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THESE

présentée par

Yunhee KIM

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de l'École Nationale Supérieure des Mines de Saint-Étienne

Spécialité : Sciences et Génie de l'Environnement

Régulation, politiques et innovation industrielle : Approche par méthodes et implications

Regulation, Policies and Innovation Activities in Industries : Approaching Methods and Implications

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Glossaire :

PR 0	Professeur classe exceptionnelle
PR 1	Professeur 1ère classe
PR 2	Professeur 2ème classe
MA(MDC)	Maître assistant
DR	Directeur de recherche
Ing.	Ingénieur
MR(DR2)	Maître de recherche
CR	Chargé de recherche
EC	Enseignant-chercheur
IGM	Ingénieur général des mines

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SMS	Sciences des Matériaux et des Structures
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G2I	Génie Industriel et Informatique
CMP	Centre de Microélectronique de Provence
CIS	Centre Ingénierie et Santé

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Régulation, politiques et innovation industrielle : approche par méthodes et implications

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Résumé

De manière générale, différentes approches s'offrent aux décideurs politiques lorsqu'il s'agit de promouvoir l'innovation. Pour reprendre la distinction posée par la plupart des économistes industriels, les politiques peuvent être de nature presciptive ou incitative. A travers une série d'analyses théoriques et empiriques, cette thèse identifie plusieurs facteurs clés qui déterminent l'efficacité des politiques d'innovation, que l'approche adoptée soit de nature prescriptive ou incitative.

En guise de préambule, nous soulignons que les politiques mises en oeuvre constituent un déterminant fondamental des capacités d'innovation d'une industrie, notamment parce que les incitations marchandes à engager des activités de recherche fortement exploratoires sont limitées. Par ailleurs, nous signalons que la nature des politiques susceptibles de favoriser l'innovation dépend fondamentalement des caractéristiques des industries, et même des firmes, auxquelles elles sont destinées. La mise en oeuvre de politiques (incitatives ou presciptives) efficaces requiert ainsi une compréhension approfondie du secteur d'activité que l'on souhaite promouvoir et de la nature des processus d'innovation qui impliquent notamment différents types d'investissements (à plus ou moins long terme, plus ou moins risqués et plus ou moins exploratoires).

Cette thèse analyse ensuite, à travers trois études de cas, l'incidence de différentes politiques (incitatives ou presciptives) mises en oeuvre dans des contextes industriels distincts. Partant de l'hypothèse selon laquelle les politiques presciptives ont un impact bénéfique sur l'innovation et le développement technologique d'un secteur à court terme mais des effects plus incertains à long terme, nous étudions l'impact des politiques de libéralisation

(ouverture à la concurrence et privatisation des opérateurs historiques) qui ont été mises en oeuvre dans le secteur des télécommunications. A travers une étude économétrique portant sur un panel de 20 pays de l'OCDE sur la période 1994-2008, nous soulignons que l'impact de la concurrence sur les décisions d'investissement s'exerce à travers deux effects : l'effet « profitabilité » et l'effet « efficacité opérationnelle ». Nous soulignons par ailleurs que la relation entre intensité concurrentielle et investissement varie signicativement entre entreprises publiques et firmes privées.

Dans une seconde étude, nous analysons le lien entre la propension des firmes à adopter spontanément des comportements écologiques (mesurée à partir des données du Carbon Discloser Project et du Dow Jones Sustainability Index) et la nature de leurs innovations. Ce travail fait apparaître de forte différences inter-industries et inter-entreprises mais permet de valider l'hypothèse d'une relation positive entre le niveau des investissements de R&D et la propension à adopter des comportements écologiques.

Nous nous intéressons enfin à la relation entre responsabilité sociale d'entreprise et innovation. Nous utilisons pour cela le classement Vigeo ainsi que des données financières sur l'année 2009. Notre étude met en évidence une relation positive entre responsabilité sociale d'entreprise et capacité des firmes à innover. Nous interprétons ce résultat de la manière suivante : la responsabilité sociale d'entreprise conduit les firmes à réaliser des investissements non seulement de court terme mais également de long terme et à tenir compte de la complémentarité de ces investissements. La responsabilité sociale d'entreprise accroît ainsi les synergies entre les différents types d'investissement réalisés par les firmes.

Mots clefs: Autorégulation des entreprises, comportements écologiques, nature de l'innovation, innovation, politiques de libéralisation, développement durable.

Regulation, Policies and Innovation Activities in Industries : Approaching Methods and Implications

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Abstract

In general, policymakers are often faced with a different choice, i.e., the choice between using regulation-based approaches and using incentive-based approaches, where the policy instruments could be based either on mandatory approach or voluntary approach with economic incentives in market. Historically, industrial economists have regarded the issue of policy design as the one focused primarily on the choice among alternative policy instruments, where those are generally viewed as falling into two broad categories: regulation-based instruments and incentive-based instruments.

Through the theoretical and empirical analysis, this study identifies some key features that are likely to increase both the effectiveness and efficiency of industrial policies with voluntary and mandatory approaches. On the other hand, we also investigate the existence of a strong relationship between innovation and industrial policies. In particular, we divide investment activities of firms into two parts like explorative and exploitative investments. Then we find that the explorative innovation increases the incentives for participation in long-term but also reduces the financial incentives in short-term. In sum, when based on the understanding and consideration on the nature of innovation and other impact factors, industrial policy can provide a mechanism for meeting industrial quality goals both effectively and efficiently.

Considering firms' characteristics and industry sector also increases the synergy effect of policies and regulations. This understanding also can help policy makers to decide whether or not use of such policy approach is advisable and to design the policy ensuring that it is as effective and efficient as possible. Consequently, the current research investigates the difference and tendency of industrial policy approaches and the type of innovation carrying

out three analyses according to the mandatory and voluntary approaches.

With the assumption that the mandatory approach has short-run impact to prompt new technology or grow a specific industry, we firstly assess the impact of regulation, such as privatization of nature monopoly. Using the firm level data of 20 OECD countries between 1994 and 2008, we tested assumptions in telecommunication market, where there exist competition and privatization regulations. Based on the empirical results, we can claim that considering interaction among liberalization policies and allowing the industry characteristics are critical to determine for the Profitability effect and Operational efficiency effect and level of investments. This means that firms seek strategies for exploitative investments in the case where competition becomes severe and many dimensions are faced. Therefore, it is necessary for policy regulators to take account of the interactions among liberalization policies providing an incentive to create new knowledge and technologies.

Secondly, we analyze the voluntary industrial policies with comparing of environmental and sustainable behaviors. This approach has long-run effective characteristics and can be applied to more general industry. Based on our assumption that the 'Corporate Environmentalism' is a bilateral agreement between a policy maker and a firm, we try to find the relationship between voluntary activities and the nature of innovation. 1032 observations are divided into specific groups according to the Carbon Discloser Project (CDP) Global 500 report and the list of Dow Jones Sustainability Index (DJSI) between 2008 and 2009. From the empirical analysis, we identify the correlation between the 'Corporate Environmentalism' and innovative activities. These results show that the variations of firms' sustainable and environmental behaviors are varied depending on the industry sectors, firm characteristics, and environmental and sustainable activities.

Finally, this study identifies the relationship between 'Business-led Initiatives (CSR)' and innovation activities of firms. We assume that CSR is a business-led initiative that recognizes that the impact businesses have on society is more than purely financial. In particular, this study advocates a new approach to incorporate sustainability with innovation strategies by taking into account voluntary sustainable activities not just for investors, but also for other shareholders including communities firms serve. Using the Vigeo rating and the Thomson Reuters financial data in 2009, we divided 619 firms into groups according to their industry sectors, regions, and firm characteristics such as size and age. This study identifies the relationship between CSR and innovation activities of firms based on the assumption that

innovative investment is needed to prepare tomorrow's profits not only by considering investments in technology and in R&D, but also by dealing with sustainability to human, social, environmental, technical, and economic investments. Consequently, when the firm builds their short- and long-run business strategies, the consideration of the relationship between types of investment and CSR practice will lead to more cooperating effect on the outcome of investments. The findings of this study could provide a comprehensive understanding on the effect of sustainable management strategies on the innovation and sustainability of firms.

Keywords: Business-led Initiatives, Corporate Environmentalism, Nature of Innovation, Innovation, Liberalization Policies, Sustainability

Je dédie cette thèse à

ma famille bien-aimée

pour leur amour inconditionnel et leur confiance absolue

mes chers amis

pour leur soutien indéfectible et chaleureux

mes honorables professeurs

pour leur disponibilité et la qualité exceptionnelle de leurs conseils
et de leur encadrement

Dedicated to

My Beloved Family

for their Unconditional Loves and Absolute Trusts

My Hearty Friends

for their Generous Helps and Warm Comradeship

My Respectful Professors

for their Enlightening Advices and Munificent Instructions

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Chapter 1. Overview

1.1 Research Background

1.1.1 Industry policies with voluntary and mandatory approaches

In the theory of economic regulations, there is a demand of industrial regulation because the subliminal uses of governmental resources and authorities can improve the economic behaviors' status. Although the regulation could and dose treat or compel or help shareholders, the effective and well-implemented regulation make the allocation of resources more fairly and efficiently (Stigler 1971). With this background, industrial economists have historically regarded the issue of policy design as the one focused primarily on the choice among alternative policy instruments, where those instruments are normally viewed as falling into two broad categories: regulation-based and incentive-based approaches (Bohm and Russell 1985). Therefore, policymakers are often faced with different choices, that is to say, the choices among using a voluntary approach or using a mandatory approach or using both approaches simultaneously, where the ways could be based either on regulation-based or market-based economic incentives (Alberini and Segerson 2002).

The key distinction between voluntary and mandatory approaches is the extent of ability to impose unwanted costs or regulations on firms. Through a voluntary approach, a firm will not participate unless his payoff is at least as high as it would be without participation, i.e., the firm must perceive some gain (or at least no net loss) from participation (Paton 2001). Through mandatory approaches (based on inducing regulations and commands), regulators can change market circumstance or impose net costs on firms, thereby making them worse than they would have been in the absence of the policy. It is assumed that the mandatory industrial policy is driven mainly by policy or public intervention, while the voluntaries industrial policy is driven rather by market. The main distinction of such policies is whether the approach dictates a firm designed to improve the quality of policy implication results or tries to induce the behavior by modifying the market signals faced by them.

For the policy maker, the interest in the use of industrial policy approaches has spurred a growing literature within industrial economics on the relative merits of voluntary vs. mandatory approaches to social welfare and satisfaction of behaviors. Much literature is

devoted to the choice between the two (Lyon and Maxwell 1999; Khanna 2001). Theoretical conclusions generally favor one of two scenarios: (i) to the extent that voluntary agreements are less costly than regulation, organizations prefer voluntary agreements; and (ii) as regulatory stringency increases, compliance costs increases the incentives to exceed compliance to gain advantage increase (Segerson and Miceli 1998; Lyon and Maxwell 2004). Regulatory constraint may be positively associated with voluntary industrial management, as organizations seek relief through strategic behavior, which is one of the conclusions supported by extensive empirical findings, as noted earlier (Jones 2010).

In addition, various theories demonstrate that regulation provides incentives and opportunities to achieve the resulting objectives through voluntary environmental management (Segerson and Miceli 1998; Lyon and Maxwell 2004). Regulation is widely considered to be more expensive and less efficient than voluntary action (Segerson and Miceli 1998; Baldwin and Cave 1999), based on theoretical conclusions and empirical results consistently finding regulatory pressures among the strongest determinants of both types of voluntary efforts (Stigler 1971; Arora and Cason 1996; Videras and Alberini 2000; Khanna, Koss et al. 2007). In terms of firms' motivation to adopt or cite voluntary initiatives, (Paton 2001) indicates that there are some limitation to present the rapid growth of voluntary behaviors of firm with conventional economic model. Using the two concepts of "the Porter hypothesis" and "the energy efficiency gap", they describe the key generic strategies for firms' voluntary adoption.

There are three typically voluntary approaches in industry policy implementations (Carraro and Siniscalco 1996; Lyon and Maxwell 1999; Segerson and Li 1999; Braathen and Co-ope 2003). Such actions are often termed "business-led initiatives," "corporate environmentalism," or "industry self-regulation[1]" (Alberini and Segerson 2002). Under these approaches, this study focuses on the 'business-led initiatives' and 'corporate environmentalism'. Because self-regulation involves rater mandatory restrictions on quantity or sales territory, such as ''cartel'' and ''collusion'', and antitrust investigation (Kaserman

[1] 'Self-regulation may encourage consumer demand by reducing uncertainty about quality of product or ensuring interoperability of the products of various firms. It may enhance labor satisfaction by improving the safety or other quality aspects of the workplace. It may also serve more strategic purposes, such as softening competition or preempting stricter government regulations. If self-regulation is more cost-effective than government regulation, firms might self-regulate even if doing so has no impact on the ultimate level of restraint required.' Maxwell, John W., Thomas P. Lyon, et al. (2000). "Self-Regulation and Social Welfare: The Political Economy of Corporate Environmentalism." Journal of Law and Economics **43**(2): 583-618.

and Mayo 1995)[2]. We presume that the second form of voluntary approach is a bilateral agreement between a policy maker and a firm. Corporate environmentalism is more related with environmental protection. The global environmental issues on climate change and wider scope of sustainability have growing impact over the few decades on the social demand and the international political agenda.

Regarding empirical methodology, industrial management studies commonly examine decisions within a profit maximization framework. However, some studies indicate that a utility maximization framework may increase explanatory power (Baron, 2001; Nakamura et al., 2001). According to a utility maximization theory, organizations are assumed to undertake voluntary management out of self-interest, both to appeal to a range of stakeholders and to achieve competitive and other benefits, rather than engaging in behaviors strictly designed to maximize profit (Khanna, 2001; Henriques and Sadorskry, 1996; Esty and Winston, 2006; Baron, 2001; Nakamura et al., 2001). So, theory and empirical evidence demonstrate the cost and efficiency advantages of voluntary action as well as a positive influence of regulatory constraint, but the choice of strategy depends on various factors.

In fact, the concepts of the industry policies with voluntary or mandatory approaches have applied in specific industry like environment and energy. This comparison is famous with metaphorical expression like mandatory control (the "Stick") and incentive subsidies (the "Carrot"). Then most studies have more emphasized on voluntary approach than mandatory one and tried to find the reasons and motivations (Paton 2001; Alberini and Segerson 2002; Khanna, Koss et al. 2007). They conclude that the voluntary approach is more comprehensive and have long-term effect, and the mandatory approach have intensive and short-run effect (Bohm and Russell 1985).

However, when we compare these two industry policy approaches in the general and broader perspectives and circumstances, mandatory approach could be effective and increase social welfare. From the positions of both regulators and governed-firms, the each approach has several desirable features that might prompt the sustainable development. In particular, the policy maker want to make a growth or a rapid diffusion of specific technology or

[2] There are some examples of self-regulation such as the Clean Air Act and the Clean Water Act in the USA. Under this acts, firms are enforced compliance with rather mandatory rules but not critical to firms' operation like receiving penalties if it does not signal its ability to reduce its level of waste generation. Anton, W. R. Q., G. Deltas, et al. (2004). "Incentives for environmental self-regulation and implications for environmental performance." Journal of Environmental Economics and Management **48**(1): 632-654.

industry, mandatory policy instruments could be chosen as industry policy. For instance, a lot of countries have implemented strong government-induced policies in telecommunication industry for last few decades[3]. The policy makers set up the price and market structure. So, the design of policy could entail numerous effects on the social welfare, shareholder's behaviors, firms' performance and innovation.

For the mandatory policy approaches, most literatures on the relationship between regulation and investment in the one industry sector focus the impact of asymmetric ex-ante regulation. From these, we argue that there is a relationship between adoption of a more general standpoint and consideration of the different regulatory policies in industry. In the liberalization policies process, there are several dimensions of regulation. Therefore, we try to clarify the relationship between these voluntary or mandatory industrial approaches and investment activities of firms according to their specific firms' characteristics and industry sectors.

In sum, the main purpose of this study is to highlight on understanding why specific policies or agreements are adopted and what impact this approach has on firms investment activities such like infrastructure and R&D investments. As an aspect of stakeholder management, company couldn't be longer held merely to their profit maximizing but shareholder. The shareholder includes customers, employees, suppliers, networking and non-government organization (Cetindamar and Husoy 2007).

[3] For the literature reviews in telecommunication regulation, see Cambini, C. and Y. Jiang (2009). "Broadband investment and regulation: A literature review." Telecommunications Policy **33**(10-11): 559-574.

1.1.2 Sustainability and innovation

The topic of the corporation social responsibilities (CSR) has been a subject of intense controversy and interest over the past three decades (Jamali 2008). In part, this debate is an outgrowth of the proliferation of different conceptualizations of CSR. Such a term has indeed been defined in various ways from the narrow economic perspective of increasing shareholder wealth (Friedman 1967)[4] to economic, legal, ethical and discretionary strands of responsibility (Carroll 1979) including good corporate citizenship (Hemphill 2004). These variations stem in part from differentiating fundamental assumptions about what CSR entails, varying from conceptions of minimal legal and economic obligations and accountability to stockholders to broader responsibilities to the wider social system in which a corporation is embedded.

Basically, the CSR is based on the concept of shareholder theory. Stakeholders, acting either formally or informally, individually, or collectively, are a key element in the firm's external environment that can positively or negatively affect the organization (Murray and Vogel 1997). The main challenge for businesses is the task of identifying to whom they are responsible and how far that responsibility extends. There are several approaches which explain the voluntary CSR behavior of firms and the CSR field presents not only a landscape of theories but also a proliferation of approaches, which are controversial, complex and unclear (Garriga and Melé 2004).

Recently, the CSR is more getting the major consideration of firms' strategies and they focus on this due to making the satisfaction of their shareholders and giving the positive image to the market. Various theories demonstrate that regulation provides incentives and opportunities to achieve these objectives through voluntary environmental management (Jones 2010). Theory and empirical evidence demonstrate the cost and efficiency advantages of voluntary action as well as a positive influence of regulatory constraint, but the choice of strategy depends on numerous factors (Porter and Linde 1995; Lyon and Maxwell 2004; Khanna, Koss et al. 2007).

On the other hands, voluntary industrial management appeals to policy makers pursuing to reduce administrative burdens and costs, and to organizations seeking to reduce

[4] "There is one and only one social responsibility of business: to use its resources to engage in activities designed to increase its profits so long as it stays within the rules of the game, which is to say, engages in open and free competition, without deception or fraud."

expenses and increase efficiency through innovating solutions, compared to using standard technologies or prescribed practices (Khanna and Brouhle 2009).

While the relationship between industrial policy and social issues is subject to a well-established academic literature, the role of innovation in influencing that relationship has received relatively little attention (Pavelin and Porter 2008). However, sustainable innovation has been widely defined as a process of creating new ideas, behavior, products and processes that contribute to a reduction in environmental burdens or to ecologically specified sustainability targets (Rennings 2000). With an interpretation which emphasize on collective learning and monitoring devices, (Aggeri 1999) also support the reason why monitoring of innovation and using of negotiated instruments by the policy makers is a pivotal issue in industrial policy. Innovation is firms' primary concerns as well as their performance. Furthermore, innovation is a sustainable engine for firm's growth and survival.

Until recently, lots of studies have showed the impact of industrial policy on the performance in the sustainable development aspect. However, there are lots of converse debates on the correlations between voluntary or mandatory activities and performances, and their results have a number of limitations statically. Furthermore, they just focus on the relationship between short-term performances and industrial policy approaches and estimate the limited effect. Therefore, this paper concludes that innovative investment is to prepare tomorrow's profits not only considering investments in technology and in R&D, but also dealing with sustainability to human, social, environmental, technical, and economic investments.

In particular, the adoption or implementation of industry policies with voluntary and mandatory approaches has longitudinal effect and it is difficult to find the causality between adoption and their performance. Nevertheless, most studies only consider the existence of significant impact for performance. Innovation is the priority of firms as well as another core sustainable factor for firms' growth and survival. In detail, this study considers the dimensions of innovation.

Based on the previous studies (March 1991), the type of investment could be defined as the allocation of resources between R&D investment (R&D expenditure; Creating new knowledge and technologies; Radical; Exploration) and capital expenditure (CAPEX; Using existing knowledge and technologies to develop new products and services; Incremental; Exploitation). There exists a tendency of the adaptive systems selecting exploration to suffer

from the costs of experimentation with no relevant benefit. In contrast, the system selecting exploitation is apt to be set in an optimal steady state. Based on these ideas, we premise that explorative investment is the one which induces and prompts firms' innovation because it has more uncertainty for future and there is less guarantee for the return of the investment. So explorative investment is rather innovative investment than exploitative investment. Thus, it is very important to keep a proper balance between exploration and exploitation pursuing firms' strategies.

Regarding the investigation into the detailed innovation, recently there are some papers. (Calderini and Garrone 2001) identify the relationship between mandatory regulation and R&D activities of firms using the patent and publication data. (Hellström 2007) also analyses environmentally sustainable innovation in order to establish dominant structures of such innovations and current weaknesses. They estimate in terms of Schumpeterian innovation type and innovation mode (radical or incremental & component or architectural). With these backgrounds, the current study tries to empirically identify the relationship between firms' behavior and their innovation activities with firm-level data. After then, we will find what factors drive the sustainable behavior and whether the industry policies with voluntary and mandatory approaches can prompt the innovative investments of firms or not.

1.2 General Research Framework

According to the research framework presented in Fig 1-1, this study investigates the difference and tendency of industry policy approaches on the type of innovation. In here, there exist three analyses according to the mandatory and voluntary approaches.

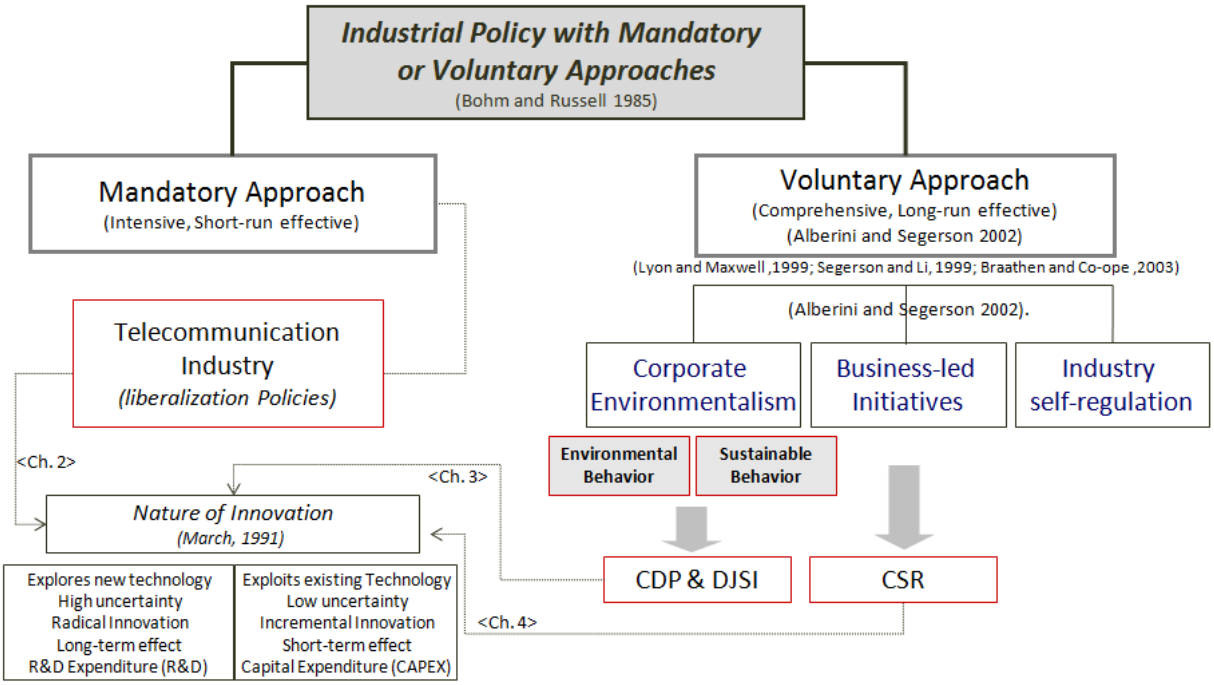

Fig 1-1 The schematic diagram of the general research framework

The mandatory approach has short-run impact to prompt new technology or grow a specific industry. For instance, incentive of investment in the telecommunication sector is a key issue since it not only increases the consumers' welfare but also generates positive externalities on many other activities. Also, it could be a source of competitive economic growth (Greenstein, McMaster et al. 1995; Roller and Waverman 2001; Datta and Agarwal 2004), and then the liberalization policies of most of the OECD countries have been implemented with the assumption that competition and privatizations would lead to the enhancement of both the static and dynamic efficiency of former "natural monopoly" industries. While policies to promote competition are the core of liberalization policies, privatizations are more optional. For example, European directives, that govern the regulation of telecommunications for the European Union Member Countries, do not set any requirement for privatization while they precisely de ne the policies to be implemented to

promote competition. Therefore, this study firstly assesses the impact of regulation, such as privatization of nature monopoly and inducing competition, on the different type of innovations. Using the 97 nature monopoly firms of 20 OECD countries between 1994 and 2008, we identify the impacts of the liberalization policies on the nature of investment in telecommunication industry.

Secondly, we analyze and compare the voluntary industrial policies with sustainable and environmental behaviors. The environmental behavior of firms can be represented by Carbon Discloser Project (CDP) activity and the other one is the Dow Jones Sustainability Index (DJSI) which shows firms' sustainable activities. This chapter chooses both of these concepts simultaneously because there are a lot of initiatives in the market as a term of firm's strategies. These approaches have long-run effective characteristics and can be applied to more general industry. Based on our assumption that the 'Corporate Environmentalism' is a bilateral agreement between a policy maker and a firm, we try to find the answers to these questions; i) what is the relation between voluntary activities and performance of firms? ii) Do firms' voluntary activities in environmental and sustainable implementations induce innovation? iii) How is the nature of innovation depending on voluntary types of firms? and iv) what is the link between firm characteristics and innovation according to voluntary types? 1032 observations are divided into specific groups according to the CDP Global 500 report and the list of Dow Jones Sustainability Index (DJSI) between 2008 and 2009. From the empirical analysis, this part identifies the relation between the 'Corporate Environmentalism' and innovative activities. Classifying the established environmental and sustainable issues as well as proposing an empirical model of the links among environmental, sustainable behaviors, and innovation activities is another contribution of this study.

Finally, using the 619 multinational firms listed on the DJ STOXX 600 and MSCI World indexes, this study introduces an empirical model according to their industry sectors, regions, and firm characteristics such as size and age. Based on the analysis, we identify the relationship between 'Business-led Initiatives (CSR)' and innovation activities of firms which can be an answer to research questions: (i) what drives the CSR behavior of firms? (ii) What are the different effects of explorative investment (long-run return) and exploitative investment (short-run return) on the CSR behavior of firms? In particular, this chapter advocates a new approach to incorporate sustainability with innovation strategies by taking into account voluntary sustainable activities not just for investors, but also for other

shareholders including communities firms serve. The findings of this study could provide a comprehensive understanding on the effect of sustainable management strategies on the innovation and performance of firms.

This study is organized as follows. The second section identifies the impacts of the different dimensions about the liberalization policies on the nature of investment in telecommunication industry. The third section explains the voluntary industrial policies with the 'Corporate Environmentalism'. The forth section presents the relationship between 'Business-led Initiatives (CSR)' and innovation activities of firms. Finally, we conclude and discuss the policy implications of the analysis in the fifth section. In order to arrive at a fair and valid evaluation of public utilities, it is indispensable to look more closely to the particular circumstances of the technological, economic and social environment and the goals of the provision of a concrete service of public interest. (Bognetti and Obermann 2008)

Chapter 2. Liberalization Policies and Innovation in the Telecommunication Industry

2.1 Introduction

Comparing the developing timeline with other industries such as material, energy and so on, it has been just a few decades since telecommunication became universe and penetrated. Now the effect and portion of telecommunication industry in our society is prodigious such that we cannot exemplify industries without telecommunication sector. So, the developing and proliferating of telecom industry was the top priority of policy maker. For this reason, a lot of mandatory industry policies (including access regulation and price regulation) like USA's telecommunication act of 1996[5] has dominated and implemented as the national policy design in order to serve the public interest and enhance consumer welfare (Hausman and Sidak 1999; Datta 2003; Cave 2006).

There also exists an incentive regulation which is the alternative to the traditional sunk cost recovery regime, like rate-of-return (RoR). It provides incumbents with the opportunity to retain as profit additional revenues or cost savings (Cave, Majumdar et al. 2002; Armstrong and Sappington 2006). However, this incentive regulation is implemented within a specified period because as long as retail based competition increases over time, regulators' concern shifts from incentive regulation to access or price regulation, becoming the key regulatory instrument (Cambini and Jiang 2009).

As a matter of mandatory policy instrument, the organization of the telecommunications sector has undergone fundamental transformations over the past 25 years. Although public or regulated monopolies have long been regarded as the most efficient way to ensure the provision of telecommunications services, some countries undertook in the mid-1980s, a change in liberalization policies aimed at removing barriers to entry, promoting effective competition and privatizing public firms (Hausman and Sidak 2005). In the 1990s, this

[5] The Telecommunications Act of 1996 sets forth rules governing the unbundling of local telecommunications networks. For detailed discussions of this open-access regulation, see Kahn, A. E. (1998). Letting go: deregulating the process of deregulation. Lansing, MI: Michigan State University Press., Harris, R. G. and C. J. Kraft (1997). "Meddling through: Regulating local telephone competition in the United States." The Journal of Economic Perspectives **11**(4): 93-112. and Sidak, J. G. and D. F. Spulber (1997). "The Tragedy of the Telecommons: Government Pricing of Unbundled Network Elements Under the Telecommunications Act of 1996." Columbia Law Review **97**(4): 1081-1161.

movement, commonly known as “liberalization policies”, has spread to most OECD countries (Ahn 2002).

Therefore, incentive of investment in the telecommunication sector is a key issue since it not only increases the consumers’ welfare but also generates positive externalities on many other activities. Finally, it could be a source of competitive economic growth (Greenstein, McMaster et al. 1995; Roller and Waverman 2001; Datta and Agarwal 2004), and then the liberalization policies of most countries have been implemented with the assumption that competition and privatizations would lead to the enhancement of both the static and dynamic efficiency of former “natural monopoly” industries (Bortolotti, D'Souza et al. 2002; Cave 2010).

These policies are largely based on the premise that competition encourages innovation. However, this hypothesis remains largely debated. The defenders who believe the ‘Schumpeterian’ assume that market concentration is ‘the price to pay’ for encouraging investment. On the other hand, it is often argued that competitive pressure creates incentives for investment and innovation.

Similarly, the impact of privatization on innovation is controversial issue. On the one hand, it can be assumed that public firms aim at maximizing social welfare. As a consequence, their investment behavior may be more socially efficient than private firms’ investment behavior, since the latter is based on profit maximization. Added to this, some authors argue that public ownership is a source of organizational inefficiency and the state owned enterprises tend to waste resources and make unprofitable investment.

This study discusses and tests the assumption that liberalization policies are favorable to innovation in telecommunications. It focuses on the impact of these policies on the incumbent operators’ investment strategies. Although new telecommunication services are not always introduced by incumbents, they are in most cases based on technologies which were developed by incumbents. Moreover, the case of incumbent operators presents a specific interest: over the last 25 years these firms have faced radical changes – in both their competitive environment and their internal organization – which have probably transformed dramatically their investment strategies (Bauer 2010).

Over the past decades, a literature has emerged to study the relationship between mandatory industrial policy approach (liberalization process) and innovation in telecommunications. However, most of this work may is dedicated to a very specific

question: the impact of access regulation on infrastructure investment (Kotakorpi 2006; Waverman, Meschi et al. 2007)[6]. Access regulation[7] is the only one tool for promoting competition (Vareda and Hoernig 2007; Cave 2010).

Moreover, the deployment of new infrastructure is a particular form of innovation: the operators are also introducing new services, investing in R&D and developing new technologies. Studying the impact of liberalization policies on the investment of incumbent telecom operators therefore require to refer to more general work on the relationship between competition and innovation and between privatization and innovation (Melody 2003; Friederiszick, Grajek et al. 2008; Jung, Gayle et al. 2008).

Although this literature is particularly abundant, empirical work on these issues have not been able to establish meaningful results regardless of the industries concerned. Furthermore, although the theoretical literature highlights different mechanisms through which privatization and the developments of competition affect innovation, there are only few unified theoretical frameworks to study how these mechanisms are related (Li 2008).

The impact of liberalization policies has been investigated empirically by some recent papers. However, no consensus has emerged from this research, although the assumption that liberalization policies encourage the operators to invest is the one that has received the most theoretical support. In addition, a central question has been largely ignored by this literature: Does competition have to same impact on investment for private and government-owned operators?

While policies to promote competition are the core of liberalization policies, privatizations are historically more optional. For example, European directives that govern the regulation of telecommunications for the European Union Member Countries do not set any requirement for privatization when they narrowly define the policies to be implemented to promote competition[8]. Thus among the incumbent telecommunications operators, we find fully private companies, partially privatized firms and firms that are still among the government control.

Although it is quite likely that the development of competition does not produce the

[6] See 'Cambini, C. and Y. Jiang (2009). "Broadband investment and regulation: A literature review." Telecommunications Policy **33**(10-11): 559-574.' for a review of this literature

[7] The obligation for incumbents to share their infrastructure with new entrants that are not able to roll out their own networks

[8] http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/09/568&format=HTML&aged=1&language=EN&guiLanguage=en

same effects on the investment of private and government-owned firms, the previous empirical studies on the relationship between liberalization and investment in telecommunications did not pay much attention to this issue. Therefore, we make some assumptions about the transition of operators' activities over the liberalization policies and identify it.

This part is organized as follows. Section 2.2 discusses the theoretical foundations of the assumption that the relationship between competition and privatization is different for private and government-owned with cost-based model. Section 2.3 describes methodology and variables after then reviews the previous empirical studies on liberalization and investment in telecommunications. Section 2.4 presents the results and analysis of the hypotheses and assumptions. Section 2.5 concludes and discusses the policy implications of the analysis.

2.2 Theoretical Background

In this section, we investigate the theoretical foundations of the assumption that the relationship between competition and innovation is different for private and government-owned firms. The impact of competition on the firms' investment and incentives to innovate has been analyzed by two types of work. The former is based on the assumption that 'firms maximize their profits and emphasize that competition affects the profitability [9] of investments'. The second set of work considers 'the agency relationship between firms' shareholders and managers'.

In big modern corporations, the decisions (including investment decisions) are not made directly by the owners of the firms but by professional business managers (Berle Jr and Means 1930). This arrangement results in an agency relationship where the owners have only incomplete information on the work undertaken by managers (Jensen 1986). Given that their decisions cannot be observed or measured directly by the owners, the managers can undertake actions that are not in the owners' interest (moral hazard). In this framework, many studies have underlined that competition (and privatization) reduces the managers' power[10]. (Vickers and Yarrow 1989; Shirley and Walsh 2000) and several papers have analyzed the consequence of this effect on the firms' investment behavior[11].

In section 2.2.1, we revisit the argument that competition affect the profitability of investment (the firms' investment decisions) and extend it to non-profit-maximizing firm. We show that this "profitability effect" of competition may be different for private and government-owned operators (ex-ante privatization) since private and government-owned firms do not have the same objective function. In section 2.2.2, following the pioneering work of (Aghion and Howitt 1998), we identify how the "profitability effect" affect the firms' investment decision in combination with the impact of competition on the managers' power (the "operational efficiency" effect). The latter is also different for private and government-owned operators, because the nature of the agency relationship varies from type of firm.

[9] By "profitability", we do not only mean the financial viability of the investment (e.g. its net present value) but also its strategic or "option" value.

[10] See. Vickers, J. and G. K. Yarrow (1989). Privatization: an economic analysis, MIT press, Shirley, M. M. and P. M. Walsh (2001). Public vs. Private Ownership: The Current State of the Debate, SSRN., of a review

[11] See e.g. Jensen, M. C. (1986). "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers." The American Economic Review **76**(2): 323-329., Stulz, R. M. (1990). "Managerial discretion and optimal financing policies." Journal of financial Economics **26**(1): 3-27.

2.2.1 The profitability effect

Many papers have highlighted that competition affects the firm's investment behavior because it has an impact on the profitability of the investment (Ahn 2002; Gilbert 2006; Vives 2008). However, the definition of a "profitable" investment is probably different for private and government-owned firm. It is a broadly accepted assumption that private firms (or at least, the shareholders of these firms) are interested in profit maximization. Consequently, from the point of view of a private telecommunication operator, a "profitable" investment is one that generates higher additional profits. In principle, a government-owned firm is not intended to maximize its profit but the social welfare and its investment decisions are not based only on pursuit of additional profits but also on the benefit to industry and consumers.

These dissimilar conceptions of what is a "profitable" investment may result in important difference as regards the impact of competition. The private incentives to invest can be defined as the difference between the profit after and before investment ($\Delta_p = \pi_2 - \pi_1$ where π_1 and π_2 are respectively the profits before and after investment). For example, "Schumpeterian" models underline that higher competition intensity results in post-investment prices (p_2) and profits (π_2) and reduce the private incentives to invest. However, because higher competition intensity implies lower post-investment prices, it increases the "social incentives to invest", that can be defined as the difference between the welfare after and before investment ($\Delta_p = w_2 - w_1$ where w_1 and w_2 are respectively the welfare before and after investment).

As underlined by the literature (Aghion, Bloom et al. 2005), the Schumpeterian models only tell one part of the story. In fact, increased competition will also reduce the pre-investment profits π_1 and thus increase the private incentives to invest ("Escape competition" effect). Thus, increased competition has conflicting effects on the private incentives to invest[12]. Similarly, it has conflicting effects on the social incentives to invest since it increases both the pre- and post-innovation welfare.

To illustrate and discuss these intuitions, we introduce a simple model of quantity competition where the investment increases the quality of service (QoS). We assume that two

[12] As shown by Aghion, P., N. Bloom, et al. (2005). "Competition and Innovation: An Inverted-U Relationship*." Quarterly Journal of Economics **120**(2): 701-728., at the industry level these conflicting effects may result in an inverted-U relationship between competition intensity and investment.

operators, the incumbent *I* and the entrant *E*, are competitions on the retail market for telecommunication services. The incumbent can invest to improve the quality of its infrastructure and service, whereas the quality of infrastructure owned by the entrant and the quality of its service is a parameter[13].

The firms face the inverse demand function

$$p_i = A + x_i - q_i - q_j \text{ , } i,\ j \in \{E, I\} \text{ , } i \neq j \tag{2-1}$$

where p_i, q_i and x_i are respectively the price, the quantity and the quality of the service provided by firm *i*, and where *A* is a parameter representing the willingness to pay for the "basic service" ($x_i = 0$) of the consumer with the highest valuation for telecommunications services[14].

To keep the notations as simple as possible and because the level of the marginal cost does not matter for the purpose of our analyses, it is normalized as zero. The profit of the entrant is thus

$$\Pi_E = p_E \cdot q_E \text{ .} \tag{2-2}$$

To increase marginally the quality of its infrastructure and services, we assume that the incumbent has to pay a fixed cost γx_I. Consequently, the cost for reaching any level quality x_I is $\frac{\gamma x_I^2}{2}$, and the profit of the incumbent is

$$\Pi_I = p_I \cdot q_I - \frac{\gamma x_I^2}{2} \tag{2-3}$$

The social welfare is the given by

$$W = \frac{[p_E + q_I]^2}{2} + p_E \cdot q_E + p_I \cdot q_I - \frac{\gamma x_I^2}{2} \tag{2-4}$$

where $\frac{[p_E + q_I]^2}{2} = CS$ is the consumers' surplus.

[13] As we will see in the following, this parameter determines the intensity of competition.

[14] For details on this model see Foros, s. (2004). "Strategic investments with spillovers, vertical integration and foreclosure in the broadband access market." International Journal of Industrial Organization 22(1): 1-24., p. 7-9.

The timing of the game is as follows: first, the incumbent invest to improve the quality of its infrastructure and services; then, the firms compete in quantities on the retail market.[15] From the computation detailed in Appendix 2.2.1, we may have the following results in table 2-3: i) for private (profit-maximizing) firms, increased SBC or FBC reduces the profitability of investment and lowers the incentives to invest (the Schumpeterian effect dominates the escape competition effect), ii) for government-owned (with hybrid behavior) firms, firstly increased FBC reduces the profitability of investment and lowers the incentives to invest (the Schumpeterian effect dominates the escape competition effect). Secondly, increased SBC increases the profitability of investment and strengthen the incentives to invest (the escape competition effect dominates the Schumpeterian effect).

2.2.2 The operational efficiency effect

As an extension of the theory of the X-inefficiency (Leibenstein 1966), numerous studies have shown that competition has - besides its consequences on prices and "Allocative" efficiency - an impact on the operational efficiency. According to (Shirley and Walsh 2000), the argument that competition facilitates monitoring the managers is based on two main arguments: the incentive and the information effects. The former emphasizes that the competitive pressure is accompanied by a threat of losing market shares and of being evicted from the market, which directly contributes to discipline the managers. The latter refers to the idea that competition acts as an information-revealing mechanism that allows the shareholders to assess the efforts made by the managers and to implement incentive contracts.

The interaction between the profitability effect and this "operational efficiency effect" has been investigated by some pioneering work such (Aghion and Howitt 1998) and (Schmidt 1997). This literature focused on the case of private firms where the shareholders seek to maximize the profit and considered forms of competition where the profitability effect always results in a decrease in the incentives to invest.

In order to combine our previous analyses on the profitability effect of competition with the mechanisms described by the literature on the operational efficiency effect of competition,

[15] In the appendix section, we use this framework to study the impact of competition on investment by a private and a government-owned incumbent operator.

we assume that a raise in the competition intensity decreases the investment cost. As underlined in section 2.2.1.1, the intensity of the competition faced by the incumbent can be measured by the price p_I (the lower is the price, the higher is the intensity of competition). Thus, we assume that the cost parameter increases when the price increases. More specifically, the cost of increasing the QoS marginally is

$$\theta = \gamma + f(p_I^o) \tag{2-25}$$

where f is an increasing function and where p_I^o is firm *I*'s equilibrium price when the QoS x_I are zero (under FBC, $p_I^o = \frac{A - x_E}{3}$; under SBC, $p_I^o = \frac{A + a}{3}$).

In line with the literature, we assume that operational efficiency (reflected by the cost parameter θ) does not result from the firm's strategic behavior. It is just a parameter that depends on the intensity of competition. As a consequence, we did not use p_I (as defined by eqs. 2-5 and 2-19) as the indicator of the competition intensity in the definition of θ, but the "pre-investment" price p_I^o [16].

Finally, while theory suggests that any raise in competition intensity increases operational efficiency, it does not specify the nature of this relationship. We will therefore analyze two cases: a linear $\left(f(p_I^o) = \beta \cdot p_I \right)$ and quadratic $\left(f(p_I^o) = \beta \cdot p_I^2 \right)$ relationship.

The new equilibrium quality and investment are determined as follows: for each type of firm (welfare-maximizing or firm with hybrid behavior) and each type of competition (FBC and SBC), we just reconsider the investment stage assuming that the cost parameter is θ (instead of γ as in section 2.2.1). The new equilibrium quantities of x_I are given by table 2-1. In order to study the impact of competition on investment under the assumption that competition affects both the profitability of the investment and the firm's operational efficiency, we derivate the investment functions of table 2-1 with respect to x_E in table 2-2.

[16] p_I depends on the incumbent's investment decision. Consequently, using p_I in the definition of the cost function would imply that firm *I* can influence its operational efficiency through its investment decisions: reducing (resp. increasing) x_I would reduce (resp. increase) p_I and improve (resp. lessen) operational efficiency.

Table 2-1 Equilibrium qualities (x_I)

	Profit-maximizing firm	Firm with hybrid behavior
Linear operational efficiency effect		
Facilities-based competition (FBC)	$\frac{4(A-x_E)}{9\gamma+3\beta(A-x_E)-8}$	$\frac{4A-7x_E}{9\gamma+3\beta(A-x_E)-11}$
Service-based competition (SBC)	$\frac{2A+5a}{9\gamma+3\beta(A+a)-2}$	$\frac{8A-a}{9\gamma+3\beta(A+a)-8}$
Quadratic operational efficiency effect		
Facilities-based competition (FBC)	$\frac{4(A-x_E)}{9\gamma+3\beta(A-x_E)^2-8}$	$\frac{4A-7x_E}{9\gamma+3\beta(A-x_E)^2-11}$
Service-based competition (SBC)	$\frac{2A+5a}{9\gamma+3\beta(A+a)^2-2}$	$\frac{8A-a}{9\gamma+\beta(A+a)^2-8}$

In addition, the operational efficiency effect increases the equilibrium quality and investment: for a given marginal incentive to invest, the lower is the marginal investment cost, the higher are the equilibrium quality and investment. When competition improves the profitability of investment (i.e. when an incumbent with hybrid investment behavior faces service-based competition), the operational efficiency effect reinforce the positive effect of competition on investment. In fact, in eqs. (2-23) and (2-27), $\frac{\partial x_I}{\partial a}<0$ and the increase in the equilibrium quality $\left|\frac{\partial x_I}{\partial a}\right|$ is higher than in appendix section 2.2.1.3.1. When competition decreases the profitability of investment a linear operational efficiency effect soften but does not compensate the negative impact of competition on investment. In fact, in eqs. (2-20) and (2-22), $\frac{\partial x_I}{\partial x_E}<0$ and in eqs. (2-21), $\frac{\partial x_I}{\partial a}>0$. However, if the operational efficiency effect is quadratic, there is a U-inverted relationship between competition intensity and investment. In eqs. (2-24) and (2-25), $\frac{\partial x_I}{\partial x_E}\geq 0$ for low values of x_E and $\frac{\partial x_I}{\partial x_E}<0$ for high values of x_E. In eqs. (2-26), $\frac{\partial x_I}{\partial x_E}<0$ for low values of a and $\frac{\partial x_I}{\partial x_E}\geq 0$ for high values of a[17]. Moreover, it can be easily shown that if competition has a very significant effect in improving the operational efficiency (e.g. $f(p_I^o)=\beta\cdot p_I^3$), the operational efficiency effect dominates the profitability effect for any level of competition intensity.

[17] This result is very similar with Schmidt (1997).

Table 2-2 Variations of the with respect to the competition intensity

	Profit-maximizing firm	Firm with hybrid behavior
Linear operational efficiency effect		
Facilities-based competition (FBC)	eq (2-20), $\frac{\partial x_I}{\partial x_E} = \frac{4(8-9\gamma)}{\left(9\gamma+3\beta(A-x_E)-8\right)^2}$	eq (2-21), $\frac{\partial x_I}{\partial x_E} = \frac{77-63\gamma-9A\beta}{\left(9\gamma+3\beta(A-x_E)-11\right)^2}$
Service-based competition (SBC)	eq (2-22), $\frac{\partial x_I}{\partial a} = \frac{45\gamma+9A\beta-10}{\left(9\gamma+3\beta(A+a)-2\right)^2}$	eq (2-23), $\frac{\partial x_I}{\partial a} = -\frac{9\gamma+27A\beta-8}{\left(9\gamma+3\beta(A+a)-8\right)^2}$
Quadratic operational efficiency effect		
Facilities-based competition (FBC)	eq (2-24), $\frac{\partial x_I}{\partial x_E} = \frac{\beta(A-x_E)^2-9\gamma+8}{\left(\beta(A-x_E)^2+9\gamma-8\right)^2}$	eq (2-25), $\frac{\partial x_I}{\partial x_E} = \frac{\beta A^2-8\beta A x_E+7\beta x_E^2-63\gamma+77}{\left(9\gamma+\beta(A-x_E)^2-11\right)^2}$
Service-based competition (SBC)	eq (2-26), $\frac{\partial x_I}{\partial a} = \frac{\beta A^2-4\beta Aa-5\beta a^2+45\gamma-10}{\left(\beta(A+a)^2+9\gamma-2\right)^2}$	eq (2-27), $\frac{\partial x_I}{\partial a} = -\frac{17\beta A^2+16\beta Aa-\beta a^2+9\gamma-8}{\left(9\gamma+\beta(A+a)^2-8\right)^2}$

It is broadly accepted in the literature that the nature of the agency relationship varies from one type of firm to the other and that the operational efficiency effect is the same for private and government-owned firms. However, there is no consensus on whether it is stronger for former or for the latter. On the one hand, many studies suggest that managerial slack is higher in government-owned than in private firms (Vickers and Yarrow 1989; Shirley and Walsh 2000). Thus, it can be considered that the profitability effect of competition is dominant for private firms while the operational efficiency effect will have a more significant (or even dominant) impact for government-owned firms (*Assumption 1*). On the other hand, several papers (Megginson and Netter 2001; Shirley and Walsh 2001) show that the positive effect of competition in improving the operational efficiency is stronger when it is combined with privatization (*Assumption 2*). In the framework of our model, Assumption 1 could be reflected by a linear operational efficiency effect for private firms and a cubic operational efficiency effect for government-owned firms. Under Assumption 2, the operational efficiency effect would be linear for government-owned firms and cubic for private firms.

Finally, the impact of competition on investment by incumbent operators can be summarized by the following table 2-3. The literatures strongly support the view that relationship between competition and investment is differ between private and government-owned firms. Our analyses suggest that in most cases the positive impact of competition on investment is more clear for government-owned than for private firms.

Table 2-3 Expected results from assumptions and hypotheses

		Privated incumbent (profit- maximizing)		Government-owned incumbent (hybrid behavior)	
Profitability effect	SBC	-		+	
	FBC	-		-	
Operational efficiency effect	Assumption 1	.		+	
	Assumption 2[18]	+		.	
Overall impact of SBC or FBC	SBC * Assumption 1	-	**« - »**	++	**« + »**
	SBC * Assumption 2	?		+	
	FBC * Assumption 1	-	**« - »**	?	**« - »**
	FBC * Assumption 2	?		-	

Notes: If the incumbent is a private firm: SBC and FBC reduce the investment through the profitability effect. Under assumption 1, the operational efficiency effect will be insignificant and the overall impact of SBC and FBC will be negative. Under assumption 2, the operational efficiency effect will be significant and the overall impact of SBC and FBC may be negative, positive, or non-linear.

2.2.3 Review of the previous studies

The theoretical literature and empirical research on the impact of liberalization policies on investment have mostly focused on the link between access regulation and investment[19]. Nevertheless, there are few general papers on the relationship between liberalization and investment, reflecting some of the issues raised in the previous section. Table 2-4 provides a Summarized previous research on the impact of liberalization policies on investment. It shows the variables that each paper seeks to explain (Column “Dependant variables”) and the variables related to liberalization policies used as explanatory variables (Column “Independent liberalization variables”).

[18] The only exception is the case of facilities-based competition (FBC) under the assumption that the operational efficiency effect is significant private firms and insignificant for government-owned firms (assumption 2).

[19] For the literature reviews, see Cambini, C. and Y. Jiang (2009). "Broadband investment and regulation: A literature review." Telecommunications Policy **33**(10-11): 559-574.

Table 2-4 Summarized previous research on the impact of liberalization policies on investment

Papers	Endogenous liberalization variable (Dependent variables)	Exogenous liberalization variables (Explanatory vriables)			Data
		Competition	Privatization	Regulations	
(Calderini and Garrone 2001)	Basic research (Publication) Applied research (Patent)	Market openned (-) Market openned (+)			17 European incumbents, 1985-1999
(Datta 2003)	R & D intensity Productivity	1 – AT&T's market share (+) 1 – AT&T's market share (+)		Divestiture (+) Divestiture (-)	AT&T, 1962-1997
(Koski and Kretschmer 2005)	New services (induce date) Prices Diffusion speed	At least 2 operators (+) At least 2 operators (-) At least 2 operators (+)		IRA (?), Standards (+) IRA (?), Standards (?) IRA (+), Standards (+)	25 countries, 1991-2000
(Li 2008)	Service penetration Network expansion Prices Labor productivity	Entry (+) Entry (+) Entry (+) Entry (+ then -)	Privatization (+,?) Privatization (-,?) Privatization (?) Privatization (?)	IRA (+) IRA (?) IRA (?) IRA (+)	30 countries 1991-2006, Mobile market
(Li and Xu 2004)	Employment Investment (industry level) Density of fixed-line network Density of mobile network Demand Prices Labor productivity Total Factor Productivity (FTP)	Nb. of market opened (?) Nb. of market opened (+,?) Nb. of market opened (?) Nb. of market opened (+) Nb. of market opened (+) Nb. of market opened (?) Nb. of market opened (?) Nb. of market opened (?)	Full (?), partial (?) Full (+), partial (?) Full (+), partial (?) Full (+,?), partial (?) Full (?), partial (?) Full (+?), partial (?) Full (+), partial (?) Full (?), partial (?)		177 countries 1990-2001
(Ros 1999)	Network density Network density growth Productivity Productivity growth	Market opened (?) Market opened (?) Market opened (+,?: +) Market opened (?)	Privatization (+?) Privatization (+; ?) Privatization (+?) Privatization (+?)		130 countries 1986-1995

Note: IRA means "Independent Regulation Authority"

The latter liberalization variables can be grouped into three categories: variables related to competition, privatization and regulation. Boxes belonging to the corresponding columns specify what proxies are used for these variables. For example, in (Calderini and Garrone 2001), competition is measured by a dummy variable that takes the value 1 if the telecommunications sector is opened to competition, and the value 0 otherwise. These boxes also show the relationship found by each paper between the independent and the dependent variable. A "+" means that the correlation is positive, a sign "-" that it is negative and a "?" that no significant correlation was found. When significance levels are low or when the results are not robust, the signs "+" or "-" are followed by a question mark. For example, (Calderini and Garrone 2001) find a positive and significant relationship between competition and investment in applied research (number of patent), and a negative and significant relationship between competition and fundamental research (number of publication). Finally, the last column specifies what kinds of data are used by the different papers.

Among these works, only (Datta 2003) and (Calderini and Garrone 2001) consider the operators' investment as the variable to explain. However, the other papers seek to explain several variables that are directly related with the operators' investments. This is particularly the case of network density (Ros 1999; Li and Xu 2004) and expansion (Li 2008) and, to a lesser extent, of service diffusion and penetration (Koski and Kretschmer 2005; Li 2008).

With the exception of (Calderini and Garrone 2001) and (Datta 2003), the works presented are based on country-level data. Although these data are clearly relevant (the development of the telecommunications sector is linked to the investment of all firms in the industry and not just to the investment of incumbent operators), studies that use them do not indicate how liberalization policies affect the investment strategies of the different types of firms of the industry. Obviously, liberalization policies do not have the same impact on the operators (who are directly affected by these policies) and on upstream firms, such as equipment suppliers. Furthermore, their impact also probably differs between incumbent and entrant operators[20].

[20] For example, while it is widely accepted that a regulation setting low access prices reduces the incumbents' incentives to invest in their infrastructures (because it reduces the post-investment profits), the impact of such a policy on infrastructure investment by the entrants is more debated. On the one hand, low access prices increase the profits of the entrants when they rely on the incumbent's infrastructure to provide services (i.e., using Bourreau and Dogan (2005)'s terminology, when they choose the "buy" rather than the "build" option) and reduce their incentives to roll-out their own infrastructure. On the other hand, the theory of the "ladder of investment" in Cave (2006) suggests that by facilitating the development of service-based competition low access charges may facilitate the further development of facilities-based competition.

Many empirical studies also show that opening the market to competition improves the operational efficiency of incumbent public firms (Phoenix 2003; Ford and Spiwak 2004). It seems however that these policies are more efficient when combined with privatizations (Megginson and Netter 2001). These results refer to the essential question of the roles of ownership and competition in promoting organizational efficiency. While (Shirley and Walsh 2000) point out that ownership is more important than competition, (Vickers and Yarrow 1989) consider that the literature supports the opposite point of view. Without trying to decide between these two positions, one can underline that there are complementarities between opening the market to competition and privatizing the incumbent firms. In other words, the improvement in monitoring the managers is more significant when these policies are combined.

In the previous literature, many studies also strongly support the view that the relationship between competition and investment is different from that between R&D investment and capital investment. Therefore, the different impacts of competition on investments can be summarized in table 2-5. The effect of competition shows different consequences when it combine with privatization (i.e. for private and government-owned firms). Therefore, it is worth noting that this was almost ignored in the previous literature (Bognetti and Obermann 2008). (Ros 1999)[21] uses privatization as a dependant variable but does not consider the interaction between competition and privatization[22]. In other words, (Ros 1999) considers privatization as a dimension of liberalization policies that may have an impact on the firms' investment behavior (just as the development of competition), but ignores the fact that competition may have different effects on private and government-owned firms.

[21] (Ros 1999) distinguishes two groups of countries. In most cases, the results are identical. When different, it first shows the results for those whose per capita GDP exceeds $ 10,000, then those obtained for countries whose GDP per capita is below $ 10,000.

[22] The same is true for most of the papers on access regulation and infrastructure investment reviewed by Cambini and Jiang (2009).

Table 2-5 Summarized previous theoretical studies

Liberalization policies		Key issues	Expected impact on R&D	Expected impact on CAPEX	References
Privatization		- Ownership - Managerial behavior - Agency problem - Risk - Short/long term - Budget constraints	(-) by "Myopic Investment Behavior (MIB)" assumption	(-) but lower than on R&D (+)[23]	(Alchian and Demsetz 1972), (Laffont and Tirole 1993), (Munari and Sobrero 2005), (Sappington and Stiglitz 1996), (Laverty 1996), (Bushee 1998), (Shirley and Walsh 2000), (Hansmann 1988), (Hart and Moore 1996)
Competition (SBC &FBC)	*Service-based competition (SBC)*	- Spillover effect - Risk - Build-or-buy strategies	(-) impact if R&D is mainly dedicated to infrastructure innovation (+) with a change in the nature of R&D	(-) for incumbents More balanced for entrants	(Foros 2004), (Kotakorpi 2006), (Vareda and Hoernig 2007), (Friederiszick, Grajek et al. 2008)
	Facilities-based competition (FBC)	- Appropriability - Cost-based rate - Contestable market - the Ladder of investment	? (-) with sunset	? (-) (+)	(Jorde, Sidak et al. 2000), (Hausman and Sidak 2005), (Bourreau and Dogan 2005), (Waverman, Meschi et al. 2007), (Cave and Vogelsang 2003), (Baumol 1982)
	Competition & Nature of investment	- Schumpeterian & Darwinian effects - Inverted-U relationship - Drastic & incremental innovations - Efficiency & Replacement effects	Depends on the level of competition intensity (-- to +)	Depends on the level of competition intensity (+) impact stronger than on R&D (-) impact lower than on R&D (- to ++)	(Arrow 1962), (Aghion, Bloom et al. 2005), (Gilbert and Newbery 1982) , (Calderini and Garrone 2001)
Interaction between privatization & competitions		- Complementarities - Productivity - Efficiency pressure		(+) (??)	(Bognetti and Obermann 2008), (Parker and Kirkpatrick 2005), (Li and Xu 2004), (Li 2008), (Koski and Kretschmer 2005), (Fumagalli, Garrone et al. 2005)

[23] Resources are reallocated from R&D (risky and long term investment) to CAPEX (short term and less risky).

This study assumes that in most cases the positive impact of competition on investment is more clear for government-owned than for private firms[24]. Finally, some dimensions of liberalization policies, and in particular privatizations, only concern the incumbent operators. As we mentioned in the introduction, two reasons led us to focus on the latter type of firms: in most countries the incumbent are still, among the operators, the main providers of new infrastructures and technologies; the liberalization policies have changed radically the incumbents' competitive environment and internal organization.

(Li and Xu 2004) and (Li 2008)[25] have paid more attention to this issue. A first limitation of this work is that they explain phenomena related to the entire telecommunications sector from policies that cover only the operators (opening markets to competition and the existence of a regulatory authority), or even only the incumbent operators (privatization). Also, how the interaction between competition and privatization is studied does not fully reflect the fact that competition may have different effects on private companies and government-owned incumbent firms.

There are still some limitations in previous studies when they consider both privatization and competition. For example, in the regressions proposed by (Li and Xu 2004) and (Li 2008), the vector exogenous variables include the proxies for competition and privatization and an interaction term "*competition*privatization*". (Li and Xu 2004) found that the coefficient on variable "*competition*" is positive but lower than the coefficient on variable "*competition*privatization*" and interpret this result as an evidence that the impact of competition on investment is higher when it is combined with privatization. This interpretation is not so obvious especially as the proxy for competition intensity is not a dummy[26].

Therefore, if one seeks to study to what extent competition has different effects on private and government-owned incumbents, it seems more natural to evaluate the correlation between the intensity of competition and investment for each type of firm (i.e. to consider

[24] The only exception is the case of facilities-based competition (FBC) under the assumption that the operational efficiency effect is significant private firms and insignificant for government-owned firms (assumption 2).

[25] (Li 2008) and (Li and Xu 2004) also consider the interaction between the liberalization variables (see p. 33).

[26] If the variable x is a dummy such as x=1 if condition A is satisfied and x=0 otherwise, and if y is a dummy such as x=1 if condition B is satisfied and x=0 otherwise, then the meaning of variable $z=x*y$ is clear: z=1 if conditions A and B are satisfied and z=0 otherwise. But if y is not a dummy but a discrete or continuous variable, the meaning of z is less clear. Moreover, interpreting the results would have been even more difficult if (Li and Xu 2004) had obtained coefficient with opposite signs on the variables "competition" and "competition*privatization".

two groups of firm: private and government-owned firms) than to introduce an interaction term as (Li and Xu 2004) and (Li 2008) did. With this intention on the liberalization dimensions, this study identifies the different effect of competition on firms' investments according to whether the firm is private or government-owned firms. Thus, it can firstly be estimated that the profitability effect of competition is dominant for private firms and the operational efficiency effect is more significant for government-owned firms (assumption 1). Secondly, it is clarified that the positive effect of competition in promoting the operational efficiency is stronger when it is combined with privatization (assumption 2). Finally, this study shows that the type of investments is changed as a result of the combination between competition and privatization.

2.3 Empirical Analysis

This study considers a model with a vertically integrated monopoly network provider who faces price taking rival operators in the retail market. The network is an essential input to the production of the downstream telecommunications services and we assume the network operator is required to provide access to its rivals. And it is supposed that the services of the rivals and the incumbent are vertically differentiated, and we examine the incumbent's decisions on how much is invested in network quality with the division of private firms and government-owned firms when there is competition.

2.3.1 Data and variables

To investigate the impact of competition on different type of investments by private and government-owned incumbent operators, this study use several databases. The firm list and yearly financial data are based on the DataStream of Thomson Reuters[27] for the fixed and mobile telecommunication industry in OECD countries. This data contains both mobile and fixed operators because the firms have nature government-owned origin. The firms are still the major telecom operator and most of them have both mobile and fixed business unit in their own domestic market. Then we choose former nature monopoly firms and match the list with regulatory variables of WBIS[28], WCIS[29] and OECD regulatory database[30]. Table 2-6 shows the definition, sources and descriptive statistics of variables such as dependent, regulatory, firm characteristics and control variables. Finally, an unbalanced yearly panel with 97 observations for 15 years from 1994 to 2008 is used and these firms account for nature monopolies of 20 OECD countries. The rationales for inclusion of each variable are described below.

[27] This database covers 51,900 active global companies and offers the broadest company coverage, representing 99% of the global market capitalization, http://online.thomsonreuters.com/datastream/ (2011).

[28] World broadband Information Service (WBIS) is an online database of broadband, fixed-line telephony and multichannel TV subscriber numbers from 2000 to 2008 and broadband forecasts to 2013. Launched in 2003, WBIS currently covers 160 countries and more than 1100 operators' market share, penetration rate and ARPU, http://www.wbisdata.com (2011).

[29] Since 1995, World Cellular Information Service (WCIS) has offered the mobile industry players and an invaluable insight into the industry - encompassing 50 different key markets, http://www.wcisdata.com (2011).

[30] Indicators of regulation in energy, transport and communications (ETCR) in OECD. The ETCR indicators cover sectors in which anti-competitive regulation tends to be concentrated, given that manufacturing sectors are typically lightly regulated and open to international competition in OECD countries, http://www.oecd.org/document/32/0,3343,en_2649_34323_35791136_1_1_1_1,00.html (2011).

Table 2-6 Definitions and descriptive statistics of variables

Dependent variables	Definitions (Units)	Source	Obs.	Mean	St. D	Min	Max
lcapex	Log value of (Capital expenditures[31] (US$))	Thomson DB	234	14.610	1.175	11.891	17.210
lrnd	Log value of (R&D expenditure (US$))	Thomson DB	189	11.645	2.198	6.358	15.081
SBC&FBC competition							
SBC_bb	Nb. of DSL non-incumbent access / Total nb. of DSL access in broadband market	Computed from WBIS and WCIS	300	.1282	.1704	0	.6509
FBC_bb	Nb. of DSL incumbent access / Total nb. of DSL access in broadband market	Computed from WBIS and WCIS	300	.1511	.2009	0	.8025
SBC_m	Nb. of mobile non-incumbent access / Total nb. of mobile access in mobile market	Computed from WBIS and WCIS	300	.0029	.0093	0	.0663
FBC_m	Nb. of mobile non-incumbent access / Total nb. of mobile access in mobile market	Computed from WBIS and WCIS	300	.5026	.2417	0	1
Privatization							
Private Ctrl	Dummy value =1 if the government the majority shareholder and if not 0.	OECD regulation DB (ETCR)	300	.43	.4959	0	1
Firm characteristics							
lemployee	Log value of (Total employees)	Thomson DB	238	10.7814	1.2125	7.4425	12.6413
lage	Log value of (1998 - Established year)	Thomson DB	238	3.2122	1.0126	0	4.8752
lnetprofit	Log value of (Net profit (US$))	Thomson DB	209	13.8634	1.2004	8.7502	16.0733
Control variables							
lnb_bb	Log value of (Nb. of subscribers for broadband)	WBIS DB	155	13.5681	1.9802	7.8240	16.5640
lnb_m	Log value of (Nb. of subscribers for mobile)	Wireless intelligence	271	15.3855	1.4639	11.1882	18.1200
gdp_pop	Gross domestic product (GDP) (US$) / Population of n country	ITU DB	300	25784.26	11641.01	0	57232.38
lpopbigcity	Log value of (Population of urban (%))	ITU DB	263	15.1946	.9284	12.7234	16.3180
_Iyear_1995 ~_Iyear_2008	Year dummies between 1995 and 2008	Calculation	300	.0667	.2499	0	1

[31] It represents the funds used to acquire fixed assets other than those associated with acquisitions. This includes property, plant and investments in machinery and equipment.

Our investment measures of exploration (creating new knowledge and technologies) and exploitation (using existed knowledge and technologies to develop new products and services) are R&D investment and capital expenditure (He and Wong 2004). Using logarithms, we can interpret the results of respective coefficients as elasticity. $lrnd_{it}$ is the log value of research and development cost and it is implicit that firms will take advantage of new business opportunities by trying to impose a different industrial structure and possibly new dominant paradigms. Traditionally, new technological trajectories do provide the chance to lead the market and play a key role (Fields 2004). *lcapex* is represented the exploitation property of investment and it is a very accurate measure of infrastructure investment (Friederiszick, Grajek et al. 2008). Once the regulatory induced in the market, the main concern of incumbent firms is to defend their position and to avoid competition. For this reason, the incumbent create strong barriers to entry and R&D efforts are in these cases mostly directed towards the incorporation of new and incremental innovations on the existing products, rather than towards the development of radically new products (Cesaroni, Minin et al. 2005).

Privatization of incumbent operators (*Private Ctrl*), inter-(*SBC_m*, *SBC_bb*) and intra-platform (*FBC_m*, *FBC_bb*) competitions on the operators' investment choices (forcing infrastructures operators to open their infrastructures; Virtual Network Operators (VNOs)), and interactions between liberalization policies are the most represent able liberalization processes in telecommunication industry. This various regulatory processes are observed in fixed-telecommunication as well as in other network industries (Bognetti and Obermann 2008). In fact, the process is not exactly the same between countries and network industries. Some of OECD countries are not forcing an access regulation. And the level of privatization is different under the specific political situations (OECD 2007). Therefore, this study identifies the impacts of the different dimensions about the liberalization policies on the level and activities of investment.

The installed network resources are used as control variables in this study. Before the 1990's, the activities of the national monopoly were almost the only fixed line telephony. Then mobile telephony and internet developed and became more and more important sources of income for the operators. Generally, the installed base of previous networking deployments and learning-by-using effects are likely to affect the timing of subsequent network investments (Farrell and Saloner 1985). For example, (Koski and Kretschmer 2005)

study that standardization prompt 2G entry and accelerated the commercialization of 2G for incumbent technologies because 1G profitability is a likely indicators for adopting new technologies and expected 2G profits. Therefore, the installed network base accelerates the possibility of higher investment based on the previous resources of network and deployments. From this, our intuition is that we have to take into account these previous market shares (*lnb_bb* and *lnb_m*) of operators as control variables to suggest the policy for the network and R&D deployment.

The characteristics of firms such as age (*lage*) and size (*lemployee*) are considered as well as the year dummies and a dummy of mobile operators. The time period effect variables can capture macroeconomic shocks that affect all operators in the analysis. For instance, the IT market bubble in early of 2000s, which affected the investments in telecommunication industry, can be accounted for by yearly dummies. GDP per population of country (*gdp_pop*) and population in big city (*lpopbigcity*) are considered as the proxies of demand and cost in this model. Population density in big city reflects the costs of infrastructure deployment for the reason that the density of households in limited area determines the expenses of constructing in the network deployment. For the demand, we assume that the level of wealth in a country is related with entry time and investment of the new network deployments. With these variables, this study estimates the activities of the operators have changed over the liberalization policies.

2.3.2 Model

To find the impacts of liberalization policies on the activities of investment, we need to set up an empirical model based on the consideration of two points. First, the consideration of endogeneity is essential for the econometric modeling of the investments because ignoring this may cause severe biases in the empirical results and difficulties in interpretation of the results . All of liberalization implementations including privatization and inter-(SBC) and intra-competitions (FBC) have the effect of political and administrative processes, which might interact with the investment strategies by firms (Friederiszick, Grajek et al. 2008). In order to control the endogeneity, this study induces instrument variables which are the determinants of liberalization implementations.

Second, the current state of investment is influenced by the last period's decisions, but static models assume that all the relationships of the model occur immediately in the same period. (Greenstein, McMaster et al. 1995) put more structure into the hypothesized dynamic process by considering a long-term equilibrium relation along with an adjustment equation. As a consequence, they derived an infrastructure equation with structural lags. For an investment model, it is very important to incorporate these dynamics. Some of the investment decisions can be made immediately and will lead to the observable short term effects. Also, they need adjustment time and will therefore only gradually translate into real effects. Hence, the accumulated effect can significantly differ from the short term effect. Investment has dynamic characteristic and two-way relations with impact factors such as sales, price and employers. To measure the regulations impact on the investment needs controlling of lots of statistics problems. So, considering the dynamic effect is necessary to identify the effect of liberalization policies. Therefore, the simplest solution to account for these dynamics is to use lagged explanatory and lagged dependent variables to the model (Alesina, Ardagna et al. 2005).

For the impact of regulation on the network deployment, (Chang, Koski et al. 2003) finds that a lower access price causes more investment of digital technology among the US incumbents. On the contrary, they suggest the competition has worked by facilitating new entry through decreasing interconnection prices using European data for interconnection. A balanced panel firm-level data for the 5-year period from 1994 to 1998 is used and they estimate Generalized Least Squares (GLS) method with the controlling of heteroscedasticity and autocorrelation. Using the 180 fixed operators of 25 European from 1990 to 2006, (Friederiszick, Grajek et al. 2008) identify relationship between entry regulation and infrastructure investment. The results of dynamic investment models show that unbundling discourages infrastructure investment by entrants but has no effect on incumbents in fixed-line telecommunications.

(Koski and Kretschmer 2005) estimate the effects of regulatory policy and competitive environment on the three the performances (entry time, service price and diffusion) using a panel of 25 countries over the years 1991-2000. Considering the non-random sampling and using 3SLS model, they suggest that the within regulation (standardization) prompt 2G entry and diffusion, whereas within- standards competition accelerate less aggressive price competition than between-standards competition. For the mobile network, (Li 2008)

examines the impacts of privatization, new entry and independent regulatory authority using 30 OECD countries (including China) over the time period 1991-2006. The three equation model shows that introducing new entry is positively correlated with mobile network penetration and expansion. Based on the national-level panel dataset, the results also highlight an independent regulator in privatized mobile markets has crucial role. For instance, privatization is negatively correlated with mobile network expansion without an independent regulator, even in certain competitive market environments.

Until now, there is few empirical findings support the relation between regulation and investment of entrants and incumbent (Cambini and Jiang 2009). The insufficiency of micro-data in the firm level data has a limitation to the evaluation for investment activities by fixed or mobile operators to prove the effectiveness of regulations. To solve this problem and test the relations between regulation and investments, this study apply The Arellano-Bond GMM estimator (1991)[32] approach to estimate how the different regulatory dimensions affect the level and the nature of investment for the natural monopoly operators.

GMM is more efficient way in cases where there is more IV than endogenous variables (over identified) (Arellano and Bond 1991). The intuition behind the optimal weights is to use weights that are inversely proportional to the variance of the moments (Holtz-Eakin, Newey et al. 1988). Dynamic panel model have their specification both lagged dependent variables and unobserved individual effects. Through explicitly including variables to consider past behavior and time-invariant individual-specific effects, dynamic panel method allow us to understand better what factors drive firms' activities over time, differentiating, even through such variables are latent (Wawro 2002). There are still some controversial issues for using GMM according to the length of time (T) and the number of observations (N), (Judson and Owen 1999) suggest a suitable time period (T) between 5 and 30 for GMM with first-moment instruments using the Monte Carlo method. Since our data set has 15 years period and 20 individual firms, it is proper to use GMM. We estimate fundamental models like this:

[32] See, Arellano, M. and S. Bond (1991). "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations." The Review of Economic Studies **58**(2): 277.

$$
\begin{aligned}
lcapex_{ijt} &= a_0 + \beta_0 lcapex_{ijt-1} \\
&+ \beta_1 SBC_bb_{ijt} + \beta_2 FBC_bb_{ijt} + \beta_3 SBC_m_{ijt} + \beta_4 FBC_bb_{ijt} \\
&+ \beta_5 PrivateCtrl_{ijt} + \beta_6 \ln b_bb_{jt} + \beta_7 \ln b_m_{jt} \\
&+ \beta_8 lage_{ijt} + \beta_9 lemployee_{ijt} + \beta_{10} lprobit_{ijt} \\
&+ \beta_{11} gdp/pop_{jt} + \beta_{12} lpop/bigcity_{jt} + \beta_{13\ldots} D.year_t + \mu_{ijt}
\end{aligned}
\tag{2- i}
$$

$$
\begin{aligned}
lrnd_{ijt} &= a_0 + \beta_0 lrnd_{ijt-1} \\
&+ \beta_1 SBC_bb_{ijt} + \beta_2 FBC_bb_{ijt} + \beta_3 SBC_m_{ijt} + \beta_4 FBC_bb_{ijt} \\
&+ \beta_5 PrivateCtrl_{ijt} + \beta_6 \ln b_bb_{jt} + \beta_7 \ln b_m_{jt} \\
&+ \beta_8 lage_{ijt} + \beta_9 lemployee_{ijt} + \beta_{10} lprobit_{ijt} \\
&+ \beta_{11} gdp/pop_{jt} + \beta_{12} lpop/bigcity_{jt} + \beta_{13\ldots} D.year_t + \mu_{ijt}
\end{aligned}
\tag{2- ii}
$$

The dependent variables ($lcapex_{ijt}$ and $lrnd_{ijt}$) in equations (i-ii) reflect the level and activities of different investments for firm *i* of *j* country in time period *t* and their previous period values are used as explanatory variables in right term. The lagged variables include the assumption that firms do not instantly adjust the investment activities according to the present market circumstance. For the competition in inter-[33] and intra- platform[34], we used for variables such as SBC_bb_{ijt}, FBC_bb_{ijt}, SBC_m_{ijt} and FBC_bb_{ijt}. The $PrivateCtrl_{ijt}$ represents the level of privatization of *j* country in time *t*.

To test the general assumption that competition has different effects on private and government-owned firms, and the specific assumption summarized by Table 2-3, this study divides data set into two parts according to $PrivateCtrl_{ijt}$ dummy such as government-owned firms (*p=0*) and private firms (*p=1*).

As control variables which stand for the installed base of previous networking deployments and learning-by-using effects, $\ln b_bb_{it}$ and $\ln b_m_{it}$ are used to represent of the market share of broadband and mobile markets. We also consider the firm characteristics variables ($lage_{ijt}$, $lemployee_{ijt}$ and $lprobit_{ijt}$), demand proxy of service (gdp/pop_{jt}) and cost proxy of investment ($lpop/bigcity_{jt}$). Finally, this model includes time dummies ($D.year$) and error term (μ_{ijt}) which captures the variation in the unexplained investment activities.

[33] For the inter-platform competition, we used *SBC_bb* and *SBC_m* which are *"broadband connections of non-incumbent fir ms using LLU or other wholesale services / total broadband connections*".

[34] For the intra-platform competition, we used *FBC_bb* and *FBC_m* which are *"broadband connections of non-incumbent fir ms using their own networks (e.g. cable, FTTH) / total broadband connections*".

Using different measures for the equation, we estimate the elasticity of each regulation on the nature of investment. In detail, we make categories of the liberalization policies which can lead to absolute or relative increase of exploitation investments at the expense of exploration investment. In addition, since there are more moment restrictions than necessary for identification, the restrictions are tested by (Sargant's test of over identifying restrictions) and Arellano-Bond test.

2.4 Results and Analysis

In order to test the implications of various regulations' dimensions presented above, the empirical analysis has been conducted for the firm level data of 20 OECD countries. In the dynamic panel models, we choose the Arellano and Bond system GMM with various assumptions for the number of lags, predetermined and endogenous variables. The results show the best efficient and consistent values of coefficients is used. To validate the proper models, we consider both over-identifying condition and first-, second-order autocorrelation tests. For the over-identifying condition, we use the Sargan test of over-identifying restrictions which has the null hypothesis such as *"H0: over-identifying restrictions are valid".* According to the values of the Sagan test, we cannot reject the null hypothesis. Therefore the model has no problem regarding the over-identifying restriction.

Concerning the test for autocorrelation in the first-differenced errors, we calculate the Arellano-Bond test (Abond test) with the null hypothesis such as *"H0: no autocorrelation".* When the idiosyncratic errors are independently and identically distributed (i.i.d), the first differenced errors are first-order serially correlated. So, as expected, the outputs of Abond test shown in the table 2-7 suggest an evidence against the null hypothesis of zero autocorrelation in the first-differences errors at first order. For the second order, the test identifies no significant evidence of serial correlation in the first-differenced errors at order 2.

There are two types of results according to dependent variables such as CAPEX and R&D in table 2-7. The results of our estimations are summarized for both private and government-owned firms (model a), for government-owned firms only (model b), and for private firms only (model c).

In the dynamic investment model, considering the previous variable is generally essential. Our results show that, capital expenditure is not significantly affected by previous invest values expect when there are both competition and privatization, whereas the last investment of R&D and investment' activities have general positive effect on present activities. Above all, the elasticity of activities in investments is significantly related with the previous investment values with 1 % confident level, as well as the previous effect of R&D is broadly significant than network deployment.

When we consider the assumptions in section 2.2, the estimated results for CAPEX (exploitative) investment fit well with the theoretical framework. For model (1), the overall

impact of competition when we consider it individually is insignificant. The impact of competition is much clearer when we distinguish between government-owned and private firm. This first results support the general assumption that competition does not have the same effect for government-owned and private firms.

More specifically, we find that the effect of competition has a negative impact on private firms (model *1-c*), whereas it fosters the infrastructure investment of government-owned firms (model *1-b*). According to our theoretical framework, this result denotes that the operational efficiency effect dominates for government-owned firms, whereas the profitability effect dominates for private firms. So, firms less focus on infrastructure investment when they are private firms and faced with market competition.

Comparing the results for the different forms of competition in model (1), we can see that for private firms, the negative impact of competition on infrastructure investment is stronger for service-based (*-2.360a* and *-7.753a*) than for facilities-based competition (*-0.842a*). Furthermore, for private firms, the negative correlation (*-0.161*) between facilities-based competition on mobile market (*fbc_m*) and investment is not significant. This result can be interpreted in different ways. First, the impact of FBC on mobile market may not be clearly negative: Although more intense competition reduces the incentives to invest since it decrease the post-investment profits of a larger amount than it reduces the post-investment profits (see section 2.2.1), it may also induce more intense "rivalry" and lead to preemption behavior and investment races (see section 2.2.2.1.3 of Appendix). A second interpretation is that the operational efficiency effect and the profitability effect cancel each other. A reason why the operational efficiency effect would be more important for FBC on mobile market than for other forms of competition, may be that *fbc_m* was chronologically the first type of competition to develop[35]. When FBC was introduced on mobile market, incumbent operators were pure monopolists. Thus, the introduction of FBC on mobile market has probably played in important role in reducing managerial slack. Conversely, when the other forms of competition have probably played a less important role in reducing managerial slack, since FBC on mobile market preexisted.

The theoretical result that for a government-owned company (model 1-b), the

[35] In fact, in most countries, mobile market were opened to competition in the early 90s whereas fixed-line market were liberalized in the late 90s. Furthermore, in mobile market, competition was originally facilities-based -- service-based competition started to develop very recently

profitability of investment increases as the intensity of SBC increases, whereas it decreases as the intensity of FBC increases is not supported by our estimations. In fact, from this theoretical result, we expected the coefficient of SBC to be higher than the one of FBC whatever the market (fixed-line or mobile). However, it is true only for the mobile market.

Although the estimated results for infrastructure investment fit well with our theoretical framework, there are some findings in R&D investment model (2). First, the sign of most of the coefficients does not clearly change between government-owned (model 2-c) and private firms (model 2-b). By examining the results more in detail, there is a negative and significant correlation between SBC in the broadband market (*-3.177a*) for government-owned firms, as well as a positive and significant correlation of FBC in the mobile market (*9.166b*) for private firms. This result could be interpreted as evidence that as regards R&D investment, the operational efficiency effect dominates for privative firms, whereas the profitability effect dominates for government-owned firms.

However, when we check general models (a) between CAPEX and R&D, we can find that the individual effects of competition and privatization are insignificant for infrastructure investment and lead to a negative effect for R&D investment (*-2.642a* and *-1.189a*). This means that for the investment of "exploration of new possibilities", each competition and privatization has separated negative effects at least. Once the firms are faced with any of liberalization policies, the firm try to reduce their long-term oriented investment. Therefore considering of the combination of each liberalization policies are important. This point is firmly backed up when we compare detailed models (*1-b* vs. *2-b* and *1-c* vs. *2-c*) of R&D.

When there is only competition without privatization in the market (in model *1-b* vs. *2-b)*, firms prefer the infrastructure investment to the R&D investment. If competition is adopted, firms are likely to emphasize investments with exploitable characteristics. That is, the firms try to aim at abundant productivity and refinement related to a creating reliability in experience. For instance, (Calderini and Garrone 2001) show that the nature of investment is shifted into more applied investment which has short-term return in the liberalization process. On the contrary, there are significant reverses of the investment strategy when there are both competition and privatization (in model *1-c* vs. *2-c*). This means that well-blended liberalization policies can prompt the long-term investment ("exploration of new possibilities). (Li 2008) also indicated the importance of liberalization policies and support system such as independent industry regulator.

Table 2-7 Estimated results on the dynamic models

	y=lcapex (exploitative investment) -Model (1)						*y=lrnd (explorative investment) -Model (2)*					
	Model(1-a) -Individual effect of competition and privatization		*Model(1-b) -Government-owned firm (p=0) -*		*Model(1-c) -Private firm (p=1)*		*Model(2-a) -Individual effect of competition and priv iza ion*		*Model(2-b) –Government -owned firm (p=0)*		*Model(2-b)-Private firm (p=1)*	
	Coef.	Se.	Coef.	Se.	Coef.	Se.	Coef.	Se.	Coef.	Se.	Coef.	Se.
Y (t-1)	0. 62	0.328	-0.178	0.191	0.294b	0.138	0,625a	0,125	0,813a	0,13	- 24	0,367
SBC_bb	-0.947	0.579	1.139b	0. 04	-2.360a	0.617	-2,642a	0,67	-3,177a	0,	-2,8 6	2,9 6
FBC_bb	-0.549	0.643	2.040a	1.063	-0.842a	0.279	-1,067	0,761	-0,591	0,859	-2,170	1,759
SBC_m	4.407	3.700	12.949b	5.721	-7.753a	4.583	-4,094	3,514	-1,232	5,774	53,808	82,97
FBC_m	0.945	1.769	7.134a	2.590	-0.161	1.169	0,545	2,300	0,354	3,268	9,166b	4,528
Private Ctrl	-0.215	0.396					-1,189a	0,332				
lnb_bb	0.288b	0.129	0.180	0.127	0.125	0.136	0,494a	0,165	0,048	0,206	1,595	1,336
lnb_m	0.865b	0.404	0.865a	0.263	0.316	0.352	0,723	0,445	1,162a	0,420	-2,229	2,184
lage	-0.164	0.277	-0.551a	0.285	-0.091	0.144	-0,483	0,359	-0,941	0,633	2,276	1,617
lemployee	0.036	0.210	0.682a	0.224	0.421a	0.101	0,192	0,130	0,424	0,351	1,325a	0,419
lprofit	0.019	0.056	-0.073	0.084	-0.070	0.044	0,091	0,098	0,036	0,094	-0,268	0,221
gdp_pop	-0.000	0.000	0.000	0.000	-0.000	0.000	-0,000	0,000	-0,000	0,000	-0,000	0,000
lpopbigcity	-0.955	0.596	-0.512	0.367	-0.295	0.511	-1,258b	0,530	-1,560b	0,771	0,135	0,428
_cons	7.265	4.533	0.377	3.368	5.425a	3.217	3,754	3,985	6,097	4,676	-0,045	10,37
Observation	97		46		51		73		43		30	
Sargan[36]	chi2(15) = 13.668 Prob > chi2 = 0.551		chi2(15) = 14.026 Prob > chi2 = 0.524		chi2(16) = 10.898 Prob > chi2 =		chi2(15) = 8.425 Prob > chi2 = 0.906		chi2(15) = 6.822 Prob > chi2 = 0.962			
Abond test[37]	-1.9789b		-0.768		-2.176b		-2.321b		-1.504		-1.7802c	
Abond test	-0.735		0.379		1.2712		-0.875		-1.020		-0.457	

Note: a= p<0.01, b= p<0.05, c= p<0.1

[36] Sargan test of over-identifying restrictions (H0: over-identifying restrictions are valid)

[37] Arellano-Bond test for zero autocorrelation in first-differenced errors (H0: no autocorrelation)

For the complementarity between competition and privatization, (Li and Xu 2004) suggest evidence of complementarity between privatization and competition in improving network penetration and in maintaining service pricing among privatized operators. (Parker and Kirkpatrick 2005) also find that if privatization is improved when it is complemented by other policies that promote competition and effective state regulation. In other words, privatization without a simultaneous implementation of competition may just make private monopolies. From this, our intuition is that the contemporaneous implementations among liberalization policies make firms concentrate more on the investment for developing new products and services than the existing knowledge and technology. This supports most of the previous economists' statements that privatization works best when there is a competition that limits the market power of the incumbents.

From these finding about combination of liberalization process and different type of investment, it is meaningful to investigate because encouraging and balancing between exploration and exploration in the development of industry (Danneels 2002; Sheremata 2004). (He and Wong 2004) also empirically support that exploration and exploitation represent two fundamental approaches in organizational learning, it is necessary for firms to maintain a balance with a sample of 206 manufacturing firms. Recently, (Bauer 2010) recommends that the design of policies might be complicated by trade-offs between short-term and long-term policy objectives in telecommunication industry.

For the detailed formation of competitions (*SBC_bb, FBC_bb, SBC_m, FBC_m*), we can find that the effect of competition of mobile industry is much bigger than that of fixed market when we compare the coefficients of the competition in mobile and broadband industries. This implies that the mobile market is much sensitive and flexible to liberalization policy. Here, it is recognized that since most of natural monopoly firms started their business in the fixed-line network and then took part in the mobile industry, they are more sensitive to external stimulation. In fact, various studies investigate the issue of infrastructure versus service competitions. However, these studies only focus on the service penetration considering just one market (Distaso, Lupi et al. 2006; Höffler 2007; Bouckaert, Van Dijk et al. 2008). This chapter considers mobile and broadband industry together and detailed firms' activities relevant to investment. From this, we can suggest not only which policy is effective according to types of markets but also what is implication regarding kinds of competition.

In addition, the result of our estimations and the difference between infrastructure and

R&D investment could be interpreted as follows: i) as regards R&D investment, the reduction of managerial slack dominates (resp. is dominated by) the profitability effect for government-owned (resp. private) firms (whereas we found the contrary for CAPEX); ii) in the case of infrastructure investment, the main consequence of reduced managerial slack is the operational efficiency effect, whereas for R&D it is the reduction of over-investment effect. It could be argued that the reduction in the managers' power (or "managerial slack") induced by increased competition does not increase but decrease R&D investment. In fact, several authors have highlighted that managers have incentives to "over-invest" (i.e. to investment more than the level of investment targeted by shareholders) if they are not monitored efficiently (Jensen 1986; Stulz 1990)[38]. In this framework, any decrease in the managerial slack will result in lower investment (in a reduction in the tendency to over-invest). Since it is probably more difficult for shareholders to assess the quality of R&D investment projects than to assess the quality of infrastructure investment projects, the "reduction of over-investment" effect is probably more significant for R&D than for CAPEX.

The drawback of interpretation i) is that it is difficult to find theoretical arguments to explain that the efficiency effect dominate for government-owned firms and is dominated for private firms when one consider CAPEX investment, and that the opposite is true when one consider R&D investment.. The drawback of interpretation ii) is that it only explains why, for R&D investment: the effect of SBC in the broadband market (*sbc_bb*) in R&D investment is negative and significant (*-3.177a*) for government-owned firms and insignificant for private firm (-2.846); the effect of FBC in the mobile market (*fbc_m*) is positive and significant (*9.166b*) for private firms and insignificant (*0.354*) for government-owned firms. However, another result contradicts our initial theoretical framework: the fact that the sign of the coefficients of *fbc_bb* and *sbc_m* in model *2-b* and *2-c* does not change between government-owned and private firms.

Finally, it is likely that our theoretical framework is not well suited to the analysis of the impact of competition on the telecommunications operators R&D investment. In fact, the rationale for the operators' R&D investment may not be producing new technologies and services (as in our theoretical model) but to absorbing knowledge created by upstream firms (see (Cohen and Levinthal 1989) on the concept of absorptive capacities, see also (Fransman

[38] If shareholders cannot monitor managers efficiently, the latter use the liquidity generated by the firm (the free cash flow) to finance unprofitable investment projects

2000) on the change in the vertical organization of R&D in telecommunications).” .

The firm’s characteristic indicates that, the sign of the variable *lage* shows significant and negative effects on CAPEX investments, which means that, more older firms invest less than younger firms. From this, we can comprehend that the new firms are more likely to concentrate on the investment activities and that they lay emphasis on infrastructure investment (“exploration of old certainties”). With the size of firms (*lemployee*), we can determine that more bigger firms are focusing on the investment. But there is no explicit difference between CAPEX and R&D investments. For the residue, we also consider other firms’ characteristics such as sales, debt, market price and tangible assets in the beginning of empirical estimation. However, there is no strong and significant coefficients just like, the *lprofit* has no effect on the investments strategies.

There are cost-, demand- proxies, yearly dummies from 1995 to 2008 and the penetration on mobile and broadband network services which used in our analysis as control variables. Yearly dummies represent macroeconomic shocks that may affect the activities of all firms, but it is not shown in table 2-7 for brevity’s sake. The demand effect measured by GDP per capital turn out insignificant and the cost effect (population in big city) mostly shows negative effect on the investment activities. One explanation for this, the cost of investment in telecommunication industry has less relationship with the decision of investment. In present, the fundamental infrastructures of big city with lots population in telecommunication industry are already matured, so the investment decision for tomorrow is less related with the population density in major city. For the former infrastructure, the *lnb_bb* and *lnb_m* shows the positive effect of market size in mobile industry on the investment activities and this means having lots of previous consumers in industry may trigger the incentives for the firm’s investment decision. When the firm makes the investment decision, the existing market size is important to determine the level of investment.

2.5 Conclusion and Implications

To encourage the invest efficiency of former “natural monopoly” industries, telecommunication liberalization policies such as competition and privatizations, have implemented. Until now, this assumption is still very controversial from a theoretical point of view. Nevertheless, prompting the investment in new knowledge and technologies is essential for economic growth (Greenstein and McDevitt 2009; Qiang, Rossotto et al. 2009). Besides, telecommunication is an infrastructure oriented industry and the possessing of new network gives a decisive role to firms in the market (Cambini and Jiang 2009). Therefore, the regulatory concerns are needed to control some problems such as under-invest problems, appropriability, and so forth. This chapter tries to shed some implication on the role of liberalization policies in determining the level and activities of firms’ investments.

Using the firm level data between 1994 and 2008, we tested assumptions in telecommunication market, where there exist competition and privatization regulations. Specifically, we consider the nature of investment and adopt more general and complemented policy. The assumption regarding Profitability effect and Operational efficiency effect related with R&D investment and network deployment allows us to decompose the investment activities of firms. Hence, this study has two distinct contributions to the regulation and innovation in telecommunication industry. First, we consider the composition of investment (exploration vs. exploitation investment) while most of the studies dedicated to the impact of competition on innovation have focused on the level of R&D investment. We apply these concepts, "exploration of new possibilities" and "exploration of old certainties" to the relationship, R&D vs. infrastructure investment. Second, not only focusing on the impacts of single regulation but also adopting more general and complemented policy views is the other main contribution of this chapter.

The main results of this chapter concern the relationship between competition and infrastructure investment. Our theoretical and empirical analyses converge on the conclusion that competition has different effect on government-owned and private operators. More specifically, we found theoretical support and empirical evidence that increased competition fosters investment by government-owned operators and deters investment by private operators, whatever the market (mobile or fixed-line) and the form of competition (service-based or facilities-based). Our results suggest that the main positive impact of competition on

investment has been achieved through an improvement of the firms' operational efficiency (operational efficiency effect). Now that the incumbent operators have reached a satisfactory level of operational efficiency, the impact of competition on infrastructure investment occurs mainly through a decrease in the profitability of investment (profitability effect). Under the assumption that it is desirable to encourage investment in telecommunications infrastructures, the main policy implication of this chapter could be that national regulatory authorities have promote forms of competition which increase the profitability of investment for private operators or induce pre-emptive strategies such as investment race[39].

Unlike the results for infrastructure investment, our empirical results on the relationship between competition and R&D investment are inconsistent with our theoretical model. Further theoretical and empirical analyses would be necessary to account for the nature of R&D investment (the main adjustment variable may be the nature of R&D investment rather than its level) and for the vertical reorganization of R&D in telecommunications. The latter phenomenon – and more specifically the shift in the innovation engine for operators towards equipment supplied (Fransmann 2000) – also open new research perspectives. This should include a better understanding of what was the impact of liberalization policies in the vertical reorganization of R&D activities (in the literature, the former appears to be both a cause and a consequence of the latter). Moreover, in a context where R&D activities are mainly performed by upstream firms such as equipment suppliers, one should not only investigate the impact of competition between operators on their own investments, but also the relationship between competition in the downstream market and investment by upstream firms.

Using the empirical method, we try to suggest the answer to these questions; i) How do liberalization policies affect the operators' investment strategies? ii) To what extend do they affect the Profitability effect and Operational efficiency effect between exploration (R&D) and exploitation (CAPEX) investments? Based on the empirical results, we can claim that considering interaction among liberalization policies and allowing the industry characteristics are critical to determine for the Profitability effect and Operational efficiency effect and level

[39] This conclusion is consistent with the literature on dynamic competition (see e.g. Ellig 2001) and with recent theoretical papers on access regulation and infrastructure investment (in particular Gans, J. S. (2001). "Regulating private infrastructure investment: optimal pricing for access to essential facilities." Journal of Regulatory Economics **20**(2): 167-189. and Vareda, J. and S. Hoernig (2007). "The Race for Telecoms Infrastructure Investment with Bypass: Can Access Regulation Achieve the First Best?" SSRN eLibrary.

of investments. More precisely, there are major three findings from our analysis. First, there is a significant Profitability effect and Operational efficiency effect among firms' investment activities. If competition is induced, firms are likely to emphasize investments with exploitable characteristics which using existing knowledge and technologies to develop new products and services. Particularly in the case of privatization, firms make more investments in "exploitation of old certainties" than in "exploration of new possibilities". Second, competition effect leads to more higher influences on liberalization policies in the mobile industry than in the broadband industry. In the case of mobile industry, inter- and intra-competition highly lead firms to make short-term investments. Finally, the simultaneous implementations among liberalization policies make firms to more concentrate on the investment for developing new product and service than existed knowledge and technology.

The implications of our overall results are straightforward. The liberalization policies may weaken the firms' sustainable ability of next generation networks in long terms. However, when privatized firms adopt competition, they focus on explorable investments in new possibilities. In other words, firms seek strategies for long-term investments in the case where competition becomes severe and many dimensions are faced. According to (Cave 2010), prompting the investment of firms for the new network infrastructure yields a chance and challenge for regulators. Therefore, it is necessary for policy regulators to take account of the complementary among liberalization policies providing an incentive to create new knowledge and technologies. Also, the design of liberalization policies should consider the Profitability effect and Operational efficiency effect between investments from a perspective of long term policy.

Some economic theory indicates that competition is the good proficient tool at the efficient allocation of scarce resources. However, it might not be good at prompting investment of new and advanced technology, particularly when the market is dominated by former natural monopoly. In such a case, governmental leadership combined with market circumstances can attain better results more easily. It has not only allowed its priorities public but has also set up an arena for the relevant stakeholders to achieve a mutual understanding of their relatively long term objectives. Again, such an intervention is able to be effective only in the existence of a cooperative circumstance among the related stakeholders.

Chapter 3. Environmental, Sustainable Behaviors and Innovation

3.1 Introduction

This part focuses on the 'Corporate Environmentalism' with the basis of typical voluntary approaches (Carraro and Siniscalco 1996; Lyon and Maxwell 1999; Segerson and Li 1999; Braathen and Co-ope 2003). We premise that this approach is a rather bilateral compromise between a policy maker and a firm. Corporate environmentalism is more related with environmental protection. For example, the global environmental issues on climate change with wider scope of sustainability have growing impact over the few decades on the social demand and the international political agenda. To make the stabilization of CO2 emissions, countries are required to reduce their emissions between 1.3% and 40% below by 2020.

These regulations for eliminating of CO2 have changed the market mechanism and activities of corporations. Moreover, the recognition and reaction of business leaders and consumers are friendly turning into voluntary. For instance, CSR (Corporation Social Responsibility)[40] and SRI (Social Responsibility Investment)[41] are becoming globalised concepts and most multinational firms try to induce the sustainability practices to make stakeholders' satisfaction and give a positive signal to the market; the stakeholder theory (Freeman 1983; Frooman 1999). Consumers and investors also show the confidence for the corporation's social responsible activities in the market: the legitimation theory (Campbell, Craven et al. 2003; Lopez, Garcia et al. 2007).

For the firms' environmentalism behaviors, this chapter considers two major concepts. One is an environmental behavior of firms which can be represented by Carbon Discloser Project (CDP) activity. The other one is the Dow Jones Sustainability Index (DJSI) which shows firms' sustainable activities. The reason why we adopt both of these concepts simultaneously is that there are a lot of initiatives in the market as a term of firm's strategies. From this, we choose major two activities of firms' environmentalism strategies then we try

[40] CSR is "A concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis." European Commission, 2011.

[41] Socially Responsible Investment (SRI) integrates - apart from the financial criteria - social, environmental and/or ethical criteria into the processes of analysis, selection, and choice of investment. "The environmental, social and governance stakes (ESG) may affect the performance of investment portfolios in different degrees according to the company, economic sectors, regions, classes of assets and the term of investment". VIGEO Group, 2011.

to find the answer of theses research questions: i) What is the relation between voluntary activities and performance? ii) Do firm's voluntary activities in environmental and sustainable implementations induce innovation? iii) How is the nature of innovation depending on voluntary types of firm? iv) What is the link between firm characteristics and innovation according to voluntary types?

Until recently, lots of studies have showed the impact of CSR and SRI on the performance in the sustainable development aspect. However, there are still conversely debates on the correlations between voluntary activities and performances as well as their results have a number of limitations statically. Furthermore, they just focus on the relation between financial performances and responsible activities and estimate the only short-term effect. (Akrich, Callon et al. 2002; Martin Curran and Moran 2007) examines whether corporate financial performance is affected by public endorsement of environmental and social performance. The results show a trend towards positive and negative announcements having the expected effects on daily returns. However, these movements are not significant and the data do not suggest that a firm's presence on the index brings it any significant financial return for signaling its CSR. (Lopez, Garcia et al. 2007) examine whether business performance is affected by the adoption of practices under the term CSR. They show a short-term negative impact on the performance produced. (Consolandi, Jaiswal-Dale et al. 2009) examines whether these incentives have been so far detectable with particular reference to the Dow Jones Sustainability Stoxx Index (DJSSI). They analyze the performance of the DJSSI over the period 2001–2006 by comparing to that of the Surrogate Complementary Index (SCI[42]). The result suggests that the evaluation of the CSR performance of a firm is a significant criterion for asset allocation activities.

In particular, environmental and sustainable implementations have a long-term impact on the performance and innovation of firms. The adoption or quotation of sustainable standard and environmental implementations has latent effect and it is difficult to find the causality between adoption and performance. Nevertheless, most studies only consider the existence of significant impact for performance. Innovation is the priority of firms as well as performance because it is also sustainable factor for firms' growth and survival. Therefore,

[42] Consolandi, Jaiswal-Dale et al. (2009), p185: "The Surrogate Complementary Index (SCI) is a new benchmark that includes only the components of the DJ Stoxx 600 that do not belong to the ethical index to evaluate more correctly the size of possible divergent performances."

we propose the each influence of environmental and sustainable behaviors on the innovation activities and performance of firms. Specifically, we divide 806 firms into three groups according to the survey response of Carbon Disclosure Project (CDP) Global 500 and the firm list of Dow Jones Sustainable Index (DJSI)[43] between 2008 and 2009.

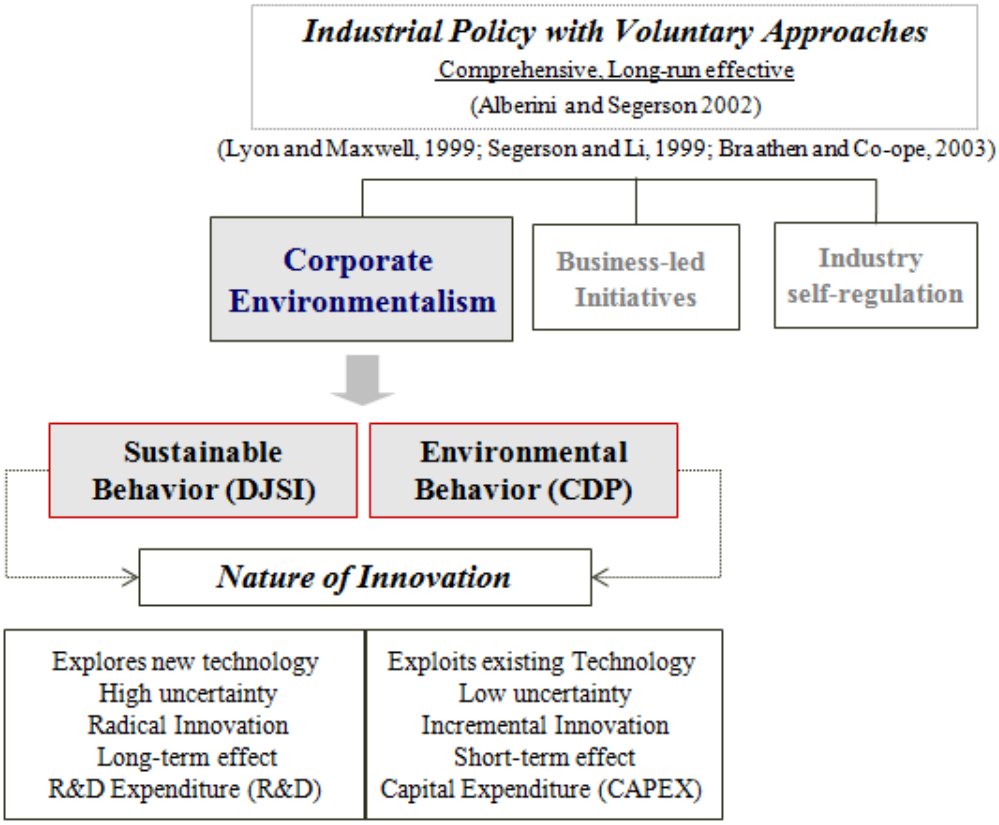

Fig 3-1 The schematic diagram of the research framework

According to the research framework in Fig 3-1, this chapter investigates the difference and tendency of performance and innovation activities for each categorized firm groups. The empirical analysis suggests the solution of the above questions based on the results of sample selection methodology. Another contribution of this study is to categorize the establishing criteria of environmental issues and to propose an empirical model of the links between the issues and innovation activities. In particular, we consider the concept of environmental and sustainable implementations simultaneously. This is expected to suggest the understanding for the effect of environmental and sustainable issues on the innovation and performance of

[43] The Dow Jones Sustainability Index (DJSI) comprises the companies with the best CSR practices in their respective industries. The evaluation is based on the cooperation of Dow Jones Indexes, STOXX Limited and SAM.

firms and market.

This chapter is organized as follows. The section 3.2 briefly categorizes the concept of environmental, sustainable issues and innovations, and then descries the innovation relevant studies. Section 3.3 explains data, variables and methodology with the state of the empirical studies between innovation and environmental and sustainable issues. The 3.4 section presents the results and analysis of the empirical models. Finally, we conclude and discuss the policy implications of the analysis.

3.2 Theoretical Background

There are two major theories which enhance the momentums of the environmental and sustainable issues. According to the first theory, the legitimation theory, it is necessary to achieve society's confidence for the survival of firms (Deegan 2002). The second one, the stakeholder theory indicates that companies should only respond to shareholders' interests, their only social responsibility being the maximization of company value. From this perspective, any positive social act undertaken by the firm is associated with costs that would reduce profit and prejudice shareholders. It would not, therefore, be opportune (Friedman 1970).

3.2.1 Environmental and sustainable behaviors of firms

There are contemporary debates on the concepts and definitions of Corporate Social Responsibility (CSR) and Corporate Sustainability (CS) since the beginning of explosive growth in the demand for social development. Based on historical perspectives with using the philosophical analyses, (Van Marrewijk 2003) provides an review for the debates of concepts and suggests a definition like that "CS(R) should be abandoned, accepting various and more specific definitions matching the development, awareness and ambition levels of organizations". Based on the corporate governance, sustainable development, and stakeholder theory literature, (Ricart, Rodriguez et al. 2005) investigate how corporate governance systems integrate sustainable development with other factors. They analyze the governance systems of the 18 corporations that are leading the market sectors considered by the Dow

Jones Sustainability World Index and suggest a sustainable corporate governance model. With a theoretical analysis for the previous studies, (Konrad, Steurer et al. 2006) empirically find that the adoption and implementation of SD can be achieved through stakeholder relations management (SRM) on the firm level. By using specific 14 issues of SD they explain solutions of multinational corporations (MNCs) to particular issues of SD and roles of particular stakeholders. Also, they conclude that SRM boosts SD but cannot act as a government regulation.

For the heterogeneity between practices and performance of sustainable behaviors, (Gjolberg 2009) develops two indexes to measure the CSR practices and CSR performance in 20 OECD countries. The two indexes find that there are significant differences between the 20 countries, indicating a need to address the impact of domestic structures on CSR. Recently, (Sandberg, Juravle et al. 2009) discuss the issue of the heterogeneity of SRI using four features such as terminological, definitional, strategic and practical features. Then, they suggest that accounting for the heterogeneity is necessary for SRI implementations because there are cultural and ideological differences between different regions and distinctions in values, norms and ideology between various SRI stakeholders. (Cerin and Dobers 2001) investigate the structure and transparency of the DJSGI by comparing with the DJGI. They show that in general the DJSGI emphasize the technical sector more than the DJGI. (Martin Curran and Moran 2007) also examines whether corporate performance is affected by public endorsement of environmental and social performance. With the FTSE4Good UK Index as a proxy measure for good (poor) CRS, their results show a trend towards positive and negative announcements having the expected effects on daily returns.

Concerning with firms' environmental behavior, (Okereke 2007) finds the motivations, drivers and barriers to carbon management, using the FTSE 100 companies. Motivations of environmental management are based on those factors that closely relate to profit and comparative advantage while drivers are regarded to be the factors that are related with wider social pressures and environmental issues. With UK study, this study presents five motivations and five drivers for corporate environmental activity on climate change. (Luo, Lan et al. 2010) also investigate how the Global 500 companies prepare to the challenge of climate change with carbon disclosure strategy. The research motivation is increasing social interesting of studies that investigates the role of large firms in carbon disclosure responsibility and practices. With considering the impact of economic, regulatory, social and

financial market factors on voluntary motivation of Global 500, they find that the financial factors are significantly related with the voluntary environmental behaviors. It means that a company which faces direct economic consequence is more easily to disclose carbon associated information. They also provide reason of why a large proportion of Global 500 firms refuse to disclose carbon information. The result shows the information demands of investors for environmental management are not determined by the carbon disclosure decision of companies.

As verified in previous studies, environmental and sustainable issues are affected by many internal and external factors of firms. That is, the firms' behavior is varied depending on the industry sectors, governance of corporation, and social pressures. Hence, with reflecting of such factors more studies on the sustainable, environmental behavior and innovation of firms are required. This can offer solution to which value for which organization.

3.2.2 Innovation, environmental and sustainable issues

There are several dimensions of market environments and several types of invest activities such as radical or incremental, explore or explicate investments. From this, the consideration and detailed analysis for the innovative activities of firms are needed. Because of the heterogeneity of firms' investment, it is necessary to take into account the composition and the level of competition in market (Mansfield 1981). In managerial processes of firms' activities, the relation and balance between the exploration of new possibilities and the exploitation of old certainties are primary factors in survival and prosperity (March 1991). Based on these ideas, we premise that explorative investment if the one which intend to induce and prompt firms' innovation because it has more uncertainty for future and there is less guarantee for the return of this investment. So explorative investment is rather innovative investment than exploitative investment. (Holmqvist 2004) also investigates the dynamics of exploitation and exploration in intra- and inter-organizational learning processes as fundamental characteristics of modem organizations. In sustainable research areas, (Halme and Laurila 2009) recently center up considering the relation between potential impact of CR Integration and CR Innovation. In their analysis, CR integration is regarded as conducting existing business operations more responsibly and CR innovation is done as developing new

business models to solve social and environmental problems. Based on these concepts, they apply investment for new possibilities and old certainties to the change in firms' strategies.

Considering the relationships among environmental, sustainable behaviors and investments of firms is a well-studied area for firms and is one of the key elements for sustainable development. However, the exact meaning of innovation in sustainable and environmental context is not clearly explained yet (Blowfield, Visser et al. 2007). For the relation between these resources management and Corporate Social Responsibility (CSR), (Zwetsloot 2003) points out the presence of a great potential for innovating business practices positively influencing People, Planet and Profit. On the other hands, the existing literature has focused mostly on regulated emissions data and few studies have included climate change in this debate. (Delmas and Nairn-Birch 2011) investigates the profitability of environmental initiatives within the context of supply chain management with empirical analysis which is based on a novel longitudinal database including over 1100 US firms between 2004 and 2008.

Empirically, (Borger and Kruglianskas 2006) study the adoption of the CSR strategy and innovation by Brazilian enterprises. They analyze how what factors related with the CSR is associated with the technological innovation and the environmental performance of firms. They adopt the case study approach, where three enterprises are considered. As a conclusion of the research, they suggest significant evidences of a strong relationship between the adoption of a CSR strategy by the firm and an effective environmental and innovative performance. (Frondel, Horbach et al. 2008) hypothesize that environmental management systems (EMSs) may increase environmental innovation performance of firms. This hypothesis involves the relevant incentives for a firm's voluntary adoption of an EMS and its environmental innovation behavior. By using a choice model for German manufacturing, they find the evidence between the decision on innovation activities and the decision on EMS adoption. (Hepburn 2010) also examines the evidence on induced innovation and the implications for the environmental policy with the conceptual basis and empirical evidence on the effectiveness and efficiency of climate technology policies.

In the present chapter, we attempt to demonstrate the effect the environmental and sustainable behaviors on the innovation and performance of firms. This chapter offers a more reflexive and structured approach for more broadly considering innovation by using a framework that distinguishes the factors of exploration and exploitation innovations from the different types of firms' environmental and sustainable behaviors.

3.3 Empirical Analysis

3.3.1 Data and variables

To consider both environmental and sustainable behaviors of firms, this study uses two data sources between 2008 and 2009. First, the Global 500 of CDP (Carbon Discloser Project) is referred to as the environmental behaviors. The Global 500 of CDP (Carbon Discloser Project) is collected by the 500 largest corporations in FTSE Global Equity Index Series and the market capitalization of these companies was 15.5 trillion dollars in 2009[44].

The other one is the DJSI (Dow Jones Sustainable Index) which shows the trend and connection between financial performance and investment of sustainable companies[45]. Since it is necessary to consider both the concepts simultaneously for global companies, there exist only two years period in our data set. Using the list of DJSI and CDP, this study makes a new list and matches it with financial data of Thomson DataStream[46].

Finally, we obtain unbalanced panel data from 1346 observations of 806 firms with 10 FTSE sectors[47]. But we drop 314 firms which are involved in financial FTSE sector so we use 1032 observations. Fig 3-2 presents the observations' distribution according to the DJSI and CDP lists. As shown in the figure, 253 firms are identified in both the DJSI and CDP lists. For only CDP firms, there are 507 observations and only DJSI observation has 272 numbers. Table 3-1 demonstrates the definition, sources, and descriptive statistics of the variable used in the analysis.

[44] CDP Global 500 Report (2009), p. 11: "CDP continues to be the global leader firms in data that records the business response to climate change. The depth and standard of responses from the world's largest companies to the latest CDP questionnaire is a measure of shareholder and corporate engagement on the issue of climate change. The responses demonstrate the many positive steps that have been taken by Global 500 companies over the past year. Climate change is becoming an increasingly important issue for the majority of large businesses and companies are keen to share information on their carbon performance and climate risks and opportunities with investors and other stakeholders."

[45] The Dow Jones Sustainability Index comprises the companies with the best CSR practices in their respective industries. The evaluation is based on the cooperation of Dow Jones Indexes, STOXX Limited and SAM.

[46] This database covers 51,900 active global companies and offers the broadest company coverage, representing 99% of the global market capitalization. http://www.thomsonreuters.com (2010)

[47] Utilities, Telecommunication Services, Materials, Information Technology, Industrials, Health Care, Financials, Energy, Consumer Discretionary, Consumer Staples

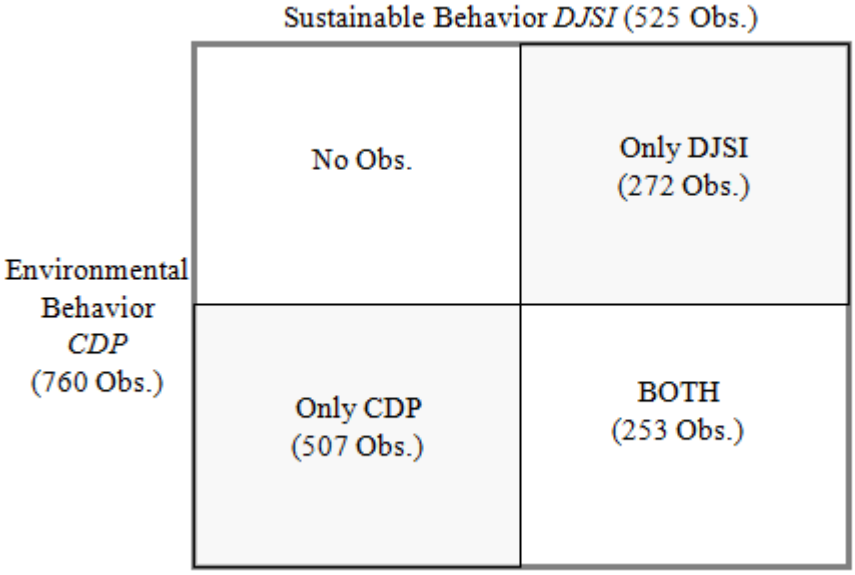

Fig 3-2 The distribution of observations according to the lists of CDP and DJSI

As dependent variables of final model, this study use three variables including log value of sales (*lsales*), log value of capital expenditure (*lcapex*), and log value of research and development expenditure (*lrnd*). Using logarithms, we can interpret the results of respective coefficients as elasticity. The characteristics of firms such as asset per shares (*lassetpershare*), revenue (*lrevenue*), market value (*lmv*), age (*lage*), and size (*lemployee*) are considered as well as the year dummies (d_2008 and d_2009) and dummies of DJSI or CDP or Both of them. The time period effect variables can capture macroeconomic shocks that affect all firms in the analysis. For instance, the Subprime Mortgage Problem in 2008, which affected the investments in all industry, can be accounted for by yearly dummies.

Regarding the industry sectors, we divide them into 10 sectors according to FTSE (Financial Times Stock Exchange) industry categories as shown in table 3-A in appendixes. To compare environmental and sustainable indices, we drop financial industrial sectors because most of financial firms do not have capital or R&D expenditure. Afterward, we make polluting dummy variable to discriminate between polluting industry and non-polluting industry based on the evidence of (Clarkson, Li et al. 2010).[48] Because considering firm's specific industry regulation prevents the bias of the normalization for entire industry sectors.

[48] The study's divide sample data into four groups such as the Pulp & Paper (SIC = 26), Chemical (SIC = 28), Oil & Gas (SIC = 29), and Metals & Mining (SIC = 33) sectors. They focused on these four industries given the prior evidence in the literature that these are the most polluting in the US (Clarkson et al., 2008).

Table 3-1 Definitions and descriptive statistics of variables

Variable	Definition	Sources	Obs	Mean	St.D	Min	Max
adoption	Dummy value=0 if firms are involved in only CDP group, Dummy value=1 if firms are involved in only DJSI group, Dummy value=2 if firms are involved in both CDP and DJSI group	Computed	1032	0.75	0.82	0	2
cdp	Dummy value=1 if the firm is involved in CDP Lists, otherwise = 0	CDP	1032	0.74	0.44	0	1
djsi	Dummy value=1 if the firm is involved in DJSI Lists, otherwise = 0	DJSI	1032	0.51	0.50	0	1
both	Dummy value=1 if the firm is involved in DJSI and CDP Lists, otherwise = 0	DJSI & CDP	1032	0.25	0.43	0	1
lcapex	Log value of Capital Expenditures (US$)	Thomson DB	713	13.85	1.51	6.70	17.31
lrnd	Log value of Research and Development Expenditure (US$)	Thomson DB	529	12.64	2.03	4.03	16.99
lrevenue	Log value of Revenues (US$)	Thomson DB	687	16.58	1.77	2.21	20.03
lemployee	Log value of Employees (Both full and part time employees of the company)	Thomson DB	865	10.49	1.38	1.10	14.56
lage	Log value of (2010 - established year)	Thomson DB	1032	4.20	0.77	1.39	7.61
lassetpershare	Log value of Asset per Shares	Thomson DB	698	2.63	1.97	-3.51	18.50
lmv	Log value of Market Value (US$)	Thomson DB	713	9.91	1.22	2.52	14.72
developed	Dummy value=1 if the country is involved in OECD countries	OECD	1032	0.90	0.30	0	1
d_2008	Year dummy of 2008	Computed	1032	0.50	0.50	0	1
d_2009	Year dummy of 2009	Computed	1032	0.50	0.50	0	1
polluting	Dummy value=1 if the firm is involved in Utilities, Materials, Industrials, Energy sectors, otherwise = 0[49]	FTSE	1032	0.52	0.50	0	1
Health	Dummy value=1 if the firm is involved in Health Care sector, otherwise = 0	FTSE	1032	0.09	0.28	0	1
ITcom	Dummy value=1 if the firm is involved in IT and Telecom sectors, otherwise = 0	FTSE	1032	0.15	0.36	0	1
service	Dummy value=1 if the firm is involved in CD and CS sectors, otherwise = 0	FTSE	1032	0.24	0.43	0	1

[49] This Polluting Industry sectors are based on the polluting industry division of Clarkson, P. M., Y. Li, et al. (2010).

For the country distribution in our dataset, there are initially 39 countries and the deviation of firms is shown in table 3-B in appendixes. Except for the developed country dummy (developed), we don't take into account specific country dummies because most of firms are listed in the US or EU stock markets and they are affected by the global general shock, standard and regulations.

3.3.2 Model

In order to control the limitation of dataset, this chapter employs an integrated model which incorporates two equations, i.e., adoption (or Choice or Quotation) equation of environmental or sustainable behaviors and output equation measured by sales, R&D investment, and CAPEX.

First, in the adoption model, we estimate a multinomial logit (MNL) model, examining the drivers for the adoption (or Choice or Quotation) of CDP or DJSI. In this study, firms have three kinds of alternatives for their adoption (or Choice or Quotation) of environmental and sustainable behaviors: only for CDP (*CDP*), only for DJSI (*DJSI*), joint adoption of CDP and DJSI (*BOTH*). The adoption (or Choice or Quotation) probabilities that firm *n* selects alternative *i* among three options are derived as follows (Train, 2003).

$$Prob(Adoption_{ni}) = Prob(V_{ni} + \varepsilon_{ni} > V_{nj} + \varepsilon_{nj} \ \forall\, i \neq j) = \frac{e^{\beta' x_{ni}}}{\sum_j e^{\beta' x_{nj}}} \tag{3-1}$$

$$where\ i, j \in \{CDP, DJSI, BOTH\}$$

Representative preference of firm for adoption choice (*i*) is usually specified to be linear in a parameter, $V_{ni} = \beta' x_{ni}$, where x_{ni} is a vector of observed variables related to adoption i , firms' activities, strategies and characteristics; ε_{ni} is a disturbance following type I extreme value distribution ,which results in a simple and elegant form of choice probability, a closed form although it exhibits restrictive substitution patterns due to the "*Independence from Irrelevant Alternatives* (IIA)". In this analysis, we have concerns with the factors that affect

the adoption (or Choice or Quotation) of environmental and sustainable activities, especially to figure out which industry sectors or firms are likely to take part in DJSI or CDP behavior.

Next, we set up the output equation to analyze the effects of DJSI or CDP adoptions and the other factors on the firm's output such as performance and innovation.

$$lsales_{nt} = \beta_1(lemployee)_{nt} + \beta_2(lage)_{nt} + \beta_3(lrevenue)_{nt} + \beta_4(lmv)_{nt} + \beta_5(developed)_{nt} + \beta_6 year.2009 + \beta_7 D.Industry + \beta_8 D.(CDP, DJSI, Both) + \beta_9 sc_{nt}^{CDP\ or\ DJSI} \tag{3-2}$$

$$lcapex_{nt} = \beta_0 lsales_{nt} + \beta_1(lemployee)_{nt} + \beta_2(lage)_{nt} + \beta_3(lrevenue)_{nt} + \beta_4(lmv)_{nt} + \beta_5(developed)_{nt} + \beta_6 year.2009 + \beta_7 D.Industry + \beta_8 D.(CDP, DJSI, Both) + \beta_9 sc_{nt}^{CDP\ or\ DJSI} \tag{3-3}$$

$$lrnd_{it} = \beta_0 lsales_{nt} + \beta_1(lemployee)_{nt} + \beta_2(lage)_{nt} + \beta_3(lrevenue)_{nt} + \beta_4(lmv)_{nt} + \beta_5(developed)_{nt} + \beta_6 year.2009 + \beta_7 D.Industry + \beta_8 D.(CDP, DJSI, Both) + \beta_9 sc_{nt}^{CDP\ or\ DJSI} \tag{3-4}$$

where $(x)_{nt}$ is a vector of the firm n's characteristics and control dummies affecting performance. sc_{nt}^{CDP} or sc_{nt}^{BOTH} are the estimated coefficients of dummy variable which might be biased due to existence of selectivity bias. That is, the unobserved characteristics of firms can affect the adoption of environmental or sustainable behaviors and also have an impact on the output of the firms, which means that there would be correlations between the error terms of adoption and the output equation. If there is not a control term in the correlations, a simple OLS (ordinary least square) regression leads to the specification error of an omitted variable. Therefore, the variable should be controlled through a methodology that corrects the selectivity bias (Greene 2003). The parameter Dummy (*CDP* or *DJSI* or *Both*) represent the effect of firms' adoptions on the performance and η_{it} denotes a distribution following normal distribution.

3.4 Results and Analysis

There are two parts in our estimations according to the firms' group of environmental and sustainable activities such as only *CDP* group, only *DJSI* group and *Both* group. First, we show the results of sustainable (DJSI) and environmental (CDP) adoptions (or Choice or Quotation) and output models with basement estimation of *Both* adoption in Table 3-2. This means that the each coefficient represents the distance from the frontier behavior because we premise the *Both* adoption (or Choice or Quotation) is the firm's most sustainable and environmental oriented behaviors.

There are three different models according to the industrial sectors of the adoption equation (3-1) including firm characteristics. The result of consists of two parts, where the first six rows indicate the effect of firm's characteristics on CDP adoption as environmental behavior while the below parts show the impact on DJSI adoption (or Choice or Quotation).

Table 3-2 The results for the adoption of CDP and DJSI groups

Y= *Adoptions*	All Industry (1)		Polluting Industry (2a)		Non-Polluting Industry (2b)	
	Coeff.	Std.E	Coeff.	Std.E	Coeff.	Std.E
Y= *CDP*						
lrevenue	-0.262c	0.147	-0.243	0.212	**-0.489b**	0.222
lemployee	0.039	0.098	-0.056	0.161	0.181	0.126
lage	**-0.565a**	0.146	-0.210	0.221	**-0.844a**	0.210
lassetpershare	**0.142c**	0.080	-0.022	0.105	**0.322a**	0.118
lmv	**-0.312b**	0.145	-0.024	0.220	**-0.586a**	0.211
_cons	**9.906a**	1.788	**6.538a**	2.268	**15.863a**	3.031
Y= *DJSI*						
lrevenue	**-0.502a**	0.184	**-0.626b**	0.275	**-0.483c**	0.274
lemployee	**0.266c**	0.155	0.117	0.238	**0.620a**	0.235
lage	-0.327	0.208	-0.200	0.288	-0.325	0.336
lassetpershare	0.069	0.105	**-0.321b**	0.163	**0.508a**	0.158
lmv	**-2.406a**	0.246	**-1.948a**	0.337	**-3.062a**	0.395
_cons	**29.741a**	2.816	**29.355a**	3.800	**31.080a**	4.391
Number of obs.	626		312		314	
LR chi2(10)	322.98		152.88		197.08	
Prob. > chi2	0		0		0	
Log likelihood	-488.800		-253.424		-220.504	
Pseudo R2	0.248		0.232		0.309	

Note: There are three choices for the sustainable and environmental behaviors: 0 is given in the case with *Both* adoption, 1 for the adoption of *CDP*, 2 for the adoption of DJSI. In the analysis, 1 and 2 were compared with 0, which is regarded as a base outcome *Both adoption=0*. * a= p<0.01, b= p<0.05, c= p<0.1

The first part of result (1) considers all industry sectors and the part 2 two parts (2a) and (2b) whether the firm is involving in polluting industry or not. Because there are some industries which have mandatory environmental regulation to produce, we try to estimate the adoption (or Choice or Quotation) of sustainable and environmental behaviors with specific consideration of industry. This Polluting Industry sectors are based on the polluting industry division of (Clarkson, Li et al. 2010).

Using the LR test (Log Likelihood Test), we compare the log likelihoods of the two models and tests whether this difference is statistically significant. If the difference is statically significant, then the considering polluting industry can be said to fit the data significantly better than without considering polluting industry model.[50] The test statistic is 65.84, and that the associated p-value is very low (less than 0.001). This results show that dividing polluting group has a statistically significant improvement in model fit.

This study drop financial sectors and compare polluting and non-polluting industries. Compared with *Both* adoption as top frontiers, the results (generally most values of coefficients might be negative) can be explained that how they are closed to *Both* adoption (Zero level). In the non-polluting industry, the group of DJSI have more revenue (*lrevenue: -0,483c > -0,489b*) and higher market value (*lmv: -3,062a > -0,586a*) than CDP groups' firms. More bigger size of firm (*lemployee: 0,620a*) is more adopt DJSI and fewer assets per share (*lassetpershare: 0,322a <0,508a*) is likely to be CDP group than DJSI group. For polluting industry, the only *DJSIP* group is significantly connected with financial status than CDP group. When we compare the assert per share between pollution and non-polluting industry, the effect *lassetpershare* shows the opposite effect on the choice of DJSI.

Regarding the result of the output equations from (3-2) to (3-5) for polluting industry shown in Table 3-3, there are three robust least squares (OLS) results of each dependent variables are presented such as *lsales*, *lcapex* and *lrnd*. Note that firms in the other industry sectors expect polluting industries are not included in this analysis. First of all, most of the selectivity correction variable (*sc1*, *sc2*) for DJSI, CDP adoption (or Choice or Quotation) has significant effect indicating that we need to treat sample selection problem in estimation, which justifies the use of DMF (Dubin Macfadden) model. So, main interpretation and

[50] The LR test statistic is calculated like this, $LR = -2\ln(L(2a_{Polluting\ Industry}) / L(2b_{Non-Polluting\ Industry}))$.
$\chi^2(2) = 65.84, (Prob > \chi^2 = 5.047e-15)$

conclusion are made based on the results of DMF model.

For the effects of firms characteristics, the firms' market value (*lmv*) is found to be not only positive but also significant for all models. The market value (*lmv*) has a positive correlation with firms' performance and innovation activities, which implies that in the case of firms' sustainable or environmental behaviors the current their market values can be the proxy for their adoption or quotation. Younger firms have more investment in CAPEX investment but more older firms shows higher effect on the performance.

The firms of developed countries show that they are concentrating more positively on R&D investment (*2.157a*) and financial performance (*0.483a*) than non-developed as well as they are less care about capex (exploitative) investment (*-0.505a*).

Table 3-3 The results of the output model for polluting industrial firms

Y=	(1) lsales		(2) lcapex		(3) lrnd	
	Coeff.	Std.E	Coeff.	Std.E	Coeff.	Std.E
lsales			**0.951a**	0.080	0.337	0.307
lemployee	**0.440a**	0.061	-0.061	0.055	**0.751a**	0.109
lage	**0.093b**	0.038	**-0.113c**	0.062	0.057	0.150
lrevenue	**0.221b**	0.100	**-0.108a**	0.026	-0.479	0.338
lmv	**0.454a**	0.072	**0.212a**	0.080	**0.818a**	0.168
developed	**0.483a**	0.129	**-0.505a**	0.147	**2.157a**	0.439
year=2009	**0.244a**	0.057	**0.148c**	0.083	0.248	0.177
CDP Group	**2.930a**	0.625	-0.608	0.732	**-3.787b**	1.664
DJSI Group	**3.197a**	0.577	-0.975	0.676	**-2.602c**	1.523
Both Group	**-3.382a**	0.574	**1.311b**	0.648	2.055	1.414
sc1	**-0.133a**	0.031	**0.120a**	0.037	**-0.284a**	0.082
sc2	0.073	0.071	**-0.230b**	0.109	**0.622c**	0.356
Obs.	486		485		373	
R-squared	0.999		0.997		0.987	
Root MSE	0.574		0.797		1.468	

For the R&D investment, more bigger size firms are more focus on the R&D investment (*0.751a*) but there is no significant effect on CAPEX. On the other hand, Capex is more related with the firms' financial status. For instance, more young firms (*-0.113c*) and having less revenue firms (*-0.108a*) have negative relation with capital expenditure. But, when the firms have more sales (*0.951a*) and higher market value (*0.212a*) then the firm try to focus on CAPEX in polluting industry.

Also, the result of the individual impact of sustainable or environmental or both behavior (*CDP* or *DJSI* or *Both*) on firms' output shows that the individual effects of environmental and sustainable behavior have negative relation with firms' R&D (explorative) investment (*-3.787b, -2.602c*) but *both* adoption has positive coefficient although it is insignificant.

On the other hands, individual adoptions have positive effects (*2.930a, 3.197a*) and both adoption *(-3.382a*) shows negative effects on sales. This implies the firm which cares individual environmental or sustainable behaviors focuses on financial performance than both considering firms. Both considering firms are more taking care investment (See. the effect of *both* adoption for capex: *1.311b*) than financial performance.

Secondly, the results of the output model for non-polluting industrial firms are presented in Table 3-4. The effect of specific industry sectors show that Health industry firms are more pay attention on the explorative investment (*2.007a*) than financial performance (*-0.359a*) and exploitative (*-0.470a*) investment. The telecom sectors also show significantly positive relation with R&D investment (*0.959a*).

In addition, we identify that the influence of firm characteristic variables on firms' performance and innovation is broadly varied depending on each condition. Higher market value of firms lead to more investments and financial performance. But the effect of firms' age and size effect on each outputs are no significant or ambiguous.

The result of the individual adoptions shows that the individual effects of environmental and sustainable behavior have positive influence on the performance (*3.117a, 3.167a*) but *both* adoption has negative coefficient (-3.255a). On the contrary, individual adoptions have positive effects on both (1.787b) but negative effect on each CDP and DJSI adoption (*-1.397c, -1.405c*). This means the firm which cares individual environmental or sustainable behaviors focuses on financial performance than both considering firms. Both considering firms are more taking care investment (See. the effect of *both* adoption for capex: *1.787b*) than financial performance. For the explorative investment, there is no significant relation between output and adoptions. Namely, there is no link between decision on investments and performances.

Table 3-4 The results of the output model for non-polluting industrial firms

Y=	(1) lsales		(2) lcapex		(3) lrnd	
	Coeff.	Std.E	Coeff.	Std.E	Coeff.	Std.E
lsales			**1.012a**	0.082	**0.822c**	0.425
lemployee	**0.163a**	0.063	-0.082	0.056	**0.932a**	0.110
lage	0.031	0.032	-0.049	0.067	-0.028	0.151
lrevenue	**0.553a**	0.142	**-0.226a**	0.029	**-0.941b**	0.469
lmv	**0.225b**	0.088	**0.349a**	0.074	**0.290b**	0.116
developed	**0.339a**	0.122	**-0.445b**	0.187	**1.886a**	0.530
year=2009	**0.192a**	0.051	**0.164b**	0.083	-0.048	0.174
Health	**-0.359a**	0.125	**-0.470a**	0.119	**2.007a**	0.256
ITcom	-0.016	0.067	-0.232	0.171	**0.959a**	0.315
service	-0.104	0.087	**-0.649a**	0.121	-0.455	0.340
CDP Group	**3.117a**	1.115	**-1.397c**	0.823	-0.064	1.352
DJSI Group	**3.167a**	1.082	**-1.405c**	0.734	0.227	1.260
Both Group	**-3.255a**	1.112	**1.787b**	0.741	-0.194	1.305
sc1	0.089	0.067	-0.175	0.108	0.181	0.298
sc2	0.130	0.155	-0.270	0.192	-0.109	0.347
Obs.	405		404		333	
R-squared	0.999		0.997		0.989	
Root MSE	0.458		0.732		1.352	

In sum, there are some findings in our results for the adoption and output models. First of all, the individual groups (CDP or DJSI) more concentrates on the performance than both considering group for both pollution and non-polluting industries. These firms do prefer performance to investments. And there are some difference type of firms' investment strategy according to the industries. That is, the individual groups have negative effects on the investment of new possibility (R&D) in polluting groups and the investment of maintains (CAPEX) in non-polluting industry. On the other hands, the *both* group in polluting industry is focusing on explorative investment (R&D) and the *both* group in non-polluting group is prefer to invest in exploitative investment (CAPEX). Secondly, it is necessary to consider specific industry sectors and firm characteristics because there exists lots of heterogeneity according to them. Nevertheless, we can find that there is more explorative friendly investment in rather Health and ITcom industries than others.

3.5 Conclusion and Implications

Environmental and sustainable implementations have a long-term impact on the performance and innovation of firms. The adoption (or Choice or Quotation) of sustainable standard and environmental implementations has rather long-term effect and it is difficult to find the significant causality between the adoption and performance. Moreover, innovation is also the crucial factor of firms as well as performance because it is another core sustainable factor for firm's growth and survival in future. Therefore, fostering innovation is the important element of policies towards sustainable development (Nill and Kemp 2009). From these, this chapter identify the relation between environmental, sustainable implementations and innovative activities based on the results of empirical analysis. Also, this study assumes that investment is the preparation of tomorrow's profits not only considering investments in technology level and in R&D, but also dealing with sustainability to human, social, environmental, technical and economic investments. Categorizing the established environmental and sustainable issues and proposing an empirical model of the links between these issues and innovation activities are another contribution of this study. In particular, we consider the concept of environmental and sustainable implementations simultaneously, which provides the understanding on the effect of environmental and sustainable issues on the innovation and performance of firms and market.

Based on the results of empirical estimations, we can suggest the solution to research questions represented in the above parts, and then make policy implication for sustainable development. First, we can see the overall positive relation between the voluntary behaviors and firms' performance which are measured by sales of firms. Second, we find that the synchronous adoption of both behaviors induces investments than others. In detail, they have different type of investment activities. The *both* group in polluting industry is more focusing on explorative investment (R&D) and the *both* group in non-polluting group is prefer to invest in exploitative investment (CAPEX). (Knoepfel 2001) also emphasizes that investors are attracted to new investment style which promises to create long-term shareholder value by embracing opportunities and managing risks from ongoing economic, environmental and social developments. Therefore, considering environmental and sustainable implementations simultaneously is important to focus on future challenges and is necessary to consider various factors including quality of management, corporate governance structures, reputational risks,

human capital management, stakeholder relations, and corporate social responsibility. Third, the polluting industries are more emphasize on long-term investment than short-term one. Because there are more considerations, negotiators, expectations for sustainable and environmental behaviors for polluting industry, the long-term oriented innovation strategies and activities are important to firms' business of this industry than non-polluting. (Chen, Lai et al. 2006) also explore whether the performance of the green innovation brings positive effect to the competitive advantage in some industry. They find that the performances of innovation and process innovation are positively correlated to the corporate competitive advantage. Therefore, the investment in innovation and consideration of the activities in innovations are necessary for sustainable development. Lastly, the effect of firms' characteristics on performance and innovation can be changed according to their heterogeneity.

Chapter 4. Corporation Social Responsibility Driven Innovation

4.1 Introduction

Corporation social responsibility (CSR)[51] and shareholder value oriented objectives lead to management strategies that have been very noticeable and successful for every business area and size. As a consequence of such behaviors of firms, relevant activities have offered a powerful and creative stepping-stone for sustainable values and development (Friedman 1967; Carroll 1979; Garriga and Melé 2004; Cetindamar and Husoy 2007; Jamali 2008; Gelbmann 2010).

The focus on social responsibility and shareholder value of companies is based on the shareholder theory that companies should only respond to shareholders' interests and their only social responsibility is to maximize companies' values (Freeman 1984). This activity guarantees achieving society's confidence for the survival of firms. Based on these backgrounds, the real interest of companies is changed (Jamali 2008).

In other words, firms consider CSR and Socially Responsible Investment (CRI)[52] for shareholders as important as profit, which is the only objective of a company. Until recently, most studies have shown the impact of CSR and SRI on performance in the sustainable development aspect, mainly social and environmental. However, there are lots of debates on the correlations between management strategies and financial performances, and also the resulting analyses have limitations statistically (Murray and Vogel 1997; Stigson 2002; González and Martinez 2004; Fassin 2005; O'Riordan and Fairbrass 2008).

On the other hand, sustainable innovation (or eco-innovation) has been widely defined as a process of creating new ideas, behavior, products and processes that contribute to a reduction in environmental burdens or to ecologically specified sustainability targets (Rennings 2000). Innovation is one of firms' primary concerns along with their performance.

[51] CSR is "A concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis." European Commission, 2010

[52] Socially Responsible Investment (SRI) integrates - apart from the financial criteria - social, environmental and/or ethical criteria into the processes of analysis, selection, and choice of investment. "The environmental, social and governance stakes (ESG) may affect the performance of investment portfolios in different degrees according to the company, economic sectors, regions, classes of assets and the term of investment". VIGEO Group, 2010

Furthermore, innovation is a sustainable engine for firm's growth and survival (Porter and Linde 1995). Today CSR without considering innovation is no longer viable in the long term (Grayson, Rodriguez et al. 2008). This chapter investigates the influence of firms' sustainable management on the innovation activities and performance of the firm.

In addition, various theories demonstrate that voluntary activities such as ISO 14001 or ISO26000[53] are not directly under the control of individuals, so environmental and social stewardship cannot directly induce firms' participation (Castka and Balzarova 2008; Heras-Saizarbitoria, Molina-Azorín et al. 2011). However, it is possible for consumers with "Social Responsibility" preferences to induce the production of social-friendly activities through the marketplace. If there is sufficient demand for CSR, firms can stand out through social responsible changes in production processes or product characteristics (Alberini and Segerson 2002).

For example, (Heras-Saizarbitoria, Molina-Azorín et al. 2011) try to find the relationship between ISO 14001 certification and financial performance with the purpose of emphasizing whether better performance is caused by the beneficial effects of ISO 14001 or caused by selection-effects where better performance induces accreditation. Using a multivariate panel data analysis, the results show that firms with a better than average performance have a greater tendency to pursue accreditation but there are no improvements in performance with certification. (Link and Naveh 2006) also shows that ISO 14001 helps firms to reduce the negative impact of their business activities on the environment as well as improving their business performance.

By using the 619 multinational firms listed on the DJ STOXX 600 and MSCI World indices, this study introduces an empirical model according to their industry sectors, regions, and firm characteristics such as size and age. Based on the analysis, we identify the relationship between CSR and innovation activities of firms which can be an answer to research questions: (i) what drives CSR behavior of firms? (ii) What are the different effects of explorative investment (long-run return) and exploitative investment (short-run return) on the CSR behavior of firms?

[53] ''International Guidance Standard on Social Responsibility—ISO 26000'' is established in 2005, the SR Working Group contains about 500 nominated experts from 99 ISO member countries and 33 liaison organizations, which represent 6 main stakeholder groups (Industry, Government, Consumer, Labor, Non-Governmental Organizations and Service, Support, Research and Others). Hence, ISO26000 is an international standard for SR in future.

We assume that innovative investment is to prepare tomorrow's profits not only considering investments in technology and in R&D, but also dealing with sustainability to human, social, environmental, technical, and economic investments. In particular, this chapter advocates a new approach to incorporate sustainability with innovation strategies by taking into account voluntary sustainable activities not just for investors, but also for other shareholders including communities firms serve.

The findings of this study could provide a comprehensive understanding on the effect of sustainable management strategies on the innovation and performance of firms. This chapter is organized as follows: section 2 illustrates the theoretical background of this study, while section 3 presents the model and data used in this study. Section 4 states the estimation results and discussion. Finally, section 5 sets out the main conclusions and implications.

4.2 Theoretical Background

4.2.1 Corporation social responsibility (CSR)

The concept of the corporation social responsibilities (CSR) has been a topic of intense controversy and interest over the last three decades (Jamali 2008). In particular, the debates for the proliferation of different CSR conceptualizations are an outgrowth. In various ways, CSR terms have been defined from the narrow economic angle of filling up shareholders' wealth (Friedman 1967)[54] to a broader economic angle such like ethical and legal issues (Carroll 1979) including outstanding corporate citizenship (Hemphill 2004).

These variations are based on differing fundamental assumptions about what CSR entails and where a stockholder of CSR is embedded. Until now, there exists a significant disagreement about the meaning of terms, and how, or why it needs to be implemented (Stigson 2002; Welford 2004). Although no formal definition of the CSR concept has been agreed upon, there are common definitions that have become rather well used. This chapter prefers the definition used by the European Commission's definition of CSR, i.e., "A concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis." (2010).

Basically, the CSR is based on the concept of shareholder theory. Stakeholder, acting whether formally or not, individually or not, is a core factor of firm's external environment that has a positive or negative effect on the organization (Murray and Vogel 1997). The main challenge for businesses is the task of identifying to whom they are responsible and how far that responsibility extends.

There are several approaches which explain the voluntary CSR behavior of firms and the CSR field. Those fields present not only a landscape of theories but also a spreading of approaches, which are controversial, mixed and vague (Garriga and Melé 2004). There are four major classifications of CSR background theories and related approaches: (i) instrumental theories, in which the firm is regarded as merely an instrument for wealth creation, and the social activities of firms are only a means to accomplish economic outputs (Friedman 1970; Windsor 2001; Jensen 2002); (ii) political theories, which related with the

[54] "There is one and only one social responsibility of business: to use its resources to engage in activities designed to increase its profits so long as it stays within the rules of the game, which is to say, engages in open and free competition, without deception or fraud."

power of firms in society and a responsible use of their power in the political scheme (Davis 1960; Davis 1967; Wood and Logsdon 2002); (iii) integrative theories, in which the firm pursues the satisfaction of social demands (Sethi 1975; Wartick and Mahon 1994; Mitchell, Agle et al. 1997; Mitchell, Agle et al. 1997) and (iv) ethical theories, based on firms' ethical responsibilities to society (Freeman 1984; Gladwin, Kennelly et al. 1995; Mele 2002; Phillips 2003). In sum, these four dimensions of CSR theories are concerned with profits, political performance, social demands and ethical values. Therefore, it is necessary to check the relationship between the business and society with the integrate view of four dimensions.

Recently, the CSR is getting more consideration as a strategy for firms' to follow. They focus on this to satisfy their shareholders and to present a positive image of the company to the market. Management strategies with shareholder value objectives have been remarkably successful for all sizes of businesses for the past fifty years (Grayson, Rodriguez et al. 2008). For example, a lot of literatures examine voluntary environmental management or compliant efforts of firms, defined as environmentally friendly actions with voluntary participation (Lyon and Maxwell 2004). Various theories support that policy or regulation gives incentives and opportunities to accomplish these objectives through voluntary environmental friendly management (Jones 2010).

Theory and empirical evidence show the efficiency and cost advantages of voluntary action have a positive relation with numerous external or internal factors of corporation (Porter and Linde 1995; Lyon and Maxwell 2004; Khanna, Koss et al. 2007). From this, we try to clarify the relationship between these voluntary behaviors and the investment activities of firms according to their characteristics and industry sectors. After that, we will find which factors drive the CSR behavior and whether the CSR can prompt the innovative investments of firms or not.

Hypothesis 1: There is a significant relation between CSR and innovative investments.

4.2.2 CSR and innovation

Voluntary social responsibility management has a potential role in the financial performance of firms. Many studies suggest that profitability is reduced by the higher production costs of environment related management (Klassen and McLaughlin 1996; Russo and Fouts 1997). A theoretical model proposes the links between environmental management and improved future financial performance, as proxy by stock market performance. The linkage to firm performance is empirically identified with financial event methodology and archival data of environmental and financial performance. Although a lot of studies find the linkage between financial performance and CSR concepts, most of debates regarding these correlations are not solved (Murray and Vogel 1997; Stigson 2002; González and Martinez 2004; Fassin 2005; O'Riordan and Fairbrass 2008).

While the relationship between the management strategy of corporations and social issues has a well-established academic background, the role of innovation in effecting that relationship has received relatively less attention (Pavelin and Porter 2008). However, sustainable innovation (or eco-innovation) has been widely and broadly defined as a process of creating new ideas, behavior, products and processes that make a reduction in environmental burdens or ecologically specified sustainability targets (Rennings 2000).

In other words, innovation is one of firms' primary concerns along with their performance. Recently, (Grayson, Rodriguez et al. 2008) suggest a integrated concept of corporate sustainability (S2AVE), which places an emphasis on innovation as the means to add value while considering the environment and society at large. Furthermore, innovation is a sustainable engine for firm's growth and survival. (Labatt 1997) reports on the role of innovation in corporate responsiveness to environmental issues and (Pavelin and Porter 2008) also explore, given innovation, the impact factors of the probability that the innovation brings a reduction of environmental impacts, and the strength of this effect.

(Vollebergh and Kemfert 2005) show that in order to transform the impacts of its business activities on society, a firm should appropriately adapt innovative production processes or product design. Jaffe and Palmer (1997) identify the impacts of environmental regulations on the innovative activities in specific industry, and show a significant positive relationship between compliance costs and R&D investments. (Klaassen, Miketa et al. 2005) also report on the positive influence of government support on the innovation for wind turbine farms in

Denmark, Germany and the U.K.

For the study of the detailed innovation type, recently there are some papers. (Blättel-Mink 1998) suggests that environmental innovations could contain the creation and introduction of new products (environmental technologies), new system and new market as well as very wider the introduction of ecological classifications in managerial strategies. These various types of improvement clearly induce a creative and thorough transformation of the innovation (radical/product innovation) rather than just replacement or incremental/process innovation.

(Hellström 2007) analyses environmentally sustainable innovation (eco-innovation) from the perspective of existing theories of innovation, in order to investigate dominant structures of such innovations and current weaknesses of firms resources. They estimate the type and mode of innovations (radical or incremental & component or architectural) in terms of Schumpeterian. However, the result of empirical estimation to what extent such innovation actually takes place is not clarified with firm level data. This chapter investigates the influence of firms' sustainable management on the innovation activities of firms. Indeed, we examine innovation based on a framework that distinguishes the factors necessary to explore and exploit innovations.

Hypothesis 2: There are significant different effects of explore and exploit investments on the CSR activities of firms.

4.3 Empirical Analysis

4.3.1 Previous empirical studies

Recently, there have been empirical studies which have considered voluntary environmental behavior and performance. (Cetindamar and Husoy 2007) have tried to shed some light on why firms adopt environmentally social responsible behavior and what impact such adoption has on their performance. Using a survey which is conducted among Global Compact (GC) participants, they found that companies have complex and multiple reasons for adopting environmentally responsible behavior and that ethical issues and economic reasons co-exist. In terms of performance, the firm receives both ethical and economic benefits from participation in the GC.

(Heras-Saizarbitoria, Molina-Azorín et al. 2011) also empirically explore the relationship between better performance and the beneficial effects of ISO 14001. They suggest that ISO 14001 causes improved financial performance. With a sample of 186 industrial companies', (González-Benito and González-Benito 2005) analyze the linkage between environmental pro-activities of firms and business performance. They show that environmental management can provide competitive opportunities and advantages for companies. (Khanna and Damon 1999) identify the motivations for voluntary participation in the 33/50 Program and the resulting impact of the program on the toxic releases arid economic performance of firms in the US chemical industry. The paper shows that voluntary participation led to a statistically significant decline in toxic releases. Table 4-1 shows the summary of previous studies linking environmental issues with performance.

4.3.2 Data

The data of this study is collected from the following two sources. First, we adopt the Vigeo database to measure corporate social responsibility. Vigeo is the leading European extra financial rating agency; it evaluates the CSR performance and risk factors on Environmental, Social and Governance (ESG) criteria of European firms listed on the DJ STOXX 600 and MSCI World indexes (Cavaco and Crifo 2010).

Table 4-1 Summary of previous studies linking environmental variables to performance

Study	Sample	Environmental variables	Y	Major findings
(Hart 1997)	127 US firms in SIC listed in S&P 500	Emission reductions based on TRI from the IRRC Corporate Environmental Profile data	ROA, ROE, return on sales (ROS)	Pollution prevention activities have a (+) influence on financial performance within 1~2 years. ROE takes longer to be affected.
(Russo and Fouts 1997)	243 US firms (several sectors)	Environmental ratings (FRDC): compliance, expenditures, waste reduction	ROA	(+) impact of environmental performance on ROA.
(Klassen and McLaughlin 1996)	69 US firms in the furniture industry	Environmental technology portfolio	Manufacturing performance measures	(+) impact of environmental technology portfolio on manufacturing performance.
(Christmann 2000)	88 US chemical companies	Envir. Management "best practices": use of pollution prevention technology (PPT)	Cost advantage (perceptual measures)	(+) effect of proprietary PPT innovation.
(Khanna and Damon 1999)	123 US firms in the chemical industry	EPA's Voluntary 33/50 Program (emissions of toxic chemicals)	ROI	Statistically (-) impact on the current ROI.
(González-Benito and González-Benito 2005)	186 Spanish firms (chemical sector 63) (electronic-electric, 96) (furniture, 27)	27 environmental management practices	ROA	Environmental management can bring about competitive opportunities for companies. Some environmental practices produce (-) effects.
(Wagner 2005)	Firms from four European countries in the pulp and paper manufacturing sector	Input-oriented index (energy and water input) and output oriented index (SO2 NOx and COD emissions) of environmental performance.	ROCE, ROE and ROS	A largely (-) relationship between the output-based index of environmental performance and financial performance. For the input based index, the relationship is generally non-significant.
(Link and Naveh 2006)	77 ISO 14001 certified organizations in Israel	ISO 14001 rules, policies and procedures. Emission of pollutions, use of recycled materials and other environmental aspects	Gross profit margin	The higher the standardization, the better the environmental performance. Environmental performance does not influence business performance.
(Heras-Saizarbitoria, Molina-Azorín et al. 2011)	ISO 14001 certified organizations in 268 Spanish firms	ISO 14001 certified dummies	ROA, Sale growth	The firms with better than average performance have a greater propensity to pursue accreditation.

Vigeo measures companies' CSR performance on the 6 broad domains[55]: Human Rights, Environment, Human Resources, Business Behavior, Corporate Governance and Community Involvement. As shown in Table 2, we also restrict our analysis to six detailed CSR related questionnaires[56] which appear to be more complementary to CSR activities of firms because all criteria in each of the CSR areas are accumulated for each sector. This leads to a trade-off effect between the sub-questionnaires of each CSR area.

The other data source is Thomson DataStream which offers firms' specific financial information. With the help of the list of the Vigeo survey data (which had 1435 observations in 2009), this study generates a new list, matching the financial data of Thomson DataStream[57]. Consequently, we use a total of 619 firms. Table 4-2 demonstrates the detailed definition and descriptive statistics of the variable used in the analysis.

As mentioned by (Tirole and Bénabou 2010), it is worth taking into account relative performance between industries. (Pavelin and Porter 2008) also investigate the influence of innovation on the relationship between corporate strategy and social issues and find a diverse range of the effects of industrial sectors on the determinants of the probability that the innovation brings about reduced environmental impacts. By using 8 industry variables[58], we try to identify the specific industry effect on the CSR behavior of firms and investment activities. To consider the regional characteristics, we also employ three representative continental variables such as the EU, Asia Pacific and North American.

[55] Each of survey questions is scored on a scale from 0 to 100, representing the level of a firm's CSR engagement and management of associated risks. A score of 0 shows little evidence of commitment (poor to very poor guarantee of risk management), 30 means an initiated commitment (poor to moderate guarantee of risk management), 65 means a consolidated commitment (reasonable guarantee of risk management) and a score of 100 shows an advanced commitment (social responsibility objectives actively promoted). Points given for each question are then consolidated through a system of weighted averages to give an overall score for each criterion and each domain (out of 100).

[56] HR23 (Responsible management of restructurings), HR24 (Career management and promotion of employability), CS22 (Sustainable Relationship with suppliers), CIN11 (Promotion of social and economic development), CIN21 (Contribution to general interest causes), CIN22 (Social impacts of company's products and services)

[57] Thomson Reuters Datastream is the world's largest financial statistical database which is covering an unrivalled wealth of asset classes, estimates, fundamentals, indices and economic data. This dataset offers more than 140 million time series, over 10,000 data types and over 3.5 million instruments and indicators.

[58] IT, BT, ENERGY, MANUFACTURE, BDTRANS, FORESTWATER, RETAIL, SERVICE

Table 4-2 Description and statistics of variables

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
lcapex	log (Capital expenditure)	618	13,060	1,540	8,691	17,376
lrnd	log (R&D expenditure)	616	11,973	1,927	4,443	16,373
lage	log (2009-founded year)	619	4,185	0,825	0,693	6,497
lemployees (SIZE)	log (Number of employees)	603	9,920	1,297	5,733	14,068
lsales	log (Sales)	619	16,058	1,308	11,236	19,947
lebitda	log (Earnings Before Interest, Taxes, Depreciation and Amortization)	594	14,117	1,368	8,742	18,262
lev	log (Enterprise value)	618	16,070	1,282	12,136	20,235
lshareholders	log (Share holders equity)	609	15,290	1,223	10,201	18,755
lhrtscore	log (Human Rights total score)	619	3,588	0,409	1,099	4,511
lhrscore	log (Human Resource total score)	599	3,086	0,756	0,000	4,394
lenvscore	log (Environment total score)	604	3,226	0,704	0,000	4,263
lcsscore	log (Business Behavior (C&S) total score)	619	3,635	0,343	2,197	4,317
lcinscore	log (Community Involvement total score)	606	3,474	0,591	1,099	4,500
lcgscore	log (Corporate Governance total score)	619	3,396	0,916	0,000	4,443
lhr23score	log (Responsible management of restructurings)	180	3,142	0,732	1,386	4,419
lhr24score	log (Career management and promotion of employability)	507	3,182	0,673	0,693	4,369
lcs22score	log (Sustainable Relationship with suppliers)	83	3,141	0,595	2,303	4,190
lcin11score	log (Promotion of social and economic development)	619	3,588	0,409	1,099	4,511
lcin21score	log (Contribution to general interest causes)	269	3,512	0,631	1,946	4,500
IT	Software & IT Services, Technology-Hardware, Telecommunications	619	0,168	0,374	0,000	1,000
BT	Health Care Equipment & Services, Pharmaceuticals & Biotechnology	619	0,128	0,334	0,000	1,000
ENERGY	Energy, Mining & Metals, Oil Equipment, Electric & Gas Utilities	619	0,141	0,348	0,000	1,000
MANUFACTURE	Aerospace, Automobiles, Mechanical Components & Equipment, Chemicals, Heavy Construction, Industrial Goods, Electric Components & Equipment	619	0,231	0,422	0,000	1,000
BDTRANS	Building Materials, Transport & Logistics	619	0,032	0,177	0,000	1,000
FORESTWATER	Forest Products & Paper, Waste & Water Utilities	619	0,023	0,149	0,000	1,000
RETAIL	Beverage, Food, Specialized Retail, Tobacco	619	0,089	0,285	0,000	1,000
SERVICE	Banks, Broadcasting & Advertising, Publishing, Business Support, Financial, Hotel, Leisure Goods, Luxury Goods & Cosmetics, Travel & Tourism	619	0,082	0,275	0,000	1,000
EU	European Union	619	0,409	0,492	0,000	1,000
Asia Pacific	Asia Pacific	619	0,333	0,472	0,000	1,000
North America	North American	619	0,258	0,438	0,000	1,000

4.3.3 Variables

With these data sets, we set up three equations to analyze the general relationship between investment activities and CSR behaviors. Our empirical analysis is a robust regression to find the correlation between the investment activities and environmental behavior of firms. In here, we explore whether higher innovative investment or better performance is due to the social beneficial effects of CSR behavior or due to selection-effects where better performance or higher innovative investment precedes accreditation. To find the effect of six CSR activities on two types of investments (*lcapex* and *lrnd*), we consider firm characteristics such as age of firms (*lage*), size of firms (*lemployees*), sales (*lsales*), operating profit (*lebitda*), enterprise value (*lev*), and shareholder's effect (*lshareholder*). When checking the correlation between explanatory variables, the existence of a high degree of correlations is identified. As a result, we take into account a robust regression to control heteroscedasticity. η_n denotes a distribution which follows the normal distribution.

$$\begin{aligned} lcapex_n &= CSR_n x_1 + lage_n \gamma_1 + lemployees_n \gamma_2 + lsales_n \gamma_3 + lebitda_n \gamma_4 \\ &+ lev_n \gamma_5 + lshareholders_n \gamma_6 + D.Industries_n \delta_1 + D.Region_n \delta_2 + \eta_n \end{aligned} \tag{4-1}$$

where x_n is a vector of the CSR related variables affecting investments. $D_Industries_n$ and D_Region_n are the industry and region dummy variables. To examine the CSR effect on each of investment activities, we also use research and development expenditure (*lrnd*) as our dependent variable in eq. (4-2). The propensities of firm's investments can be different according to firms' strategies, behavior and governance. Therefore, this study identifies the effect of CSR on the investment characteristics of firms. Based on survey data from 88 chemical companies, (Christmann 2000) also indicates that capabilities for process innovation and implementation are complementary assets moderating the relationship between best practice and cost advantage, which is a significant factor in determining firm performance.

$$lrnd_n = CSR_n x_1 + lage_n \gamma_1 + lemployees_n \gamma_2 + lsales_n \gamma_3 + lebitda_n \gamma_4$$
$$+ lev_n \gamma_5 + lshareholders_n \gamma_6 + D.Industries_n \delta_1 + D.Region_n \delta_2 + \eta_n \quad (4\text{-}2)$$

Finally, we estimate the effects of firms' investment activities on the CSR behaviors using the 6 Vigeo items (*lhrtscore, lhrscore, lenvscore, lcsscore, lcinscore* and *lcgscore*) with eq. (4-3). *lhrtscore* means a firms' general respect for human rights, and *lhrscore* indicates a firms' support for their labors and working conditions. *lenvscore* shows the environmental consideration of firms' business strategy and organization, and *lcsscore* is the sustainable business behaviors for customers and suppliers. Lastly, *lcinscore* shows micro level openness of firms to the communities, and *lcgscore* means the contribution of shareholders to corporation governance.

$$lCSR_n = lcapex_n x_1 + lrnd_n x_2 + lage_n \gamma_1 + lemployees_n \gamma_2 + lsales_n \gamma_3 + lebitda_n \gamma_4$$
$$+ lev_n \gamma_5 + lshareholders_n \gamma_6 + D.Industries_n \delta_1 + D.Region_n \delta_2 + \eta_n \quad (4\text{-}3)$$

Specifically, we consider 6 sub-questionnaires (*lhr23score, lhr24score, lcs22score, lcin11score, lcin21score* and *lcin22score*), which are more closely related to firms' shareholders oriented behaviors. These sub-questionnaires focused more on shareholder oriented CSR activities. This is because the former six general CSR indices are the summations of every sub-question which can cause a trade-off between each value (See Appendix).

Finally, this study estimates the total CSR index using principal component analysis (PCA) which is a statistical technique for analyzing the structure of interrelationships among the six CSR variables. The PCA can be used as a multidimensional measure for general forces affecting CSR activities. PCA methods make the factors more interpretable. Factors which have an eigenvalue over 1 are perceived as being adequate and therefore acceptable for analysis. Based on the eigenvalue rule, the Varimax rotation method is used to look for a linear combination of the original factors, so that the variance of the loadings is maximized (Qi, Shen et al. 2010).

4.4 Result and Analysis

Table 4-3 shows the estimation result of firms' capital expenditure (*CAPEX*), which shows that it is short-term return oriented. We compared the effects of the CSR behaviors on the firms' investments considering firm characteristics, industry and regional variables. Each column shows the separated estimations of robust regressions. The general R-squares (coefficient of determination) are about 0.82 which means there is a high degree of the model explanation. This implies that since strong linear relationships exist among variables, the firm's CSR behaviors may have a direct effect on the investment activities of firms.

This indicates that the capital expenditure amounts are positively related to size, profit and enterprise value, which are strongly connected to the financial situation of firms. However, the age of a firm is not related to its investment patterns. (Pavelin and Porter 2008) also demonstrated the positive relationship between the probability of innovation and roles for firm size using firm-level data from the UK. For the industry sectors, traditional industry sectors such as energy (*ENERGY*), building and transportation (*BDTRANS*), forest and water (*FORESTWATER*) show strong positive investment tendency for exploitative investment.

Regarding CSR related variables, we can find that the Human Resource (*lhrscore*), Environment (*lenvscore*), Business Behavior (=C&S) (*lcsscore*), and Community Involvement (*lcinscore*) have positive effects on the capital expenditure of firms, i.e., these CSR behaviors improve the likelihood of exploitative investment (short-term return). On the other hand, Human Resources (*lhrtscore)* and Corporate Governance (*lcgscore)* do not have any relationship with the short-term investment of firms. These results mean that when the firm supports their laborers, their working conditions more, and pay more attention to environmental issues such as eco-design and green product/service, it tries to focus on rather exploitative investment. Also, the integration of environmental factors in the supply chain and the contribution of shareholders to corporation governance (= micro level openness of firms to the communities) shows a positive effect on short-term investment. This result also shows that the management strategies driven by shareholder value objectives are no longer viable in the long term. Based on the resource-based view of the firm, (Russo and Fouts 1997) have shown that environmental performance and performance are positively linked using independently developed environmental ratings.

Table 4-3 Estimation results of the CSR behaviors' effect on CAPEX

Variables	Human Rights	Human Resources	Environment	Business Behavior	Community Involvement	Corporate Governance
lage	-0,029	-0,033	-0,058	-0,028	-0,033	-0,026
lemployees	0,180a	0,168a	0,172a	0,171a	0,178a	0,176a
lsales	0,258a	0,215a	0,238a	0,259a	0,256a	0,263a
lebitda	0,241a	0,230a	0,217a	0,239a	0,234a	0,243a
lev	0,188a	0,188a	0,179a	0,187a	0,185a	0,186a
lshareholders	0,240a	0,272a	0,262a	0,242a	0,249a	0,246a
lhrtscore	0,085					
lhrscore		0,156a				
lenvscore			0,174a			
lcsscore				0,175c		
lcinscore					0,096c	
lcgscore						0,006
IT	-0,243b	-0,258b	-0,254b	-0,251b	-0,273a	-0,240b
BT	-0,517a	-0,477a	-0,497a	-0,547a	-0,507a	-0,519a
ENERGY	0,700a	0,656a	0,696a	0,699a	0,708a	0,692a
MANUFACTURE	0,013	-0,024	-0,012	-0,008	0,007	0,011
BDTRANS	0,431b	0,414b	0,408b	0,420b	0,447a	0,425b
FORESTWATER	0,709a	0,658a	0,660a	0,714a	0,703a	0,726a
RETAIL	-0,212b	-0,200c	-0,197c	-0,199c	-0,227b	-0,221b
SERVICE	-0,250c	-0,308b	-0,289b	-0,280c	-0,263c	-0,251c
EU	0,206a	-0,251a	0,118	0,203a	0,192a	0,222a
Asia Pacific	0,378a		0,304a	0,381a	0,389a	0,373a
North America		-0,356a				
Constants	-3,337a	-2,558a	-2,843a	-3,571a	-3,272a	-3,191a
Observations	568	549	555	568	559	568
R-Squared	0,818	0,821	0,824	0,818	0,818	0,817

Note: a= p<0.01, b= p<0.05, c= p<0.1

For explorative investment, Table 4-4 shows the estimation result of the CSR behaviors' effect on the R&D expenditure which has long-term return. The general R-squares are about 0.60 which means that moderate linear relationships exist among variables, and that the firm's CSR behaviors may directly affect the R&D investment activities.

This finding implies that firm size (*lemployees*) and shareholder's equity (*lshareholders*) have a strong and positive effect on the R&D investment of firms. However, the other characteristic variables of the firm such as age (*lage*), sales (*lsales*), enterprise value (*lev*) and operating profit (*lebitda*) do not have a significant relationship with R&D investment. From this result, we find that the R&D investment is not directly affected by the financial status of firms. This is the opposite situation from the capital expenditure of firms. This supports our assumption which divides the investment activities of firms into two dimensions including explorative investment (long-term return) and exploitative investment (short-term return) on the CSR. Concerning the industry sectors, relatively new industry sectors such as the telecommunication industry (*IT*), pharmacy and medical industry (*BT*) have positive influences on exploring investment including the manufacturing industry (*MANIFACTURE*). Table 4-5 shows the rather different effects on the investment activities in each industry sector.

For the CSR related variables, we can find that just the Human Rights (*lhrtscore*) and Corporate Governance (*lcgscore*) have an effect on the R&D expenditure of firms, i.e., these CSR behaviors influence the likelihood of explorative investment (long-term return). These show that the firms' general respect for human rights has a positive effect on long-term investment, while the contribution of shareholders to corporation governance shows a negative influence on the explorative investment.

Table 4-4 Estimation results of the CSR behaviors' effect on R&D

Variables	Human Rights	Human Resources	Environment	Business Behavior (C&S)	Community Involvement	Corporate Governance
lage	0,009	0,017	0,021	0,018	0,021	0,023
lemployees	0,298a	0,280a	0,288a	0,284a	0,273a	0,284a
lsales	0,120	0,154	0,159	0,139	0,183	0,139
lebitda	0,123	0,123	0,114	0,129	0,131	0,149
lev	0,063	0,040	0,046	0,057	0,033	0,058
lshareholders	0,372a	0,371a	0,362a	0,388a	0,385a	0,373a
lhrtscore	0,305b					
lhrscore		0,150				
lenvscore			0,125			
lcsscore				0,039		
lcinscore					-0,079	
lcgscore						-0,181c
IT	1,259a	1,268a	1,249a	1,275a	1,297a	1,308a
BT	1,167a	1,177a	1,221a	1,150a	1,209a	1,129a
ENERGY	-1,532a	-1,589a	-1,581a	-1,565a	-1,598a	-1,601a
MANUFACTURE	0,440a	0,388b	0,359b	0,424a	0,420a	0,407a
BDTRANS	-1,514a	-1,541a	-1,596a	-1,544a	-1,579a	-1,563a
FORESTWATER	-2,037a	-2,025a	-2,050a	-1,978a	-1,954a	-1,987a
RETAIL	-0,585a	-0,592b	-0,695a	-0,615a	-0,623a	-0,635a
SERVICE	-0,956a	-0,994a	-1,052a	-0,963a	-0,959a	-0,934a
EU	-0,375b	-0,352b	-0,326b	-0,272c	-0,284b	-0,006
Asia Pacific			-0,038		-0,049	
North America	-0,016	0,027		0,030		0,287
Constants	-2,339a	-1,721b	-1,651b	-1,865b	-1,626b	-1,382c
Observations	567	548	555	567	558	567
R-Squared	0,600	0,601	0,606	0,597	0,600	0,600

Note: a =p<0.01, b =p<0.05, c= p<0.1

Table 4-5 The comparison of the CSR effect on exploitative investment (short-term) and explorative investment (long-term)

	[A] y=*lcapex*: exploitative investment (short-term return)						[B] y= *lrnd*: explorative investment (long-term return)					
Variables	A-(1)	A-(2)	A-(3)	A-(4)	A-(5)	A-(6)	B-(1)	B-(2)	B-(3)	B-(4)	B-(5)	B-(6)
Age												
Size	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
Sales	+++	+++	+++	+++	+++	+++						
Operating Profit	+++	+++	+++	+++	+++	+++						
Enterprise value	+++	+++	+++	+++	+++	+++						
Shareholder's equity	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
Human Rights							++					
Human Resources		+++										
Environment			+++									
Business Behavior (C&S)				+								
Community Involvement					+							
Corporate Governance												-
IT	---	--	--	--	---	--	+++	+++	+++	+++	+++	+++
BT	---	---	---	---	---	---	+++	+++	+++	+++	+++	+++
ENERGY	+++	+++	+++	+++	+++	---	---	---	---	---	---	---
MANUFACTURE							+++	++	++	+++	+++	+++
BDTRANS	++	++	++	++	+++	++	---	---	---	---	---	---
FORESTWATER	+++	+++	+++	+++	+++	+++	---	---	---	---	---	---
RETAIL	--	-	-	-	--	--	---	---	---	---	---	---
SERVICE	-	--	--	-	-	-	---	---	---	---	---	---

Note: +++ p<0.01, ++ p<0.05, + p<0.1 & --- p<0.01, -- p<0.05, - p<0.1

When we compare the significances for six CSR variables, the significant variables are exactly contrarily distributed as shown in table 4-5. As a result, respect for laborer's rights can encourage firms' R&D investment, but can also increase complexity and so a wider breadth of directors might be discouraged firm following an explorative investment strategy. (Khanna and Damon 1999) also explored voluntary participation in the 33/50 Program and estimate the impact of the program on the toxic releases arid financial performance of firms in the US. In this case, they show a statistically significant negative impact on the current return to the investment (ROI) of firms, but its impact on the expected long run profitability of firms is positive and statistically significant.

This study proposes two hypotheses; (i) there is a significant relationship between CSR and innovative investments. (ii) there are a number of significant and different effects of explore and exploit investments on the CSR activities of firms. For this, our results show significant and different effects of CSR activities on the investment strategies of firms. The six CSR behaviors show diverged effects according to the type of investment activities. For short-term and exploitative investments, CSR activities are related to human resources, the environment, business behavior (= C&S) and community involvement. On the other hand, human rights and corporate governance have a relationship with long-term oriented investment. This shows that understanding the specific connection between CSR behavior and innovative investment activities is important to set up the firms' manageable strategies.

For the effect of different types of investment on the CSR activities, table 6 demonstrates the investment activities (CAPEX and R&D expenditure) on the firms' general and specific CSR behaviors. Because of the possibility of leading having a trade-off effect between sub-questionnaires of each CSR area in the case where we use the gross CSR scores, we restrict our analysis to specific questionnaires (HR23, HR24, CS22, CIN11 and CIN21) which appear to be more complementary to the CSR activities of firms with shareholder theory. Note that all criteria in each of the CSR areas are accumulated for each sector. This leads to trade-off effects between the sub-questionnaires of each CSR area.

From these results, we can confirm that there are almost mutual effects between CSR behavior and investment activities. For example, exploitative investment (*lcapex*) has a generally positive effect on the exact same CSR variables (human resource, environment, business behavior (= C&S) and community involvement) which are already found impact factors on *CAPEX* in table 3. Explorative investment (lrnd) also shows a positive effect on

human rights and a negative relationship with corporation governance. We can also check the detailed relationship between the type of investments and specific CSR behaviors from these results. However, there is no relatively positive and significant effect of CAPEX investment on the specific CSR activities of firms, whereas the R&D investment is positively related with human rights and community involvement.

Table 4-6 Estimation results for the effect of different type of investment on the CSR activities

Y=	Human Rights	Human Resources	Environment	Business Behavior (C&S)	Community Involvement	Corporate Governance	*HR23*	*HR24*	*CS22*	*CIN11*	*CIN21*
lcapex	0,024	0,147a	0,138a	0,034c	0,055c	0,003	0,151	0,072	-0,171	0,024	0,074
lrnd	0,028b	0,045c	0,032	0,004	-0,013	-0,047c	0,092b	0,058b	-0,105	0,028b	-0,001
lage	0,032	0,096a	0,100a	0,013	0,052c	0,028	-0,148b	0,029	0,111	0,032	0,026
lemployees	-0,053c	-0,072	-0,034	0,024	0,035	0,010	0,016	-0,052	0,122	-0,053c	-0,008
lsales	0,055	0,127a	0,006	0,016	0,008	-0,003	0,038	0,051	0,237c	0,055	0,078
lebitda	0,014	0,048	0,069	0,017	0,072	0,115b	-0,185b	0,063	-0,126	0,014	0,122c
lev	-0,029	-0,072	-0,030	-0,015	-0,040	0,010	0,034	-0,014	0,135	-0,029	-0,046
lshareholders	0,039	-0,040	0,046	0,005	0,016	-0,069	-0,009	0,009	0,163	0,039	-0,081
IT	0,031	0,171	0,158c	0,080c	0,346a	0,229a	0,240	0,152		0,031	0,467a
BT	-0,058	0,059	-0,222c	0,170a	-0,003	-0,092	-0,255	-0,225c		-0,058	0,234
ENERGY	-0,080	0,070	-0,142	-0,066	-0,182c	-0,260b	-0,326	-0,075		-0,080	-0,708a
MANUFACTURE	-0,051	0,210b	0,155b	0,101b	0,027	-0,100	-0,168	0,029	-0,015	-0,051	0,188
BDTRANS	-0,068	-0,038	0,072	-0,003	-0,292c	-0,177	-0,371	-0,116		-0,068	
FORESTWATER	0,236a	0,408c	0,324	0,050	0,233	-0,157	0,849a	-0,108		0,236a	0,550a
RETAIL	-0,094	-0,103	-0,044	-0,122b	0,101	-0,112	0,051	-0,310b	-0,177	-0,094	0,385b
SERVICE	0,031	0,201	0,244b	0,184a	0,069	0,078	0,559b	0,268b		0,031	0,354
EU	0,203a	0,594a	0,471a	0,107a	0,539a	0,011	0,602a	0,428a	-0,033	0,203a	0,504a
Asia Pacific	-0,171a	-0,052	0,235a	-0,106a		-1,405a	-0,441	0,105		-0,171a	
North America					0,345a				-0,263		0,391a
Constants	2,136a	-0,370	-0,653c	2,444a	1,224a	3,519a	1,734c	0,100	-1,678	2,136a	1,001c
Observations	566	547	554	566	557	566	161	466	73	566	245
R-Squared	0,223	0,317	0,319	0,220	0,287	0,576	0,967	0,967	0,975	0,991	0,982

Note: a = p<0.01, b = p<0.05, c= p<0.1

This study also tries to create a more integrated general CSR index using the PCA method. This is then used to find the relationship between integrated CSR and certain types of investments. Basically, Vigeo's framework includes 6 evaluation fields with 37 criteria, which is a CSR evaluation based on internationally recognized standards, conventions, recommendations, statements, and guidelines from the UN, ILO, UNEP, Global Compact, OECD, etc. Therefore, each item represents the CSR principles of universal application translated into action steps for the management of corporations. On the other hand, since CSR is an integration of firms' total shareholder oriented behaviors, it is valuable to check the integrated general CSR index finding the direct relationship between total CSR activity and type of innovative investments.

The relative importance of these individual rating factors is measured through the questionnaire survey based on the score from 0 to 100. As a result of PCA, one retained factor is obtained with an eigenvalue greater than 1, capturing about 52% of the variation. We rename this factor as CSR and then try to find the relationship among CSR, CAPEX and R&D. The result in table 4-7 shows that CSR is more related to exploitative investment than explorative one. For the other variables, we can find consistent results with previous individual analysis for the relationship between six CSR ratings and type of investments.

Table 4-7 Estimation results of the CSR behaviors' effect on CAPEX and R&D

	y= CSR		y=Capex		y=R&D	
	Coef,	P>|t|	Coef,	P>|t|	Coef,	P>|t|
lcapex	0,132a	0,008				
lrnd	0,045	0,166				
csr			0,092c	0,011	0,101	0,183
lage	0,105b	0,031	-0,032	0,395	0,042b	0,578
lebitda	0,124	0,163	0,229a	0,000	0,123	0,167
lemployees	-0,091	0,166	0,163a	0,001	0,291a	0,001
lev	-0,075	0,355	0,168a	0,006	0,052	0,709
lshareholders	0,124c	0,093	0,216a	0,001	0,144	0,242
lshareholders	0,025	0,736	0,297a	0,000	0,356a	0,005
IT	0,322b	0,015	-0,267a	0,009	1,241a	0,000
BT	0,072	0,624	-0,482a	0,000	1,140a	0,000
ENERGY	-0,277b	0,049	0,686a	0,000	-1,574a	0,000
MANUFACTURE	0,153	0,173	-0,004	0,965	0,364b	0,025
BDTRANS	-0,185	0,363	0,423b	0,013	-1,578a	0,004
FORESTWATER	0,505c	0,074	0,685a	0,000	-2,063a	0,000
RETAIL	-0,152	0,360	-0,197c	0,066	-0,700a	0,003
SERVICE	0,523a	0,001	-0,311b	0,049	-1,133a	0,000
EU	-4,311a	0,000	-2,362a	0,000	-1,584c	0,074
Asia Pacific	-5,443a	0,000	-2,092a	0,000	-1,217	0,203
North America	-4,946a	0,000	-2,475a	0,000	-1,266	0,176
Obs.	533		534		534	
R-squared	0,387		0,998		0,99	
Root MSE	0,785		0,657		1,223	

Note: a =p<0.01, b =p<0.05, c= p<0.1

4.5 Conclusion and Implications

This chapter carries out an empirical analysis of the interactions between CSR practices and investment and specifically, examines the explorative investment (long-term return) and exploitative investment (short-term return). With the use of multinational firm-level data, we identify the relationship between CSR and innovation activities and find the answers to the following research questions: (i) what are the distinctive effects of explorative investment (long-term return) and exploitative investment (short-term return) on the CSR behavior of firms? and, (ii) what drives the CSR behavior of firms?

For the first question about the distinction in the effects of explorative investment and exploitative investment on the CSR behavior of firms, we identify the difference between capital expenditure and R&D expenditure. For exploitative investment (short-term return), we clarify that when the firm supports their laborers more and pays more attention to environmental issues, it tries to focus on exploitative investment. Also, the integration of environmental factors in the supply chain and the micro level openness of firms to communities shows positive effects on short-term investment.

For the explorative investment (long-term return), we find that respect for labor's rights can encourage firms' R&D investment, but a more complex and broader management structure might discourage an explorative investment strategy. When we compare the significances of six CSR variables, the significant variables are found to be exactly contrarily distributed. This implies that there is a strong relationship between these types of investments and the CSR activities. Consequently, when the firm builds their short- and long-run business strategies, the consideration of the relationship between the types of investment and CSR practice will lead to a greater synergy effect on the outcome of investments.

Concerning the firms' characteristic variables, the result also shows a significantly different effect of finance related variables on the types of investments. For example, the R&D investment is not directly affected by the financial status of firms, while the capital expenditure of firms is readily affected by sales, operating profit, and enterprise value in market, all of which are strongly connected with the financial situation of firms. The effect of each industry sector also shows that rather new industry sectors including IT and BT show a positive influence on the exploring investment, whereas traditional industry sectors including energy, industrial, etc. have strong positive tendency for exploitative investment. This

indicates that considering the different effects of specific industry sectors is of importance in order to encourage exploitative investment and explorative investment.

Finally, we identify the impact factors of general and specific CSR behaviors. From these results, we can confirm that there are almost mutual effects between each CSR behavior and investment activities. This shows that exploitative investment has positive effect on the same CSR variables which are already found impact factors on exploitative investment, and explorative investment also has positive effect on human right and negative relation with corporation governance. Indeed, we also measure the gross CSR index which contains six individual CSR fields by using PCA method.

From this, the current study demonstrates that the gross CSR is relatively more related with capex investment which has short-run and exploitative investment than R&D investment. Hence, considering each specific CSR field is important, which is more related with innovative investment with long-run and explorative investment. Therefore, the results of this study support the proposition that type of investments and corporation social responsibility have consistent and interactive relations. Overall, these findings are expected to develop implications for MNE management and research, as well as public policy.

Chapter 5. Conclusion

5.1 Summary of the Study

5.1.1 The mandatory industry policy

For the telecommunication industry, it has been just a few decades since it became universe and penetrated when we are comparing the developing timeline with other industries such as material, energy and so on. Now the effect and portion of telecommunication industry in our society is prodigious such that we cannot exemplify industries without telecommunication sector. So, the developing and proliferating of telecom industry was the top priority of policy maker.

To encourage the invest efficiency of former “natural monopoly” and diffuse the new technologies, telecommunication liberalization policies such as competition and privatizations, have implemented for last three decades in most OECD countries. Until now, this assumption is still very controversial from a theoretical point of view. From this, this study tries to shed some implication on the role of liberalization policies in determining firms’ investment activities.

Using the firm level data between 1994 and 2008, we tested assumptions in telecommunication market, where there exist competition and privatization regulations. Specifically, we consider the nature of investment and adopt more general and complemented policy. The assumption regarding Profitability effect and Operational efficiency effect related with R&D investment and network deployment allows us to decompose the investment activities of firms.

Hence, this study has two distinct contributions to the regulation and innovation in telecommunication industry. First, we consider the composition of investment (exploration vs. exploitation investment) while most of the studies dedicated to the impact of competition on innovation have focused on the level of R&D investment. We apply these concepts, "exploration of new possibilities" and "exploration of old certainties" to the relationship, R&D vs. infrastructure investment. Second, not only focusing on the impacts of single regulation but also adopting more general and complemented policy views is the other main contribution of this chapter.

With the empirical method, we try to suggest the answer to these questions; i) How do liberalization policies affect the operators' investment strategies? ii) To what extend do they affect the Profitability effect and Operational efficiency effect between exploration (R&D) and exploitation (CAPEX) investments? Based on the empirical results, we can claim that considering interaction among liberalization policies and allowing the industry characteristics are critical to determine for the Profitability effect and Operational efficiency effect and level of investments.

More precisely, there are major three findings from our analysis. First, there is a significant Profitability effect and Operational efficiency effect among firms' investment activities. If competition is induced, firms are likely to emphasize investments with exploitable characteristics which using existing knowledge and technologies to develop new products and services. Particularly in the case of privatization, firms make more investments in "exploitation of old certainties" than in "exploration of new possibilities". Second, competition effect leads to more higher influences on liberalization policies in the mobile industry than in the broadband industry. In the case of mobile industry, inter- and intra-competition highly lead firms to make short-term investments. Finally, the simultaneous implementations among liberalization policies make firms to more concentrate on the investment for developing new product and service than existed knowledge and technology.

There are some implications of this part. Firstly, the liberalization policies may weaken the firms' sustainable ability of next generation networks in long terms. However, when privatized firms adopt competition, they focus on explorable investments in new possibilities. In other words, firms seek strategies for long-term investments in the case where competition becomes severe and many dimensions are faced. Therefore, it is necessary for policy regulators to take account of the complementary among liberalization policies providing an incentive to create new knowledge and technologies.

Also, the design of liberalization policies should consider the Profitability effect and Operational efficiency effect between investments from a perspective of long term policy. Some economic theory indicate that competition is the good proficient tool at the efficient allocation of scarce resources. However, it might not be good at prompting investment of new and advanced technology, particularly when the market is dominated by former natural monopoly. In such a case, governmental leadership combined with market circumstances can attain better results more easily. It has not only allowed its priorities public but has also set up

an arena for the relevant stakeholders to achieve a mutual understanding of their relatively long term objectives. Again, such an intervention is able to be effective only in the existence of a cooperative circumstance among the related stakeholders.

5.1.2 The corporate environmentalism

The corporate environmentalism is more bilateral agreement, the terms of the agreement are determined by implementation between the regulator and the firms (Alberini and Segerson 2002). These terms include the obligations of both parties. There are typically firm's obligations involve certain restricted activities that will be undertaken. For example, the global environmental issues on climate change and with wider scope of sustainability have growing impact over the few decades on the social demand and the international political agenda and some regulations for eliminating of CO2 have changed the market mechanism and activities of corporations.

Therefore, the recognition and reaction of business leaders and consumers are turning into voluntary. CSR (Corporation Social Responsibility) and SRI (Social Responsibility Investment) are becoming globalised concepts and most multinational firms try to induce the sustainability practices to make stakeholders' satisfaction and give a positive signal to the market; the stakeholder theory (Freeman 1983; Frooman 1999). Consumers and investors also show the confidence for the corporation's social responsible activities in the market; the legitimation theory (Campbell, Craven et al. 2003; Lopez, Garcia et al. 2007).

For the firms' environmentalism behaviors, this chapter considers two major concepts. One is an environmental behavior of firms which can be represented by Carbon Discloser Project (CDP) activity. The other one is the Dow Jones Sustainability Index (DJSI) which shows firms' sustainable activities. The reason why we adopt both of these concepts simultaneously is that there are a lot of initiatives in the market as a term of firm's strategies. From this, we choose major two activities of firms' environmentalism strategies then we try to find the answer of theses research questions: i) What is the relation between voluntary activities and performance? ii) Do firm's voluntary activities in environmental and sustainable implementations induce innovation? iii) How is the nature of innovation depending on voluntary types of firm? iv) What is the link between firm characteristics and

innovation according to voluntary types?

In particular, environmental and sustainable implementations have a long-term impact on the performance and innovation of firms. The adoption or quotation of sustainable standard and environmental implementations has latent effect and it is difficult to find the causality between adoption and performance. Nevertheless, most studies only consider the existence of significant impact for performance. Innovation is the priority of firms as well as performance because it is also sustainable factor for firms' growth and survival. Therefore, we propose the each influence of environmental and sustainable behaviors on the innovation activities and performance of firms.

From these, we identify the relation between environmental, sustainable implementations and innovative activities based on the results of empirical analysis. Based on this, we can suggest the solution to research questions represented in the above parts, and then make policy implication for sustainable development. First, we can see the overall positive relation between the voluntary behaviors and firms' performance which are measured by sales of firms. Second, we find that the synchronous adoption of both behaviors induces investments than others. In detail, they have different type of investment activities. The *both* group in polluting industry is more focusing on explorative investment (R&D) and the *both* group in non-polluting group is prefer to invest in exploitative investment (CAPEX). Therefore, considering environmental and sustainable implementations simultaneously is important to focus on future challenges and is necessary to consider various factors including quality of management, corporate governance structures, reputational risks, human capital management, stakeholder relations, and corporate social responsibility. Third, the polluting industries are more emphasize on long-term investment than short-term one. Because there are more considerations, negotiators, expectations for sustainable and environmental behaviors for polluting industry, the long-term oriented innovation strategies and activities are important to firms' business of this industry than non-polluting. Therefore, the investment in innovation and consideration of the activities in innovations are necessary for sustainable development. Lastly, the effect of firms' characteristics on performance and innovation can be changed according to their heterogeneity.

Categorizing the established environmental and sustainable issues and proposing an empirical model of the links between these issues and innovation activities are another contribution of this study. In particular, we consider the concept of environmental and

sustainable implementations simultaneously, which provides the understanding on the effect of environmental and sustainable issues on the innovation and performance of firms and market. investment than short-term one. The innovation strategies and activities are important to firms' business.

5.1.3 The business-led initiatives

This chapter carries out an empirical analysis of the interactions between CSR practices and investment and specifically, examines the explorative investment (long-term return) and exploitative investment (short-term return). With use of the multinational firm-level data, we identify the relationship between CSR and innovation activities.

By using the 619 multinational firms listed on the DJ STOXX 600 and MSCI World indices, this study introduces an empirical model according to their industry sectors, regions, and firm characteristics such as size and age. Based on the analysis, we identify the relationship between CSR and innovation activities of firms which can be an answer to research questions: (i) what drives CSR behavior of firms? (ii) What are the different effects of explorative investment (long-run return) and exploitative investment (short-run return) on the CSR behavior of firms?

From the results, we find the different effects of explorative investment and exploitative investment on the CSR behavior of firms. For the exploitative investment (short-term return), we clarify that when the firm more supports their labors and more pays attention to the environmental issue, it tries to focus on rather exploitative investment. Also, the integration of environmental factors in the supply chain and the micro level openness of firms to the communities show positive effect on the short-term investment. For the explorative investment (long-term return), we find that the respect for labor's right can encourage firms' R&D investment, but more complex and boarder management structure might discourage the explorative investment strategy.

Concerning the firm characteristic variables, we also find significantly different effect of finance related variables on the types of investments. The effect of each industry sector also shows that new industry sectors show positive influence on the exploring investment, whereas traditional industry sectors have strong positive tendency to exploitative investment.

This indicates that considering the different effects of specific industry sectors is of importance in order to encourage exploitative investment and explorative investment.

Finally, we identify the impact factors of general and specific CSR behaviors. From these results, we can confirm that there are almost mutual effects between CSR behavior and investment activities. Therefore, the results of this study support the proposition that type of investments and corporation social responsibility have consistent and interactive relations. Overall, these findings are expected to develop implications for MNE(Multi-National Enterprise)s management and research, as well as public policy.

5.2 General Conclusions and Implications

To increase the cooperating effect arising from innovation activities of firms and industrial policies with voluntary or mandatory approaches, policy makers are required to understand the driving and impact factors of policy approaches. This understanding can help policy makers to decide whether or not use of such policy approach is advisable and to design the policy ensuring that it is as effective and efficient as possible. Through the theoretical and empirical analysis, this study identifies some key features that are likely to increase both the effectiveness and efficiency of industrial policies with voluntary and mandatory approaches. Consequently, the current study investigates the difference and tendency of industrial policy approaches and the type of innovation carrying out three analyses according to the mandatory and voluntary approaches.

Firstly, the mandatory approach is positive and effective to prompt or growth in telecommunication industry. In detail, there are major three findings from our analysis. First of all, there is a significant Profitability effect and Operational efficiency effect among firms' investment activities. If competition is induced, firms are likely to emphasize investments with exploitable characteristics which using existing knowledge and technologies to develop new products and services. Particularly in the case of privatization, firms make more investments in "exploitation of old certainties" than in "exploration of new possibilities". Second, competition effect leads to more higher influences on liberalization policies in the mobile industry than in the broadband industry. In the case of mobile industry, inter- and intra-competition highly lead firms to make short-term investments. Finally, the simultaneous implementations among liberalization policies make firms to more concentrate on the investment for developing new product and service than existed knowledge and technology.

Secondly, we analyze the voluntary industrial policy like the Corporate Environmentalism using CSP and DJSI activities of firms. This analyzing attempts to find the relations among voluntary activities, performance, and the type of innovation. Then we find that the overall positive relation between the voluntary behaviors and firms' performance which are measured by sales of firms, as well as the synchronous adoption of both behaviors induces investments than others. These results show that the firms' behavior is varied depending on the industry sectors, firm characteristics, and environmental and sustainable activities. Hence, our study considering the sustainable, environmental behavior and

innovation of firms can offer solution to which value for which organization. For instance, there are some difference type of firms' investment strategy according to the industries. That is, the individual groups have negative effects on the investment of new possibility (R&D) in polluting groups and the investment of maintains (CAPEX) in non-polluting industry.

Finally, using the 619 multinational, this study identify the relationship between 'Business-led Initiatives (CSR)' and innovation activities of firms. Consequently, when the firm builds their short- and long-run business strategies, the consideration of the relationship between types of investment and CSR practice will lead to more synergies effect on the outcome of investments. The findings of this study could provide a comprehensive understanding on the effect of sustainable management strategies on the innovation and performance of firms.

Through the theoretical and empirical analysis, this study identifies some key features that are likely to increase both the effectiveness and efficiency of industrial policies with voluntary and mandatory approaches. One key feature is the existence of a strong relationship between innovation and industrial policies. The explorative innovation increases the incentives for participation in long-term but also reduces the financial incentives in short-term. Considering firms' characteristics and industry sector also increases in the cooperating effect of policies and regulations. In sum, when based on the understanding and consideration on the nature of innovation and other impact factors, industrial policy can provide a mechanism for meeting industrial quality goals both effectively and efficiently.

Some researches indicate that industry policy design can contribute the efficient allocation of scarce resources. In such a case like telecommunication industry, governmental leadership combined with market circumstances can attain better results more easily. It has not only allowed its priorities public but has also set up an arena for the relevant stakeholders to achieve a mutual understanding of their relatively long term objectives. Such an intervention is able to be effective only in the existence of a cooperative circumstance among the related stakeholders. On the other parts, regulation is widely considered to be more expensive and less efficient than voluntary action making them worse than they would have been in the absence of the policy. That is, the voluntary approach is more comprehensive and have long-term effect, and the mandatory approach have intensive and short-run effect. In terms of policy makers implementation, it is necessary to consider the specific industry circumspect and characteristics to accomplish sustainable development in the society.

Résumé en français

Résumé

De manière générale, différentes approches s'offrent aux décideurs politiques lorsqu'il s'agit de promouvoir l'innovation. Pour reprendre la distinction posée par la plupart des économistes industriels, les politiques peuvent être de nature presciptive ou incitative. A travers une série d'analyses théoriques et empiriques, cette thèse identifie plusieurs facteurs clés qui déterminent l'efficacité des politiques d'innovation, que l'approche adoptée soit de nature prescriptive ou incitative. En guise de préambule, nous soulignons que les politiques mises en oeuvre constituent un déterminant fondamental des capacités d'innovation d'une industrie, notamment parce que les incitations marchandes à engager des activités de recherche fortement exploratoires sont limitées. Par ailleurs, nous signalons que la nature des politiques susceptibles de favoriser l'innovation dépend fondamentalement des caractéristiques des industries, et même des firmes, auxquelles elles sont destinées. La mise en oeuvre de politiques (incitatives ou presciptives) efficaces requiert ainsi une compréhension approfondie du secteur d'activité que l'on souhaite promouvoir et de la nature des processus d'innovation qui impliquent notamment différents types d'investissements (à plus ou moins long terme, plus ou moins risqués et plus ou moins exploratoires). Cette thèse analyse ensuite, à travers trois études de cas, l'incidence de différentes politiques (incitatives ou presciptives) mises en oeuvre dans des contextes industriels distincts. Partant de l'hypothèse selon laquelle les politiques presciptives ont un impact bénéfique sur l'innovation et le développement technologique d'un secteur à court terme mais des effects plus incertains à long terme, nous étudions l'impact des politiques de libéralisation (ouverture à la concurrence et privatisation des opérateurs historiques) qui ont été mises en oeuvre dans le secteur des télécommunications. A travers une étude économétrique portant sur un panel de 20 pays de l'OCDE sur la période 1994-2008, nous soulignons que l'impact de la concurrence sur les décisions d'investissement s'exerce à travers deux effects : l'effet «profitabilité» et l'effet «efficacité opérationnelle». Nous soulignons par ailleurs que la relation entre intensité concurrentielle et investissement varie signicativement entre entreprises publiques et firmes privées. Dans une seconde étude, nous analysons le lien entre la propension des firmes à adopter spontanément des comportements écologiques (mesurée à

partir des données du Carbon Discloser Project et du Dow Jones Sustainability Index) et la nature de leurs innovations. Ce travail fait apparaître de forte différences inter-industries et inter-entreprises mais permet de valider l'hypothèse d'une relation positive entre le niveau des investissements de R&D et la propension à adopter des comportements écologiques. Nous nous intéressons enfin à la relation entre responsabilité sociale d'entreprise et innovation. Nous utilisons pour cela le classement Vigeo que des données financières sur l'année 2009. Notre étude met en évidence une relation positive entre responsabilité sociale d'entreprise et capacité des firmes à innover. Nous interprétons ce résultat de la manière suivante : la responsabilité sociale d'entreprise conduit les firmes à réaliser des investissements non seulement de court terme mais également de long terme et à tenir compte de la complémentarité de ces investissements. La responsabilité sociale d'entreprise accroît ainsi les synergies entre les différents types d'investissement réalisés par les firmes.

Politiques industrielles prescriptives ou volontaristes

D'un point de vue théorique, la régulation est fondée sur l'idée que le libre jeu des forces du marché ne conduit pas nécessairement à une allocation optimale des ressources. La régulation est toutefois susceptible d'induire des coûts et des distorsions et le remède peut parfois s'avérer pire que le mal. Les économistes industriels cherchent donc à déterminer sous quelles conditions la régulation se traduit effectivement par une allocation plus efficace des ressources.

Il existe par ailleurs différentes formes de régulation. On peut notamment distinguer deux grandes approches : la régulation prescriptive (ou « réglementation ») et la régulation incitative (Bohm et Russell 1985). La conception des politiques et le choix des instruments constitue donc également une question fondamentale pour les économistes industriels. Cette question se pose également pour les décideurs qui peuvent choisir entre l'approche prescriptive ou l'approche incitative ou encore combiner ces deux approches (Alberini et Segerson 2002).

Les approches prescriptives et incitatives se distinguent par la capacité (ou l'incapacité) du régulateur à imposer des coûts et des contraintes aux entreprises. Dans le cadre de l'approche incitative, la régulation doit être conçue de sorte qu'il soit dans l'intérêt des firmes

d'adopter le comportement que l'on souhaite promouvoir. En d'autre termes, la contrainte de participation des firmes doit être satisfaite (Paton 2001). Le régulateur dispose d'une marge de manoeuvre plus importante dans le cadre de l'approche prescriptive : il peut imposer des coûts et des contraintes qui réduisent les profits (ou plus généralement, les « gains ») des entreprises. L'approche prescriptive traduit généralement une volonté politique tandis que l'approche incitative vise simplement améliorer le fonctionnement d'un marché. La régulation incitative peut émaner des acteurs d'une industrie. Nous parlerons dans ce cas d'approche volontariale.

L'intéret que suscitent les politiques d'innovation auprès des décideurs s'est traduit par le développement d'une littérature sur les mérites respectifs des approches prescriptives et incitatives (voir Lyon et Maxwell 1999 et Khanna 2001 pour une revue de cette littérature). Deux conclusions principales ont été mises en évidence par ces travaux : (i) l'approche incitative est généralement préférée à l'approche prescriptive car elle est moins coûteuse et plus simple à mettre en oeuvre; (ii) plus la régulation est stricte, plus ils est coûteux d'adopter un comportement conforme à cette régulation et plus les incitations des firmes à aller au delà des exigences du régulateur sont fortes (Segerson et Miceli 1998; Lyon et Maxwell, 2004).

En outre, de nombreuses études empiriques ont mis en évidence une corrélation positive entre régulation prescriptive et régulation incitative : lorsqu'ils régulent étroitement une industrie, les pouvoirs publics ne se contentent pas de fixer des règles et des sanctions mais cherchent à ce que leurs objectifs soient relayés par les comportements stratégiques des entreprises (Jones 2010).

De manière générale, la littérature souligne que les politiques prescriptives sont moins efficaces et plus coûteuses que les politiques incitatives (Segerson et Miceli 1998; Baldwin et Cave 1999). Cependant, parmi les différentes formes de régulation incitative, il a été montré empiriquement par plusieurs études que l'approche volontariale n'a généralement qu'un impact limité sur le comportement des firmes (Stigler 1971 ; Arora et Cason 1996; Videras et Alberini 2000; Khanna, Koss et al 2007). Par ailleurs, la théorie microéconomique standard peine à expliquer les motivations des entreprises à adopter des régulations sur une base purement volontariale (Paton 2001).

En matière de politiques environnementales, trois types d'approches volontariales peuvent être distinguées (Carraro et Siniscalco 1996; Lyon et Maxwell, 1999; Segerson et Li 1999; Braathen et Co-ope 2003).: «les initiatives des entreprises », « l'environnementalisme

de l'entreprise » et « l'auto-réglementation industrielle » (Alberini et Segerson 2002).[59] Parmi ces approches, notre travail se concentre sur les initiatives des entreprises et l'environnementalisme de l'entreprise.

D'un point de vue méthodologique, plusieurs études examinent les décisions des firmes en se fondant sur l'hypothèse de maximisation des profits. Cependant, d'autres travaux indiquent que l'hypothèse de la maximisation de l'utilité permet d'accroître le pouvoir explicatif des modèles (Baron, 2001;. Nakamura et al, 2001). Cette hypothèse est moins restrictive que l'hypothèse de maximisation des profits. Elle revient à supposer que les firmes cherchent à maximiser la satisfaction de leurs nombreuses parties-prenantes et permet d'expliquer pourquoi les entreprises adoptent des régulations sur une base volontariale (Khanna, 2001 ; Henriques et Sadorskry, 1996; Esty et Winston, 2006; Baron, 2001; Nakamura et al, 2001). Elle permet également de comparer les coûts et bénéfices associés aux différentes formes de régulation.

A ce jour, les travaux comparant les approches volontariales aux autres formes de régulation (régulation incitative obligatoire et réglementation) sont encore relativement peu nombreux et s'intéressent uniquement à quelques secteurs (l'énergie) ou domaines (l'environnement) spécifiques. Par ailleurs, la plupart des études consacrées à l'approche volontariale ont surtout cherché à expliquer les motivations des firmes à mettre en place de telles régulations (Paton 2001; Alberini et Segerson 2002; Khanna, Koss et al 2007.). Les quelques comparaisons existantes concluent que l'approche volontariale a un effet diffus et de long terme, alors que l'approche obligatoire a un effet intense et de court terme (Bohm et Russell 1985).

Dans une certaine mesure, il peut être avancé que ces deux approches sont complémentaires. Si les décideurs souhaitent promouvoir la diffusion rapide de technologies spécifiques ou le développement de certaines industries, la politique obligatoire sera sans doute la plus efficace. Par exemple, au cours des dernières décennies la plupart des pays de l'OCDE ont mis en place des politiques réglementaires et incitatives (privatisations, régulation pro-concurrentielle) pour stimuler le développement du secteur des

[59] « L'autorégulation peut stimuler la demande en reduisant l'incertitude sur la qualité des produits ou en assurant l'interopérabilité des produits de plusieurs entreprises. Elle peut mettre accroître le bien-être au travail en améliorant la sécurité ou d'autres dimensions de la qualité du lieu de travail. Elle peut aussi servir des causes plus stratégiques, comme la réduction de l'intensité de la concurrence (...) ». Maxwell, John W., Thomas P. Lyon, et al. (2000). "Self-Regulation and Social Welfare: The Political Economy of Corporate Environmentalism." Journal of Law and Economics **43**(2): 583-618.

télécommunications[60]. Si l'objectif du régulateur est d'infléchir à long terme le comportement des firmes, l'approche volontariste sera sans doute la plus efficace.

En somme, cette thèse vise à expliquer les motivations des pouvoirs publics et des acteurs industriels à mettre en place tel ou tel type de régulation (réglementation, régulation incitative obligatoire ou volontariale) et à étudier leurs effets sur les comportements d'investissement. Pour cela, nous assouplisson l'hypothèse selon laquelle les firmes cherchent à maximiser leurs profits et considérons plus généralement qu'elle maximisent une fonction d'utilité qui traduit les motivations des différentes parties-prenantes (actionnaires, dirigeants, clients, fournisseurs, salariés, Etat, organisation non gouvernementales).

Développement durable et innovation

Au cours des trois dernières décennies, le thème de la responsabilité sociale des entreprises (RSE) a fait l'objet d'un intérêt croissant mais a également donné lieu à de nombreuses controverses (Jamali 2008). Plusieurs définitions et tentatives de conceptualisation concurrentes ont été proposées. La conception la plus étroite consiste à supposer que la firme a pour fonction la maximisation de la richesse des actionnaires (Friedman 1967)[61]. Les conceptions les plus larges incluent les responsabilités non seulement économiques mais également sociales, juridiques et éthiques de l'entreprise (Carroll 1979). Certains auteurs parlent même de citoyenneté d'entreprise (Hemphill, 2004).

Le concept de RSE est essentiellement fondé sur la théorie des partie-prenantes (ou « hypothèse de maximisation de l'utilité des parties-prenantes »). Le terme « parties-prenantes » désigne l'ensemble des intervenants, individuels ou collectifs, qui influencent le comportement des firmes de manière officielle ou officieuse (Murray et Vogel 1997). Dans ce cadre, le principal défi auquel sont confrontés les entreprises consiste à identifier ces parties-prenantes et à déterminer quelles sont leurs réponsabilités envers elles.

Depuis quelques années, les entreprises semblent tenir davantage compte de leur responsabilité sociale. Plusieurs travaux montrent que certains objectifs en matière

[60] Voir Cambini et Jiang (2009) pour une revue de la littérature consacrée au lien entre régulation et investissement dans les t élécommunications.

[61] "Il existe une seule responsabilité sociale de l'entreprise: utiliser les ressources dont elle dispose pour s'engager dans des a ctivités créatrices de richesses, tout en respectant les règles du jeu, c'est-à-dire en s'engageant dans une concurrence ouverte et libre, sans défection ni fraude."

d'environnement ne pourront être atteint que grâce à une combinaison des approches obligatoires et volontariales (Jones 2010). Des travaux théoriques et des études empiriques montrent que les deux approches ont un impact positif, tout en soulignant les avantages de l'approche volontariale en termes de coûts et d'efficacité, notamment dans le long terme (Porter et Linde, 1995; Lyon et Maxwell 2004;. Khanna, Koss et al 2007).

Bien qu'il soit établi par de nombreux travaux que les politiques industrielles permettent d'atteindre des objectifs sociaux et environnementaux, la question de l'innovation a été relativement peu traitée par cette littérature (Pavelin et Porter, 2008). Rennings (2000) définit néanmoins l'innovation durable comme l'introduction d'idées nouvelles, de comportements, produits et procédés nouveaux qui contribuent à diminuer les coûts environnementaux.

Plusieurs travaux ont cherché à mettre en évidence l'impact de la régulation sur les « performances » des industries en matière d'écologie et de développement durable. Toutefois, l'existence d'un tel impact reste fortement débattu et les corrélations établies par les études statistiques souffrent d'un certain nombre de biais. Il convient notamment de souligner que les politiques de régulation ont un effet longitudinal et qu'il est difficile d'en mesurer l'impact, c'est-à-dire de mettre en évidence un lien de causalité entre ces politiques et les comportements des firmes. De surcroît, les effets dont tiennent compte ces travaux sont essentiellement des effets de court terme.

Sur la base des études précédentes (March 1991), la nature des investissements peut être définie comme la répartition des ressources entre la recherche exploratoire et les activités plus appliquées (ou « investissement d'exploitation »). La première renvoie aux dépenses de R&D, à la création de technologies et connaissances nouvelles, à l'innovation radicale ; les secondes désignent les dépenses en capitaux (« *capital expenditure* » ou « CAPEX ») qui consistent à exploiter les connaissances et technologies existantes et donnent essentiellement lieu à des innovation incrémentales. La recherche d'une combinaison optimale entre investissement exploratoire et investissement d'exploitation constitue une dimension essentielle des stratégies d'investissement des firmes.

Quelques travaux récents ont cherché à mettre en évidence l'incidence de la régulation sur les nature des investissements. Calderini et Garrone (2001) se sont par exemple intéressés à l'impact des politiques de libéralisation sur l'investissement des opérateurs de télécommunications. Hellström (2007) a étudié la structure des innovations environnementales.

Dans le prolongement de ces travaux, notre thèse tente d'établir une relation entre régulation et nature des activités innovantes. Nous nous intéressons plus généralement aux déterminants des comportements d'investissements et aux différents facteurs susceptibles d'exercer une influence sur les arbritages entre exploration et exploitation.

Cadre général de la recherche

Ce travail consiste à étudier et à comparer les effets de différents types de politiques industrielles sur la nature des innovations introduites par les firmes. Le cadre d'analyse sur lequel il se fonde est présenté par la figure 1-1.

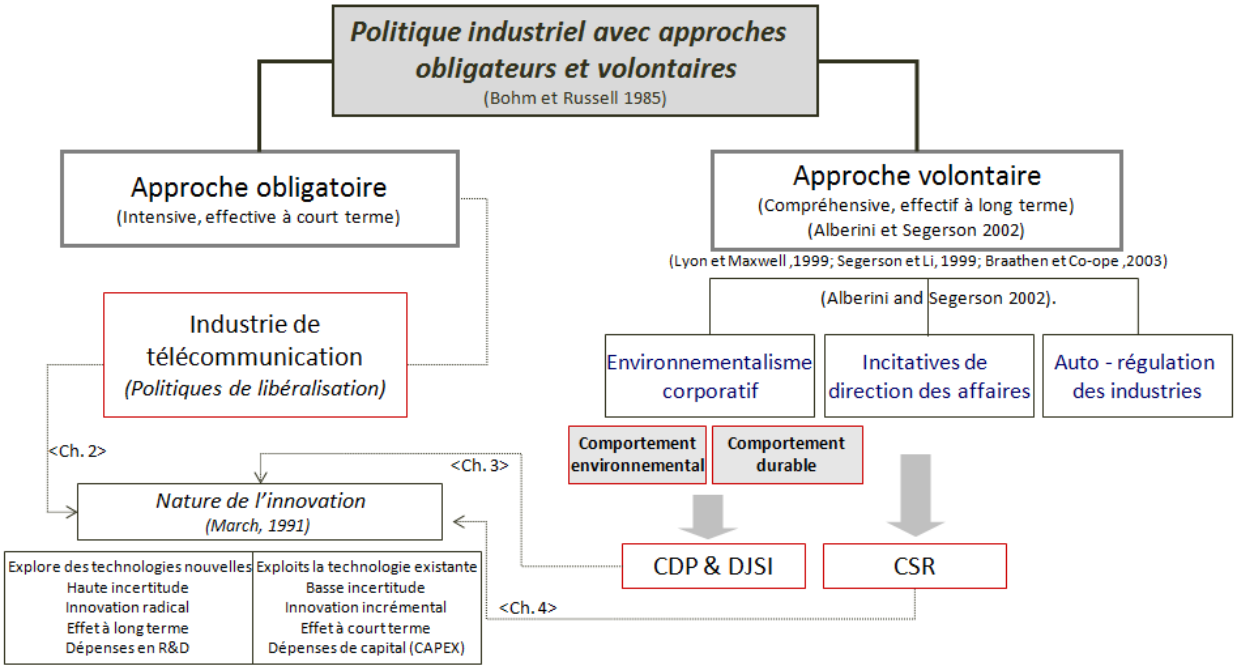

Fig. 1-1 Le diagramme schématique des approches de la politique de l'industrie

La première partie de notre travail souligne que l'approche obligatoire a un impact à court terme et est efficace pour stimuler l'adoption de nouvelles technologies et favoriser le développement d'une industrie spécifique. Dans cette partie, nous nous intéressons plus spécifiquement aux investissements des opérateurs de télécommunications. Il s'agit là d'une question essentielle dans la mesure où ces investissements ne sont pas seulement à l'origine de gains pour les consommateurs mais génèrent des externalités positives sur de nombreux

secteurs. Ils constitueraient par conséquent une source de croissance économique et d'avantages concurrentiels (Greenstein, McMaster et al 1995;. Roller et Waverman 2001; Datta et Agarwal 2004).

Dans la plupart des pays de l'OCDE, des politiques ont été mises en oeuvre pour « libéraliser » ou « déréglementer » le secteur des télécommunications. Ces politiques reposent sur un postulat qui reste largement débattu : le développement de la concurrence et les privatisations seraient par nature favorables à l'innovation.

La première partie de cette thèse consiste ainsi à évaluer l'impact des politiques de libéralisation (privatisation et concurrence) sur la nature des innovations introduites par les opérateurs de télécommunications. A travers une étude économétrique portant sur un panel de 20 pays de l'OCDE sur la période 1994-2008, nous soulignons que l'impact de la concurrence sur les décisions d'investissement s'exerce à travers deux effects : l'effet « profitabilité » et l'effet « efficacité opérationnelle ». Nous soulignons par ailleurs que la relation entre intensité concurrentielle et investissement varie signicativement entre entreprises publiques et firmes privées.

Dans la deuxième partie de cette thèse, nous analysons et comparons les effets de politiques volontariales sur l'adoption par les entreprises de comportement écologiques. Etant donné la nature de ces politiques, les effets mesurés ici sont des effets de long terme. Dans cette partie, nous nous efforçons notamment de répondre aux questions suivantes. i) Comment les politiques volontariales affectent-elles la performance des firmes. ii) Ces politiques favorisent-elles les comportements écologiques ? iii) Plus généralement, comment ces politiques affectent-elles la nature des investissements iv) Dans quelle mesure et à travers quels mécanismes les caractéristiques des entreprises influencent-elles leurs incitations à mettre en place des régulations sur une base volontariale.

La troisième partie de notre thèse s'intéresse à la Responsabilité Sociale des Entreprises et cherche à répondre aux questions suivantes. i) Quelles sont les motivations des firmes en matière de RSE ? ii) Quelle est la relation entre nature des investissementes (arbitrage exploration/exploitation) et RSE ?

Conclusions générales et implications politiques

La nature des politiques susceptibles de favoriser l'innovation dépend fondamentalement des caractéristiques des industries, et même des firmes, auxquelles elles sont destinées. La mise en oeuvre de politiques (incitatives ou presciptives) efficaces requiert ainsi une compréhension approfondie du secteur d'activité que l'on souhaite promouvoir et de la nature des processus d'innovation qui impliquent différents types d'investissements (à plus ou moins long terme, plus ou moins risqués et plus ou moins exploratoires).

A travers des analyses théoriques et empiriques, nous avons identifié quelques dimensions clés susceptibles d'améliorer l'efficacité des politiques de régulation, qu'elles soient fondée sur une approche prescriptive ou incitative, obligatoire ou volontariale.

La première partie de notre thèse souligne que l'approche obligatoire s'est avérée efficace pour promouvoir l'investissement dans le secteur des télécommunications. Plus spécifiquement, nous avons mis en évidence les trois résultats suivants. Les politiques de libéralisation affectent l'investissement des opérateurs de télécommunications à travers deux effets : l'effet « profitabilité » et l'effet « efficacité opérationnelle ». Ces effets se traduisent tout d'abord par un accroissement significatif des investissements d'exploitation, qui peut s'effectuer au détriment d'investissements plus exploratoires. Par ailleurs, la concurrence sur le marché mobile affecte davantage les stratégies d'investissement des firmes que la concurrence sur le marché fixe : qu'elle s'effectue « par les infrastructures » ou « par les services », la concurrence sur le marché mobile se traduit toujours par d'avantage d'investissement d'exploitation, ce qui n'est pas le cas de la concurrence sur le marché mobile. Enfin, la combinaison des privatisations et des politiques de régulation pro-concurrentielle amènent les firmes à privilégier l'exploitation des connaissances et technologies existantes au développement de connaissances et technologies nouvelles.

Dans une seconde étude, nous analysons le lien entre la propension des firmes à adopter spontanément des comportements écologiques (mesurée à partir des données du Carbon Discloser Project et du Dow Jones Sustainability Index) et la nature de leurs innovations. Ce travail fait apparaître de forte différences inter-industries et inter-entreprises mais permet de valider l'hypothèse d'une relation positive entre le niveau des investissements de R&D et la propension à adopter des comportements écologiques.

Nous nous intéressons enfin à la relation entre responsabilité sociale d'entreprise et innovation. Nous utilisons pour cela le classement Vigeo ainsi que des données financières sur l'année 2009. Notre étude met en évidence une relation positive entre responsabilité sociale d'entreprise et capacité des firmes à innover. Nous interprétons ce résultat de la manière suivante : la responsabilité sociale d'entreprise conduit les firmes à réaliser des investissements non seulement de court terme mais également de long terme et à tenir compte de la complémentarité de ces investissements. La responsabilité sociale d'entreprise accroît ainsi les synergies entre les différents types d'investissement réalisés par les firmes.

Résumé en coréen

많은 산업 정책 수립 시, 일반적으로 정책 입안자는 시장중심의 경제적 인센티브를 줄 수 있는 자발적인 참여 유도의 정책접근법과 조세 및 할당제 등을 포함하는 다소 강제적인 정책접근법을 고려할 수 있다. 역사적으로 많은 산업 경제학자들은 어떤 정책 도구를 사용하여 가장 효율적인 정책을 구성할 것인지에 대해서 많은 연구를 해왔으며 대표적으로 그 정책구성은 규제기반의 정책 틀과 인센티브기반의 틀로 축약되어 왔다.

이론적 설명 및 실증적 분석을 통해서 본 연구는 두 가지 정책접근의 효율성과 효과를 유발하는 요인을 규명하고자 한다. 특히 본 연구는 혁신과 산업정책간의 강한 상호 관계의 존재를 찾고자 하였고 기업의 투자활동을 탐험적 투자 (Explorative investment)와 활용적 투자 (Exploitative investment)로 세분화 하여 산업 정책 및 규제와의 관계를 분석하였다. 그 결과 우리는 탐험적 투자의 경우 좀 더 장기적인 관점에서 기업의 자발적 참여를 유도하는 정책과 관련성이 높았으나 단기적인 면에서는 기업의 재정적 투자 인센티브의 감소를 보였다.

기업의 개별적 특성 및 특정 산업분야를 고려하는 것도 정책 및 규제와 강한 상호작용 효과를 보였다. 이런 결과들은 특정 산업의 특성 및 기업의 개별적 특성을 고려한 정책이 적절히 실행된다면 정책의 실현 및 수준에 있어서 효율성을 추구할 수 있음을 제시한다. 또한 이런 상황에 대한 이해는 정책입안자가 특정 산업에 대한 정책을 수립할 경우 그 효과를 최대화 할 수 있는 정책설계를 할 수 있도록 한다. 이런 정책적 시사점 제시를 위하여 본 연구는 다소 규제적이거나 기업의 자발적 참여를 유도하는 다양한 산업 정책과 탐험적 또는 활용적 투자 형태를 동시에 고려하여 실증적인 연구결과를 바탕으로 각 영향요인 및 상관관계를 분석하고자 한다.

첫째, 다소 강제적인 산업 정책의 경우 새로운 기술의 확산을 특정 산업에서 단기적으로 촉진시키고 기술을 발전시킬 수 있다라는 전제로 우리는 정보통신 산업의 경우를 분석하였다. OECD 20 여 개국의 1994 년부터 2008 년의 기업기반 자료를 이용하여 우리는 국영기업의 민영화 과정 및 경쟁 도입의 효과가 기업의 특성에 따라 각각 다르며 기업의 투자 형태에도 다르게 영향을 미치는 것을 알 수 있었다.

두 번째로 기업의 좀 더 자발적인 참여를 유도하는 정책실현 (Corporate Environmentalism) 의 예로서 본 연구는 대표적인 기업의 에너지 환경관련 활동지표인 탄소배출 보고서 (the Carbon Discloser Project Rreport) 와 다우존스 지속가능지수 (Dow Jones Sustainability Index) 를 이용하여 기업의 투자 활동에 대한 영향을 분석하였다. 분석 결과는 기업의 투자 활동이 분명하게 기업이 속한 분야, 기업의 규모 및 사이즈와

같은 특성에 따라 장, 단기적으로 달라짐을 보여준다 .

마지막으로 본 연구는 기업의 가장 자발적인 참여 (Business-led Initiatives) 를 유로하는 청책의 예로서 기업의 사회적책임과 기업의 투자형태에 대한 분석을 제시하였다. 프랑스의 대표적인 기업의 사회적 책임 6 분야 (인권, 인적자원관리, 환경친화활동, 지역사회 참여, 기업지배구조) 에 대한 평가를 하는 Vigeo 기관의 2009 년 보고서를 바탕으로 기업의 투자형태가 기업의 사회적 책임활동에 따라서 어떤 상호관계를 갖는지를 분석하였다. 결과적으로 기업이 장-단기적인 사업전략을 수행시 기업의 투자활동과 사회적 참여활동의 적합한 상쇄효과를 고려해서 반영한다면 좀 더 투자의 효율성을 높일 수 있음을 알 수 있었다.

세가지의 실증분석 사례를 바탕으로 본 연구는 산업정책 환경과 기업의 특성이 각각 기업의 탐험적 투자와 활용적 투자에 어떤 영향을 가지고 있음을 제시 하였고 이런 포괄적인 접근법과 세부적인 상관관계에 대한 이해는 정책입안자의 정책설계와 기업의 사업전략 수입에 중요한 정보를 제공할 수 있다. 또한 이런 효율적인 정책이 실행되고 기업의 투자활동도 촉진된다면 사회적 후생 측면에서도 기여할 수 있다고 본다.

주요어: Business-led Initiatives, Corporate Environmentalism, Nature of Innovation, Innovation, Liberalization Policies, Sustainability

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Appendices

Ch. 2.2.1

In this section, we use this framework to identify the impact of competition on investment by a private and a government-owned incumbent operator. In section 2.2.1.1, we suppose that the private incumbent maximized its profit. For government-owned incumbent in section 2.2.1.2, we consider two sub-cases, the case of a firm which is maximizing the social welfare at the competition and the investment stage, and a firm which is maximizing its profit at the competition stage, but maximizes the welfare at the investment stage. Finally we discuss the results considering different forms of competition in section 2.1.1.3.

2.2.1.1 The case of a private (profit-maximizing) incumbent

When the incumbent is privatized, we assume that it maximizes its profit function. It is competition on the retail market with entrant which is also a private profit-maximizing firm. In this case, the equilibrium qualities are the solutions of the system $\begin{cases} \dfrac{\partial \Pi_I}{\partial q_I} = 0 \\ \dfrac{\partial \Pi_E}{\partial q_E} = 0 \end{cases}$ where Π_E and Π_I are respectively given by eqs. (2-2) and (2-3) of section 2.2.1.

Under the assumption that both firms are active in the market (q_I , q_E ≥ 0)[62], the equilibrium quantities and the corresponding prices are

$$q_I = p_I = \frac{2x_I - x_E + A}{3} \tag{2-5}$$

$$q_E = p_E = \frac{2x_E - x_I + A}{3}. \tag{2-6}$$

[62] This condition is $x_I \in \left[\dfrac{x_E - A}{2}, 2x_E + A \right]$.

As standard, the intensity of competition can be measured by the price - marginal cost margin. Since we normalized the marginal cost to zero, the price p_I can be used as an indicator of the intensity of competition faced by firm *I*. From eq. (2-5), we see that the higher is the quality of the service provided by the entrant, the lower is the equilibrium price set by *I* ($\frac{\partial q_I}{\partial x_E} < 0$), and thus the higher is the intensity of competition faced by *I*.

The incumbent's equilibrium profit Π_I^* is found by introducing the equilibrium prices and quantities (eqs. 2-5 and 2-6) in eq. (2-3). The quality of service chosen by *I* is derived from the first order condition

$$\frac{\partial \Pi_I^*}{\partial x_I} = \frac{4}{9}\left[2x_I - x_E + A\right] - \gamma x_I = 0 \tag{2-7}$$

which is solved for

$$x_I^* = \frac{4(A - x_E)}{9\gamma}, \tag{2-8}$$

under the assumption that the second order condition $\frac{\partial^2 \Pi_I^*}{\partial x_E \partial x_I} < 0 \Leftrightarrow \gamma > \frac{8}{9}$ is satisfied. As x_I^* decrease when x_E increases, firm *I*'s investment $\left(\frac{\gamma x_I^*}{2}\right)$ decreases when x_E increases, and as a consequence when the competition intensity increases.

Referring to the effects described in the introduction of section 2.2.1, we can interpret this result as follows: the Schumpeterian effect dominates the "Escape competition" effect. In fact, firm *I* decides to marginally increase the quality of its service if the difference between the before and after profits, and the marginal increase (i.e. the "marginal incentive to invest) is higher than the corresponding increase in the investment cost (γx_I).

The marginal incentive to invest can be written $\pi_I(\overline{x_I}) - \pi_I(\underline{x_I})$ where $\pi_I(x_I) = p_I \cdot q_I$ and $\overline{x_I} = \underline{x_I} + \varepsilon$ where with ε infinitesimal, i.e. $\frac{\partial \pi_I}{\partial x_I} = \frac{\partial q_I}{\partial x_I} \cdot p_I + \frac{\partial p_I}{\partial x_I} \cdot q_I$. From Eq. (2.5), we know that $\frac{\partial q_I}{\partial x_I}, \frac{\partial p_I}{\partial x_I} > 0$. Consequently, the marginal incentive to invest is always

positive and the impact of an increase in the quality of service on the revenue π_I can be decomposed into two positive effects: the "price effect" $\frac{\partial p_I}{\partial x_I} \cdot q_I$ and the "quantity effect" $\frac{\partial q_I}{\partial x_I} \cdot p_I$.

The variation of the marginal incentive to invest with respect to the QoS of the entrant is $\frac{\partial^2 \pi_I}{\partial x_E \partial x_I} = \frac{\partial^2 q_I}{\partial x_E \partial x_I} \cdot p_I + \frac{\partial q_I}{\partial x_I} \cdot \frac{\partial p_I}{\partial x_E} + \frac{\partial^2 p_I}{\partial x_E \partial x_I} \cdot q_I + \frac{\partial p_I}{\partial x_I} \cdot \frac{\partial q_I}{\partial x_E}$. From eq. (2-5), we know that $\frac{\partial^2 q_I}{\partial x_E \partial x_I} = \frac{\partial^2 p_I}{\partial x_E \partial x_I} = 0$. Thus $\frac{\partial^2 \pi_I}{\partial x_E \partial x_I} = \frac{\partial q_I}{\partial x_I} \cdot \frac{\partial p_I}{\partial x_E} + \frac{\partial p_I}{\partial x_I} \cdot \frac{\partial q_I}{\partial x_E}$. As $\frac{\partial q_I}{\partial x_E}, \frac{\partial p_I}{\partial x_E} < 0$ (eq. 2-5), $\frac{\partial^2 \pi_I}{\partial x_E \partial x_I} < 0$: the marginal incentive to invest decreases when x_E increases, and as a consequence when the competition intensity increases. This result can be explained as follows: the raise in the revenue resulting from an increase in the quality x_I is lower when x_E increases, because the quantity effect $\left(\frac{\partial q_I}{\partial x_I} \cdot p_I\right)$ is lowered by a decrease in price $\left(\frac{\partial^2 p_I}{\partial x_E \partial x_I} < 0\right)$ and the price effect $\left(\frac{\partial p_I}{\partial x_I} \cdot q_I\right)$ is lowered by a decrease in quantities $\left(\frac{\partial^2 q_I}{\partial x_E \partial x_I} < 0\right)$.

2.2.1.2 The case of a government-owned incumbent

In this part, it can be assumed that government-owned incumbents are welfare-maximizing firms in section 2.2.1.2.1. However, in most cases, incumbent operators are partially government-owned. Moreover, they operate on competitive markets. In this context, it is uncertain that these companies will be pure welfare-maximizes[63] and it may be more realistic to assume that these companies mimic the behavior of their private competitors in their routine decisions such as setting quantities but are subject to political pressure for welfare maximization in their investment decisions. In section 2.1.2.2.2, we assume that public incumbent operators adopt this kind of "hybrid behavior".

2.2.1.2.1 Welfare-maximizing firm

In this case, we suppose that the entrant maximizes its profit, whereas the incumbent maximizes the social welfare. Thus first order conditions used to determine the equilibrium quantities are thus $\frac{\partial W}{\partial q_I} = 0$ and $\frac{\partial W}{\partial q_E} = 0$. From eqs. (2-1), (2-2) and (2-4), we find

$$q_I = A + 2x_I - x_E \tag{2-9}$$

and

$$q_E = x_E - x_I \tag{2-10}$$

The corresponding prices are

$$p_I = 0,\ p_E = x_E - x_I \tag{2-11}$$

However, this result only applies for $x_E \geq x_I$ (case 1), i.e. if the entrant has higher QoS than the incumbent. As this assumption is very restrictive, the case where $x_I > x_E$ (case 2) must also be taken into consideration. In this case, we have

[63] See e.g Caves, D. W. and L. R. Christensen (1980). "The Relative Efficiency of Public and Private Firms in a Competitive Environment: The Case of Canadian Railroads." The Journal of Political Economy **88**(5): 958-976., p. 959: "There is no clear consensus as to whether public firms facing competition behave more like their private counterparts or more like their noncompetitive government counterparts".

$$q_I = A + x_I \tag{2-12}$$

$$q_E = p_E = p_I = 0\,. \tag{2-13}$$

In case 1, we find $x_{I,1}^* = \frac{(A-2x_E)}{\gamma-3}$. The second order condition $\frac{\partial^2 W}{\partial x_I^2} < 0$ is satisfied for $\gamma > 3$, and $x_E \geq x_I$ is true if and only if $\gamma \geq 1 + \frac{A}{x_E}$ ($1 + \frac{A}{x_E} > 3$ since $1 + \frac{A}{x_E} = 3 + \frac{A-2x_E}{x_E}$ and $A - 2x_E > 0$). In case 2, we find $x_{I,2}^* = \frac{A}{\gamma-1}$. The second order condition $\frac{\partial^2 W}{\partial x_I^2} < 0$ is satisfied for $\gamma > 1$, and $x_I \geq x_E$ is true if and only if $\gamma < 1 + \frac{A}{x_E}$. As a consequence, for $\gamma \in \left]1;\, 1 + \frac{A}{x_E}\right[$, the QoS chosen by the incumbent is $x_{I,2}^* = \frac{A}{\gamma-1}$, and for $\gamma \geq 1 + \frac{A}{x_E}$, its $x_{I,1}^* = \frac{(A-2x_E)}{\gamma-3}$.

Finally, the investment and quantity decisions of the incumbent can be described as follows. When the cost of increasing the quality is low (case 2, $\gamma < 1 + \frac{A}{x_E}$), the welfare-maximizing incumbent's QoS is higher than the QoS of the entrant, and the former decide to preempt the market for telecommunications services and to set a null price. In this case, the incumbent's investment is independent from the QoS of the entrant. When the cost of increasing the quality is high (case 1, $\gamma \geq 1 + \frac{A}{x_E}$), the incumbent does not invest much and provide a low quality service at a null price. In this case, the incumbent's investment decreases when the QoS of then entrant increases. In both cases the price of the service provided by the incumbent is zero. This result is not related to the intensity of competition faced by the incumbent but is the direct consequence of its decision the set a quantity q_I that maximizes the welfare. Consequently, when the government-owned incumbent is a welfare-maximizing firm, nothing can be said about the relationship between competition and investment.

2.2.1.2.2 Firm with hybrid behavior

As explained above a government-owned incumbent adopting a hybrid behavior, maximizes its profit at the competitive stage and maximizes the welfare at the investment stage. Thus, the equilibrium quantities and corresponding prices are the same as in section 2.2.1.1 eqs. (2-5) and (2-6). We use these prices and quantities in eq. (2-4) to compute the objective function of the incumbent at the investment stage. Under the assumption that the second order condition $\frac{\partial^2 W_H}{\partial x_2^I} < 0 \Leftrightarrow \gamma > \frac{11}{9}$ is satisfied, we derive the equilibrium QoS from the first order condition.

$$\frac{\partial W_H}{\partial x_I} = \frac{1}{9}(4A + 11x_I - 7x_E) + \gamma x_I = 0 \tag{2-14}$$

Then, we find

$$x_I^* = \frac{4A - 7x_E}{9\gamma - 11} \tag{2-15}$$

and we deduce the following result: ***If the government-owned incumbent adopts a hybrid behavior, any increase in the competition intensity decrease its investment.***

This result indicates that increase competition raises the social welfare before investment more than it raises the social welfare after investment. In fact, the incumbent with hybrid behavior decides to marginally increase its QoS if the corresponding increase in the social welfare ($\frac{\partial w}{\partial x_I}$ with $w = \pi_I + \pi_E + cs$[9]) is higher than the corresponding increase in cost (γx_I).

The marginal social incentive to invest is always positive. Indeed, we have $\frac{\partial w}{\partial x_I} = \frac{\partial \pi_I}{\partial x_I} + \frac{\partial \pi_E}{\partial x_I} + \frac{\partial cs}{\partial x_I}$. From section 2.2.1.1, we know that $\frac{\partial \pi_I}{\partial x_I} = \frac{\partial q_I}{\partial x_I} p_I + \frac{\partial p_I}{\partial x_I} q_I > 0$ since $\frac{\partial q_I}{\partial x_I} = \frac{\partial p_I}{\partial x_I} = \frac{2}{3}$. From eq. (2-6), we find $\frac{\partial q_E}{\partial x_I} = \frac{\partial p_E}{\partial x_I} = -\frac{1}{3}$, and thus $\frac{\partial \pi_E}{\partial x_I} = \frac{\partial q_E}{\partial x_I} p_E + \frac{\partial p_E}{\partial x_I} q_E < 0$.

Moreover $\frac{\partial cs}{\partial x_I} = \left(\frac{\partial q_E}{\partial x_I} + \frac{\partial q_I}{\partial x_I}\right)(q_E + q_I) > 0$ because $\frac{\partial q_I}{\partial x_I} > -\frac{\partial q_E}{\partial x_I}$. Since any increase in x_I

raises the consumers' surplus more than it reduces the profit of the entrant $\left(\frac{\partial cs}{\partial x_I} > \frac{\partial \pi_E}{\partial x_I}\right)$, the marginal social incentive to invest is always positive $\left(\frac{\partial w}{\partial x_I} > 0\right)$.

However, the marginal social incentive to invest decreases when x_E raises, i.e. when competition intensity increases. After simplifications, the variation of the marginal social incentive to invest can be written $\frac{\partial^2 w}{\partial x_E \partial x_I} = \frac{\partial^2 \pi_I}{\partial x_E \partial x_I} + \frac{\partial^2 \pi_E}{\partial x_E \partial x_I} + \frac{\partial^2 cs}{\partial x_E \partial x_I}$. From section 2.2.1.1 (see the interpretation of lemma 1), we know that $\frac{\partial^2 \pi_I}{\partial x_E \partial x_I} < 0$ (the "Schumpeterian" effect dominates the "Escape competition" effect). For the same reason, $\frac{\partial^2 \pi_E}{\partial x_E \partial x_I} = \frac{\partial^2 \pi_E}{\partial x_I \partial x_E} < 0$, $\frac{\partial^2 cs}{\partial x_E \partial x_I} = \left(\frac{\partial q_E}{\partial x_I} + \frac{\partial q_I}{\partial x_I}\right)\left(\frac{\partial q_E}{\partial x_E} + \frac{\partial q_I}{\partial x_E}\right) < 0$, and $\frac{\partial^2 w}{\partial x_I \partial x_E} < 0$ are derived. This result can be explained as follows: the higher is the contribution of q_E in the social welfare. Consequently, the negative impact of *I*'s investment on the consumers' surplus (i.e. the decrease in q_E) is reinforced by an increase in x_E. The higher is x_E, the lower is the contribution of q_I in the social welfare. As a consequence, the positive impact of *I*'s (i.e. the increase x_I) in is lessened by an increase in x_E.

2.2.1.3 The different form of competition in telecommunications

So far, we have assumed that the incumbent is competing with an entrant that owns an infrastructure and cannot invest to improve it. However, this representation of the competition is quite distant from those used in literature on the relationship between competition and investment in telecommunications. Previous works usually distinguish two forms of competition[64]: service-based and facilities-based competition. Service-based competition (SBC) means that only the incumbent has its own infrastructure and that the entrant needs to access this infrastructure to provide services. Facilities-based competition (FBC) implies that both the incumbent and the entrant have their own infrastructure.

2.2.1.3.1 Service-based competition (SBC)

Under SBC, the profit functions of the entrant and the incumbent are respectively

$$\Pi_E^* = (p_E - a)q_E \tag{2-16}$$

and

$$\Pi_I^* = p_I \cdot q_I + aq_E - \frac{\gamma x_I^2}{2} \tag{2-17}$$

where a is the per unit access price charged by the incumbent to the entrant. The welfare and inverse demand functions are unchanged are respectively given by eqs. (2-1) and (2-4). As firms I and E use the same infrastructure, we assume that they provide the same service $\left(x_E = x_I\right)$[65].

[64] See the table 2-A Summarized previous theoretical studies in appendix.

[65] For a model on profit-maximizing firms relaxing this assumption, see Foros, s. (2004). "Strategic investments with spillovers, vertical integration and foreclosure in the broadband access market." International Journal of Industrial Organization **22**(1): 1-24.

For the profit maximizing firm and the firm with hybrid investment behavior the equilibrium quantities derived from the first order conditions ($\frac{\partial \Pi_E^*}{\partial q_E} = 0$ and $\frac{\partial \Pi_I^*}{\partial q_I} = 0$) are

$$q_I = \frac{A + a + x_I}{3} \text{ and } q_E = \frac{A - 2a + x_I}{3}. \tag{2-18}$$

The corresponding prices are

$$p_I = p_E = \frac{A + a + x_I}{3}. \tag{2-19}$$

The access price determines the access price set by firm *I* and is thus the determinant of the competition intensity. From eq. (2-19), we find $\frac{\partial p_I}{\partial a} > 0$: the higher is the access price (i.e. the higher is the retail price set by firm *I*), and thus the lower is the competition intensity faced by firm *I*.

For the welfare-maximizing firm, the equilibrium quantities are derived from the first order conditions $\frac{\partial \Pi_E^*}{\partial q_E} = 0$ and $\frac{\partial W}{\partial q_I} = 0$, $q_I = A + a + x_I$ and $q_E = -a$. As q_E cannot be negative, the equilibrium quantities and prices are

$$q_I = A + x_I, q_E = 0, \tag{2-20}$$

$$p_I = p_E = 0. \tag{2-21}$$

As in section 2.2.1.1, when it maximizes the social welfare, the incumbent set a quantity that implies null retail prices. Moreover, the incumbent always preempt the market for the innovative service

The equilibrium QoS of the profit-maximizing incumbent is derived from the first order condition $\frac{\partial \Pi_I^*}{\partial x_I} = 0$ where q_I, q_E, p_I and p_E given by eqs. (2-18) and (2-19). In this case, we have

$$x_I = \frac{2A + 5a}{9\gamma - 2} \tag{2-22}$$

and the following property can be highlighted: ***A decrease in the access price, i.e. an increase in the intensity of service-based competition decreases the investment of the profit maximizing incumbent.***

The equilibrium QoS of the welfare-maximizing firm is derived from the condition $\frac{\partial W}{\partial x_I} = 0$ where W is defined by eq. (2-4) and where the values of q_I, q_E, p_I and p_E are given by eqs. 2-20 and 2-21. In this case,

$$x_I = \frac{A}{\gamma - 1}. \tag{2-23}$$

Since the incumbent always preempts the market for telecommunications services, nothing can be said about the relationship between competition intensity and investment when the incumbent is a welfare-maximizing firm.

The equilibrium quality of the firm with a hybrid behavior is derived from $\frac{\partial W}{\partial x_I} = 0$, with q_I, q_E, p_I and p_E given by eqs. (2-18) and (2-19). Here,

$$x_I = \frac{8A - a}{9\gamma - 2} \tag{2-24}$$

and the following property can be highlighted:

Lemma 1. ***A decrease in the access price, i.e. an increase in the intensity of service-based competition, increases the investment of the firm with a hybrid behavior.***

2.2.1.3.2 Facilities-based competition (FBC)

Competition as it was modeled in sections 2.2.1.1.1 and 2.2.1.1.2 can be considered as a particular case of FBC where the entrant cannot invest to improve its infrastructure. It also represents a case where both firms can invest but where the investment is a sequential game in which the entrant invests first. However, an important characteristic of FBC as it was defined by previous literature is that firms make their investment decision simultaneously (Gans 2001; Hori and Mizuno 2006; Vareda and Hoernig 2007; Hori and Mizuno 2009). In this framework, investment follows a logic of preemption and firms do not maximize their profit with the meaning of $\max_{x_i} \Pi_i = p_i(x_i) \cdot q_i(x_i) - c(x_i)$ but adopt the level (or, in the papers mentioned above, the date) of investment such as they win the preemption game at the lowest cost. In these models, investment can be compared to an auction and the stronger is rivalry between firms, the higher (or the earlier) is investment.

However, the concept of rivalry refers more to competition “for” than “on” the market and is not well reflected by the standard proxies for competition intensity such as the price - cost margin, the learner index or the Herfindahl-Hirschman index (HHI) (Vickers 1995). Finally, the analyses of sections 2.2.1.1 and 2.2.1.2 can be considered as an adequate representation of the effects of FBC as it has been measured by previous empirical studies.

Table 2-A The list of firms used in the empirical analysis

Number	Country	Fixed or Mobile	Name of Firms
1	Australia	F	TELSTRA CORP LTD
2	Austria	F	TELEKOM AUSTRIA
3	Canada	F	BCE (Bell Canada Enterprises)
4	Denmark	F	TDC
5	France	F	FRANCE TELECOME
6	Greece	F	HELLENIC TELECOM(OTE)
7	Hungary	F	MAGYAR TELEKOM
8	Italy	F	TELECOM ITALIA
9	Japan	F	NIPPON TELEG/TELEPH.
10	South Korea	F	KT CORP
11	Netherland	F	KPN
12	New Zealand	F	NEW TEL LIMITED
13	Spain	F	TELEFONICA
14	Switzerland	F	SWISSCOM
15	UK	F	BT GROUP
16	US	F	AT&T
17	Germany	M	DEUTSCHE TELEKOM AG
18	Japan	M	NTT DOCOMO INC.
19	South Korea	M	KT FREETEL CO
20	Sweden	M	TELIASONERA AB

(Source: the Thomson Datastream Database)

Table 3-A The frequencies of firms according to the industry sectors

	FTSE Industry Sectors	Freq.	Percent	Cum.
1	Utilities	82	7.95	7.95
2	Telecommunication Service	75	7.27	15.21
3	Materials	126	12.21	27.42
4	Information Technology	84	8.14	35.56
5	Industrials	202	19.57	55.14
6	Health Case	88	8.53	63.66
7	Financial			
8	Energy	125	12.11	75.78
9	CD (Consumer Discretionary)	117	11.34	87.11
10	CS (Consumer Staples)	133	12.89	100.00
	Total	1347	100	

Table 3-B The frequencies of firms according to the countries

	Country	Freq.	Percent	Cum.
1	Australia	20	1.94	1.94
2	Austria	1	0.10	2.03
3	Belgium	4	0.39	2.42
4	Bermuda	1	0.10	2.52
5	Brazil	13	1.26	3.78
6	Canada	44	4.26	8.04
7	Chile	1	0.10	8.14
8	China	19	1.84	9.98
9	Czech	2	0.19	10.17
10	Denmark	9	0.87	11.05
11	Finland	13	1.26	12.31
12	France	64	6.20	18.51
13	Germany	48	4.65	23.16
14	Greece	1	0.10	23.26
15	Hong Kong	9	0.87	24.13
16	India	19	1.84	25.97
17	Indonesia	1	0.10	26.07
18	Ireland	6	0.58	26.65
19	Israel	2	0.19	26.84
20	Italy	19	1.84	28.68
21	Japan	131	12.69	41.38
22	Korea	13	1.26	100.00
23	Luxembourg	2	0.19	41.57
24	Mexico	7	0.68	42.25
25	Morocco	1	0.10	42.34
26	Netherlands	25	2.42	44.77
27	Norway	7	0.68	45.45
28	Portugal	4	0.39	45.83
29	Russia	15	1.45	47.29
30	Singapore	2	0.19	47.48
31	South Africa	8	0.78	48.26
32	Spain	35	3.39	51.65
33	Sweden	15	1.45	53.10
34	Swiss	25	2.42	55.52
35	Taiwan	9	0.87	56.40
36	Thailand	4	0.39	56.78
37	Turkey	2	0.19	56.98
38	UK	97	9.40	66.38
39	US	334	32.36	98.74
	Total	1,032	100	100

Table 4-A Vigeo's detailed rating framework (6 evaluation fields / 37 criteria)

1.	Human Rights (lhrtscore)
HRts1	Respect for human rights
HRts1.1	Respect for human rights standards and prevention of violations
HRts2	Respect for human rights in the workplace
HRts2.1	Respect for freedom of association and the right to collective bargaining
HRts2.4	Non-discrimination
HRts2.5	Elimination of child labor and forced labor

2.	Human Resources (lhrscore)
HR1	Continuous improvement of industrial relations
HR1.1	Promotion of labor relations
HR1.2	Encouraging employee participation
HR2	Career development
HR2.3	Responsible management of restructurings
HR2.4	Career management and promotion of employability
HR3	Quality of working conditions
HR3.1	Quality of remuneration systems
HR3.2	Improvement of health and safety conditions
HR3.3	Respect and management of working hours

3.	Environment (lenvscore)
ENV1	Integration of environmental issues into corporate strategy
ENV1.1	Environmental strategy and eco-design
ENV1.2	Pollution prevention and control
ENV1.3	Development of « Green » products and services
ENV1.4	Protection of biodiversity
ENV2	Incorporation of environmental issues into the manufacturing and distribution of products
ENV2.1	Protection of water resources
ENV2.2	Minimizing environmental impacts from energy use
ENV2.4	Management of atmospheric emissions
ENV2.5	Waste management
ENV2.6	Management of environmental nuisances: dust, odor, noise
ENV2.7	Management of environmental impacts from transportation Environment
ENV3	Environmental consideration in the use and disposal of products/services
ENV3.1	Management of environmental impacts from the use and disposal of products

4.	Business Behavior (Customers and suppliers - C&S) (lcsscore)
C&S1	Customers
C&S1.1	Product safety
C&S1.2	Information to customers
C&S1.3	Responsible Contractual Agreement
C&S2	Suppliers and Contractors
C&S2.2	Sustainable Relationship with suppliers
C&S2.3	Integration of environmental factors in the supply chain
C&S2.4	Integration of social factors in the supply chain
C&S3	Business Integrity
C&S3.1	Prevention of corruption
C&S3.2	Prevention of anti-competitive practices

5.	Community Involvement (lcinscore)
CIN1	Impact on local communities
CIN1.1	Promotion of social and economic development
CIN2	Responsible societal behavior
CIN2.1	Social impacts of company's products and services
CIN2.2	Contribution to general interest causes

6.	Corporate Governance (lcgscore)
CGV1	Board of Directors
CGV1.1	Board of directors
CGV2	Audit and Internal controls
CGV2.1	Audit and Internal Controls
CGV3	Shareholders
CGV3.1	Shareholders' Rights
CGV4	Executive remuneration
CGV4.1	Executive Remuneration

É cole Nationale Supérieure des Mines
de Saint-É tienne

N° d'ordre : ……

Author : Yunhee KIM

Title : ***Regulation, Policies and Innovation Activities in Industries : Approaching Methods and Implications***

Speciality : Sciences and Engineering for the Environment

Keywords : Business-led Initiatives, Corporate Environmentalism, Nature of Innovation, Innovation, Liberalization Policies, Sustainability

Abstract :

In general, policymakers are often faced with a different choice, i.e., the choice between using regulation-based instruments and using incentive-based instruments, where the policy instruments could be based either on mandatory approach or voluntary approach with economic incentives in market. Historically, industrial economists have regarded the issue of policy design as the one focused primarily on the choice among alternative policy instruments, where those are generally viewed as falling into two broad categories: regulation-based instruments and incentive-based instruments. Through the theoretical and empirical analysis, this study identifies some key features that are likely to increase both the effectiveness and efficiency of industrial policies with voluntary and mandatory approaches. One key feature is the existence of a strong relationship between innovation and industrial policies. The explorative innovation increases the incentives for participation in long-term but also reduces the financial incentives in short-term. Considering firms' characteristics and industry sector also increases the synergy effect of policies and regulations. In sum, when based on the understanding and consideration on the nature of innovation and other impact factors, industrial policy can provide a mechanism for meeting industrial quality goals both effectively and efficiently. This understanding also can help policy makers to decide whether or not use of such policy approach is advisable and to design the policy ensuring that it is as effective and efficient as possible. Consequently, the current study investigates the difference and tendency of industrial policy approaches and the type of innovation carrying out three analyses according to the mandatory and voluntary approaches. With the assumption that the mandatory approach has short-run impact to prompt new technology or grow a specific industry, we firstly assess the impact of regulation, such as privatization of nature monopoly. Using the firms' data of 20 OECD countries between 1994 and 2008, we can claim that considering interaction among liberalization policies and allowing the industry characteristics are critical to determine for the Profitability effect and Operational efficiency effect and level of investments. Secondly, this study analyzes the relationship between 'Corporate Environmentalism' and composition of innovation using the Carbon Discloser Project (CDP) and (Dow Jones Sustainability Index) DJSI index data. The result shows the significant variation of firms' investment activities according to the industry sector, firm characteristics, sustainable and environmental behaviors of firms. Finally, this study identifies the relationship between 'Business-led Initiatives (CSR)' and innovation activities of firms. Using the Vigeo rating and financial data in 2009, this study shows the relationship between CSR and innovation activities of firms. Consequently, when the firm builds their short- and long-run business strategies, the consideration of the relationship between types of investment and CSR practice will lead to more synergic effect on the outcome of investments. The findings of this study could provide a comprehensive understanding on the effect of sustainable management strategies on the innovation and sustainability of firms.

É cole Nationale Supérieure des Mines
de Saint-É tienne

N° d'ordre : ……

Auteur : Yunhee KIM

Titre de la these : ***Régulation, politiques et innovation industrielle : approche par méthodes et implications***

Spécialité : Sciences et Génie de l'Environnement

Mots clefs : Autorégulation des entreprises, comportements écologiques, nature de l'innovation, innovation, politiques de libéralisation, développement durable.

Résumé :

De manière générale, différentes approches s'offrent aux décideurs politiques lorsqu'il s'agit de promouvoir l'innovation. Pour reprendre la distinction posée par la plupart des économistes industriels, les politiques peuvent être de nature presciptive ou incitative. A travers une série d'analyses théoriques et empiriques, cette thèse identifie plusieurs facteurs clés qui déterminent l'efficacité des politiques d'innovation, que l'approche adoptée soit de nature prescriptive ou incitative. En guise de préambule, nous soulignons que les politiques mises en oeuvre constituent un déterminant fondamental des capacités d'innovation d'une industrie, notamment parce que les incitations marchandes à engager des activités de recherche fortement exploratoires sont limitées. Par ailleurs, nous signalons que la nature des politiques susceptibles de favoriser l'innovation dépend fondamentalement des caractéristiques des industries, et même des firmes, auxquelles elles sont destinées. La mise en oeuvre de politiques (incitatives ou presciptives) efficaces requiert ainsi une compréhension approfondie du secteur d'activité que l'on souhaite promouvoir et de la nature des processus d'innovation qui impliquent notamment différents types d'investissements (à plus ou moins long terme, plus ou moins risqués et plus ou moins exploratoires). Cette thèse analyse ensuite, à travers trois études de cas, l'incidence de différentes politiques (incitatives ou presciptives) mises en oeuvre dans des contextes industriels distincts. Partant de l'hypothèse selon laquelle les politiques presciptives ont un impact bénéfique sur l'innovation et le développement technologique d'un secteur à court terme mais des effects plus incertains à long terme, nous étudions l'impact des politiques de libéralisation (ouverture à la concurrence et privatisation des opérateurs historiques) qui ont été mises en oeuvre dans le secteur des télécommunications. A travers une étude économétrique portant sur un panel de 20 pays de l'OCDE sur la période 1994-2008, nous soulignons que l'impact de la concurrence sur les décisions d'investissement s'exerce à travers deux effects : l'effet «profitabilité» et l'effet «efficacité opérationnelle». Nous soulignons par ailleurs que la relation entre intensité concurrentielle et investissement varie signicativement entre entreprises publiques et firmes privées. Dans une seconde étude, nous analysons le lien entre la propension des firmes à adopter spontanément des comportements écologiques (mesurée à partir des données du Carbon Discloser Project et du Dow Jones Sustainability Index) et la nature de leurs innovations. Ce travail fait apparaître de forte différences inter-industries et inter-entreprises mais permet de valider l'hypothèse d'une relation positive entre le niveau des investissements de R&D et la propension à adopter des comportements écologiques. Nous nous intéressons enfin à la relation entre responsabilité sociale d'entreprise et innovation. Nous utilisons pour cela le classement Vigeo que des données financières sur l'année 2009. Notre étude met en évidence une relation positive entre responsabilité sociale d'entreprise et capacité des firmes à innover. Nous interprétons ce résultat de la manière suivante : la responsabilité sociale d'entreprise conduit les firmes à réaliser des investissements non seulement de court terme mais également de long terme et à tenir compte de la complémentarité de ces investissements. La responsabilité sociale d'entreprise accroît ainsi les synergies entre les différents types d'investissement réalisés par les firmes.