way. Administrative costs imposed by rigid regulations were also identified as being significant in themselves (thus directly affecting financial performance and private sustainability benefits). The timescales over which regulations are introduced was further identified as being an issue as shorter time scales reduce level of flexibility in regulations and force even innovative firms to be reactive as they do not have enough time to innovate.

This study also broadly identified a positive link between innovation and financial performance (private sustainability benefits): energy and waste-efficiency measures were seen as being beneficial to a company's bottom line, as were process innovations that reduced hazardous waste and product innovations that exploited the desire (or requirement) for improved environmental performance in customer markets. Thus the following additional propositions emerge from the case studies.

**Proposition 2:** When the government enacts environmental regulations that focus on outcomes but do not prescribe the processes (i.e. flexible regulations), and when firms approach such flexible regulations with a dynamic mindset and develop innovative solutions, the firms will experience a positive impact on financial performance and private sustainability benefits. Private sustainability benefits of firms will also improve public benefits.

**Proposition 3:** Firms that take a reactionary attitude towards regulations will incur significant expenditure in meeting the requirements of these regulations and suffer adverse impact on their financial bottom line irrespective of whether the regulations are flexible or inflexible.

**Proposition 4:** Firms that approach other environmental pressures (such as customer demand, strategic position and economic pressures) with a dynamic mindset and innovate will experience a positive impact on their financial performance and private sustainability benefits. Private sustainability benefits of firms will also improve public benefits.

**Proposition 5:** Inflexible environmental legislations that stipulate the use of best available techniques lead to higher capital expenditure and other administrative costs to firms, and hence adversely affect the financial performance and reduce private sustainability benefits. Public sustainability benefits will be adversely affected.

All these propositions have implications for policy makers in terms of regulatory design. Furthermore, they all contribute to the generation of the conceptual framework that stresses the importance of adequate regulatory design for innovation and better private sustainability

benefits. This study identified the links between environmental regulation and innovation. The other (non-regulatory) pressures to improve environmental performance have been backed up in discussion: the economic pressures (because waste reduction is both cost reduction and improved environmental performance) were foremost, but customer demand for greener products and the strategic positioning of a company as a market leader in environmental issues also featured.

### 6.3 Conceptual framework

Thus the empirical findings above can feed into a conceptual framework (shown in Figure 1), which can be a useful aid in explaining the complex interconnections between environmental pressures on firms and the reactions of those firms. The framework has notable features, including the effects of regulations on the other pressures (economic pressures, customer demand for green products, and strategic market leadership in environmental issues) to improve environmental performance. These range from the most obvious (measures such as the Climate Change Levy imposing an additional cost on energy usage and thus strengthening the economic case for improved energy efficiency) to other less obvious links (such as the levelling of the playing field so that high environmental standards are not penalized, and the effects of customer markets, which can necessitate improved environmental performance of products).

Furthermore, the example was given of the threat of regulations inspiring voluntary action by firms in an attempt to avoid the need for future regulations, suggesting that the link between regulatory and other pressures (economic pressures, customer demand for green products, and strategic market leadership in environmental issues) and firms' responses may in fact be multidirectional. Inflexible regulations cause an administrative burden that reduces private sustainability benefits for both proactive and reactive firms. For firms following reactive pollution-control practices, the excessive administrative cost generated can hardly be offset by the potential benefits brought by those practices. These findings are not unique to environmental regulations. For example, Almeida and Carneiro (2009) found that stricter labour regulations have led to higher unemployment in Brazilian firms.

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Insert Figure 1 about here  
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The framework extends the original broad a priori assumptions with additional complex links highlighted from case-study interviews. One example is that the administrative cost of complying with all the different levels of regulations at work in different countries or regions would be huge, thereby making the logical option for a company to simply set its own standards as being higher than that required by the most stringent regulations. Clearly such a response is only available to those firms with a dynamic mindset and excessive resources. This relationship could be interpreted in terms of a dynamic setting where such a response reduces some of the administrative cost of dealing with regulations.

Given the analysis, it is proposed that the conceptual framework shown in Figure 1 provides an appropriate structure for evaluating environmental regulations, be it from a research perspective, a policy perspective or from the perspective of a manager affected by such regulations. It is worth pointing out that any given regulation (or set of regulations) faced by a company cannot be characterized as purely ‘flexible’ or ‘inflexible’. In reality, all regulations have more or less flexible elements to them. Therefore a linear two-dimensional spectrum would be more appropriate than two distinct categories to characterize a regulation or set of regulations. The same is true to a lesser extent of the difference between dynamic and reactionary approaches to tackling the need to improve environmental performance. In this case it is easier to categorize an organization as one or the other, but a sliding scale would be more appropriate. It is proposed that the conceptual framework can be used for this purpose and as an approximation of the key issues involved.

The conceptual framework and the propositions closely support the theme of this special volume (Nielsen and Lozano, 2015) by providing better understanding of the mechanisms for maximizing private and public benefits of sustainability, and demonstrate effective hybrid (Williamson, 1999) governance structure to enable firms better integrate economic and sustainability benefits. Public benefits relate to overall reduction in environmental impact of production processes used in firms. Proposition 1 shows that regulations may or may not increase positive externalities, decrease negative externalities or achieve the public benefits of sustainability depending on adequate level of involvement from firms. However, all these propositions provide the key for understanding the drivers of private benefits of sustainability to individual firms. For example, Proposition 2 provides the most important requirements for improving private sustainability benefits: governments should enact flexible regulations while firms should have dynamic mindset to exploit the flexibility. Propositions 3 and 5, on the other hand, shows that private sustainability benefits may not be realized if firms are not innovative enough. Finally, proposition 4 highlights mechanisms for dealing with stakeholder pressures – being innovative with open mind for example via developing improved production practices or more sustainable products or even improved product-service systems. Thus flexible regulations increase the incentive to firms in seeking innovative practices to increase their private sustainability benefits. The innovative practices can involve improved business models including, for example, new product-service combinations, effective involvement of partners in building sustainable supply chains, and improved design-for-sustainability whereby end-of-life processes are considered at the design stage itself. As highlighted earlier, the EU-ETS regulations offer economic incentives and are classified as an example of flexible regulations. Research on the economic impact of these regulations are continuing and there is consensus that the overall influence of these regulations is generally positive but may need further economic adjustments and also need longer time frame to manifest (Zhang and Wei, 2010).

These propositions and other findings were discussed in a post-hoc workshop with participation from a number of manufacturers in the UK, and the deliberations of the workshop participants were very closely in agreement with the findings of this study.

## **6.4 Contributions and link to previous literature**

The propositions developed above and the conceptual framework have anecdotal literature support, although few prior studies have focused on all of the constructs (i.e. flexibility of

regulation, innovation and private sustainability benefits) simultaneously (Montabon et al., 2007; Visser et al., 2008; Lopez-Gamero et al., 2010).

This paper has followed an inductive approach, broadly informed by three broad assumptions stated in section 3, which were used *as starting points and guidelines* for the case studies. The rich qualitative data from our analysis has helped to get newer and better insights that take us beyond these initial assumptions and gain more detailed understanding on Porter hypothesis. For example, our analysis have found that a linear two-dimensional spectrum would be more appropriate than dichotomous (flexible/inflexible) description of regulations. Regulations are complemented by other pressures (such as customer demand, strategic position and economic pressures) in inducing private sustainability initiatives in firms.

This study has contributed to the previous theory by verifying the complex issues surrounding the evaluation of the Porter hypothesis (Porter and van der Linde, 1995b; Porter and van der Linde, 1995a). It further contributes to the debate of effective hybrid (Williamson, 1999) governance structures that maximize private and public benefits of sustainability. Inflexible regulations cause excessive administrative burden, reduce private benefits of sustainability to firms and impact negatively on financial performance. The original Porter hypothesis did not put enough emphasis on the mechanisms for maximizing private and public sustainability benefits. However, the study suggests that the dynamic mindset held by the firm will enable the firm to better translate regulatory and other environmental pressures into opportunities for innovation and financial benefits.

Nevertheless, this study does not suggest that any firm with a dynamic mindset will be able to engage in performance-enhancing innovation. Instead, this study suggests that the application of the dynamic mindset is resource and capability dependent. While doing so, ample support was found for the DCV (Eisenhardt and Martin, 2000), especially in the role of firms' resources and capabilities in Proposition 1. Previous research highlighted the importance of the DCV in explaining the varied strategic choices, but was limited in providing evidence to relate the reconfiguration of firms' resources with financial performance (Rugman and Verbeke, 2000). The theoretical predictions of the DCV have been supported in this study, because evidence was found for a positive impact on financial performance only when firms' resources and capabilities are effectively utilized to develop innovation.

This also echoes the concept of capability lifecycle (Helfat and Peteraf, 2003), which extends the dynamic resource-based view to explain temporal patterns and paths in the evolution of organizational capabilities. It has been argued that while some capabilities may deal specifically with adaptation, learning and change processes, all capabilities have the potential to accommodate change. Helfat and Peteraf (2003) highlight that organizations can either renew, redeploy or recombine resources in response to a selection event that threatens to make a capability obsolete, or provide new opportunities for capability growth or change. A new or modified environmental regulation is an example of such an event. In this context, firms can put effort into the bundling or combining of firms' resources to create value in an uncertain environment (Sirmon et al., 2007).

## 6.5 Limitations

In spite of significant contributions, this study is not without limitations. First, although the interviewees had the required experience that could offset the limitations of the relatively

small sample size, the sample size could be increased further. Second, it would be useful to conduct case studies with more firms in the same sector (e.g. chemical industries alone or electricity generation alone) so as to control for sectoral contingencies. Finally, findings from this qualitative study could be verified by using more quantitative oriented research, either by using secondary data collected by government, content analysis of the interview data, or by collecting primary data from questionnaire surveys. They form scope for future research.

## 7. CONCLUSIONS

The results of the framework development and evaluation presented in this paper provide valuable insights into understanding the mechanisms by which government can use environmental regulations to help achieve public benefits of sustainability (e.g., by reducing pollution levels faced by the society and environmental impact of business activities) and also private benefits by influencing the environmental behaviours of firms. The results show that firms that take a dynamic approach to proactively managing their environmental performance are generally able to improve private benefits of sustainability (e.g., by reducing consumption of energy and raw materials that result in reduced waste/pollution, or enjoying better market performance) better than those firms who do not prioritize environmental performance as highly. However, the fact remains that compliance with regulations has proved costly for all firms, and so it is in the area of regulatory design that most significant changes need to be made.

Specifically, there has been widespread support for (flexible) market mechanisms over command-and-control (inflexible) regulations. Instead of uniformly damaging all firms, and hence removing some of the incentives to improve environmental performance, such flexible mechanisms allow firms that seek to improve environmental performance to reap private sustainability benefits and penalize laggard firms.

It seems that the best way of encouraging innovation and environmental responsibility in firms is to focus on changing the conditions in which firms operate. In terms of the conceptual framework shown in Figure 1, this means focusing on regulations that affect the ‘other pressures’ to improve private sustainability benefits. These include the economic pressures, affected by measures such as the Climate Change Levy, Landfill Tax and other regulations that drive customer demand for greener products.

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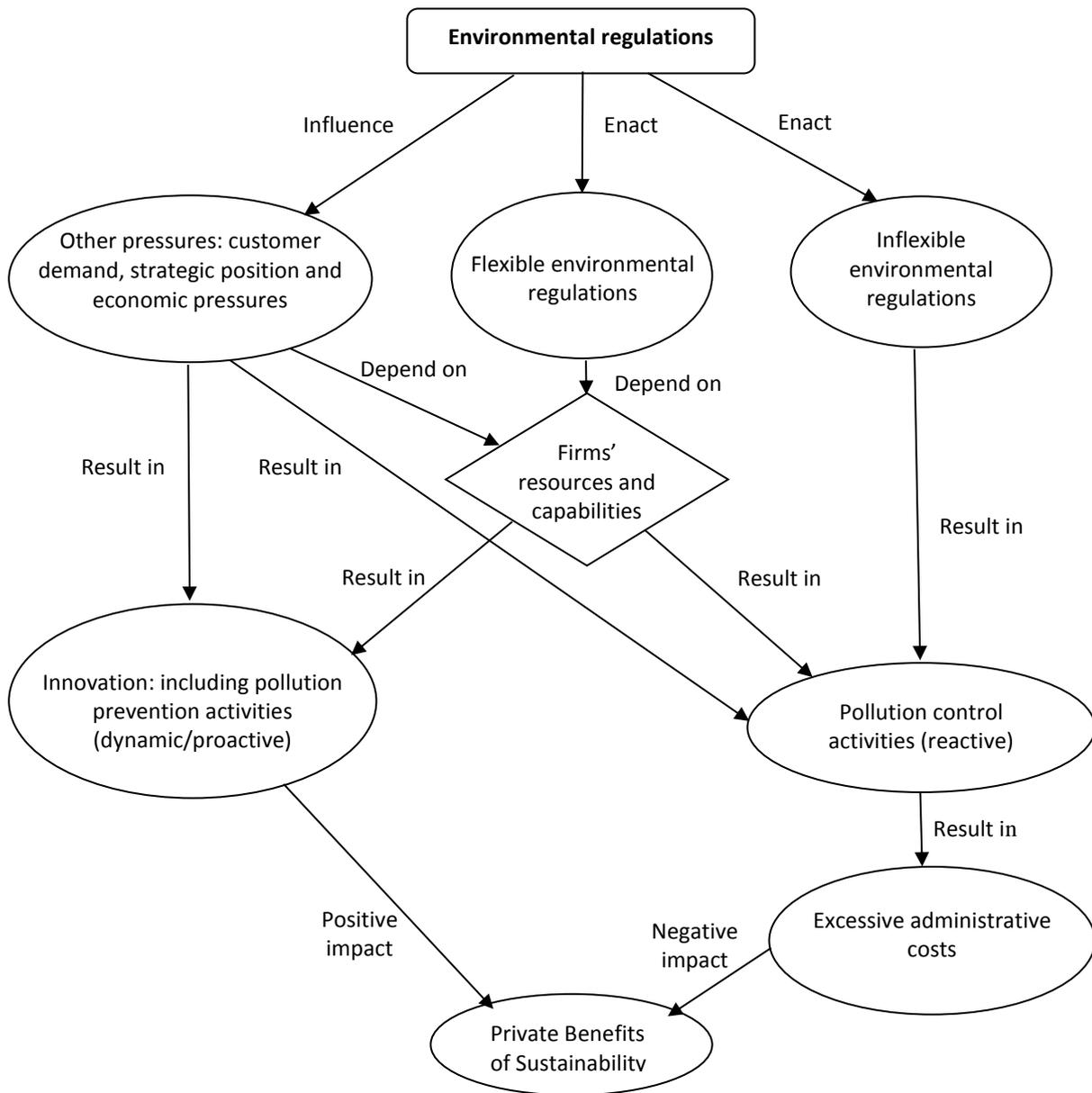


Figure 1. A conceptual framework of environmental regulations, innovation and private benefits of sustainability.

Table 1  
Initial template based on a priori assumptions.

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<b>A priori concepts</b>
1. Environmental regulations
1.1. Flexible regulation
1.2. Inflexible regulation
2. Firms' responses to regulation
2.1. Dynamic mindset
2.2. Reactive action
3. Innovation and investment
3.1. Investment in environmental management practices
3.2. Environmental innovation initiatives
4. Firms' performance
4.1. Financial performance
4.1.1. Positive impact on financial performance
4.1.2. Negative impact on financial performance
4.2. Environmental performance
4.2.1. Positive impact on environmental performance
4.2.2. Negative impact on environmental performance

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Table 2  
Final template based on in-depth analysis of transcripts.

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<b>Concepts emerged</b>
1. Environmental regulation
1.1. Flexible environmental regulations
1.1.1. Directory policy and market-based instrument
1.1.2. Pull-through government funding
1.2. Inflexible environmental regulations
1.2.1. Sudden regulations
1.2.2. Ambiguous regulations
1.2.3. Complexity due to number of regulations
1.2.4. Complicated regulations
1.2.5. Regulations focus on the process
1.2.6. Rigid command-and-control regulations
2. Other pressures: customer demand, strategic position and economic pressures
2.1. Customer demand
2.2. Economic pressures
2.3. Strategic position
3. Firms' resources and capabilities
3.1. Environmental management in organizational structure
3.2. Firm's ability to cope with standards or set the higher standards
3.3. Firms being environmentally conscious
3.4. Tangible and intangible resources
4. Firms' responses to regulations
4.1. Innovation: including pollution-prevention activities (dynamic proactive activities)
4.1.1. Adoption of environmental management practices
4.1.2. Environmental innovation initiatives
4.1.3. Proactive own voluntary environmental initiatives
4.2. Pollution control activities (reactive)
4.2.1. Comply with regulations
4.2.2. Resistance to regulation or transfer pressure to others
5. Excessive administrative costs
6. Environmental performance
6.1. Positive impact on environmental performance
6.2. Negative impact on environmental performance
7. Financial performance
7.1. Positive impact on financial performance
7.2. Negative impact on financial performance

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## Appendix A. Interview questions

1. What are the environmental regulations that your organisation has been subjected to?
2. Can you classify them as (1) direct regulations (that specify some pollution limits) or those that provide economic incentives/disincentives, (2) stipulate environmental standards vs. specify technologies, and (3) encourage integration vs. end-of-pipe?
3. Do you take your decisions on environmental sustainability on the basis of these regulations? What has been the role of environmental regulations (in the UK/China and in other countries) in the adoption of this strategy?
4. Has compliance with environmental regulations produced significant costs for the company which would not have been suffered had the regulations not been in place?
5. What other factors drive your interest in environmental sustainability – voluntary initiatives, economic pressures, stakeholder pressures, etc.?
6. Please outline some voluntary initiatives that you developed to be a leader in environmental sustainability.
7. Can you list the stakeholders that put pressure on you in improving your performance on environmental sustainability?
8. Please list some of the environmental innovations/environmentally friendly activities that you have been involved in (recycling, remanufacturing, using materials internally, waste reduction, energy conservation, outsourcing risk, rewards, supplier selection, environmental awards/recognition, integration with corporate policies, environmental mission, EMS, ecodesign, LCA, DfE, employee programmes, environmental risk analysis, etc.)
9. Can you describe in more detail how some of the specific environmentally focused process innovations that have been implemented work?
10. Have you developed innovative products/processes/patents (not directly relating to environment)? How are these innovations driven by the environmental sustainability agenda?
11. Have you been measuring your environmental achievements – in terms of energy conservation, recycling, waste reduction, savings, etc.?
12. Have you received any important environmental certifications (e.g. ISO 14001)?
13. Have you received any important environmental awards?
14. In terms of its overall performance, is your company registering good sales growth/increase in market share? Have you diversified your product portfolio? Have you reached new geographical markets? Have you introduced new products in the market?
15. What has been the economic impact of the company's improving environmental performance? Please make reference to direct and indirect costs and benefits of the various initiatives undertaken.

**Appendix B. Details of companies chosen for case studies (Within-case analysis)**

Company short name	Main activity	Company profile				Headquarter	Number of interviews	Respondents		Secondary Data
		Annual sales	No. of employees	Business experience (years)	Function			Position		
CHEM Co.	Chemical technology	>£10m	>1000	>25	UK	1	Head of sustainable development, Europe	Strategic	Company website, annual reports, and news reports	
ELEC Co.	Electricity generation, distribution and sale	>£10m	>1000	5–10	UK	1	Chief environment officer	Strategic	Company website, annual reports, and news reports	
RAIL Co.	Rail vehicle manufacturers	>£10m	>1000	>25	UK	1	Environmental specialist	Senior/middle	Company website, annual reports, and news reports	
SUPR Co.	Superconductor energy technology	£2m–5m	50–250	2–5	UK	1	Head of corporate development	Strategic	Company website, annual reports, and news reports	
TEL Co.	Tele-communication	>£10m	>500	15	UK	2	Head of logistics for UK and Ireland; Project manager	Senior/middle	Company website, annual reports, company newsletters, Environmental Protection Agency announcements	
TEX Co.	Consumer products, Textile, Import/export	>£10m	>1000	>15	China	1	Group assistant general manager	Strategic	Company website, company environmental information	

CHXIN Co.	Pharmaceutical	>£10m	50–250	>20	China	4	CEO; Operation director; Procurement director; Sales director	Strategic; Senior/middle	disclosed, Environmental Protection Agency reports and announcements, Company website, internal newsletters, governmental agency announcements
KLUN Co.	Pharmaceutical	>£10m	>1000	>15	China	2	Director of safety and environment protection department; Production line manager	Senior/middle	Company website, annual reports, internal newsletters. Environmental Protection Agency announcements
OIL Co.	Edible oil	>£10m	>1000	12	China	1	General manager of regional operations	Strategic	Company website, company newsletters. Environmental Protection Agency announcements